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ABSTRACT PROCEEDINGS

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Contents

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Symposium 1: Novel technologies for enhancing rehabilitation in Parkinson's disease

S.01.1 - New Technological Approaches - feasibility and effects in advanced disease

Alice Nieuwboer [1]; Moran Gilat [1]

[1] KU Leuven

Gait and balance impairments are common among persons with Parkinson's disease (PD) and contribute to the emergence of serious disease milestones, including freezing of gait and falls. In this talk, we will discuss technology's active role in addressing Parkinson's-related gait and balance impairments when the disease has progressed. We will focus on wearable technology optimizing the uptake and adoption in real-life healthcare settings. We also recognize that there are various motor and non-motor disease characteristics that may influence the use of technology in PD. For instance, our group demonstrated that touchscreen manipulation is affected by PD, but that these issues can be improved by home-based tablet training. Next, we will discuss how exercise programs, that target compensatory networks for managing gait dysfunction, are enhanced through adaptive technology in advanced PD. Emerging approaches for managing freezing of gait will be highlighted, including the use of on-demand cueing in the home setting. We anticipate that ongoing advances in artificial intelligence, such as machine learning applications, increased automation potential, and faster signal processing will enhance technology-supported rehabilitation. In conclusion, technology has the potential to transform rehabilitation practices and create a meaningful impact on mobility in PD.

S.01.2 - Innovative technology to improve gait outcomes in Parkinson disease

Terry Ellis [1]

[1] Boston University

This presentation will focus on two types of technology to improve gait outcomes in persons with Parkinson disease. The first is an autonomous closed-loop music-based rhythmic auditory stimulation system to improve the amount, intensity, and quality of walking in the naturalistic setting. Results from recent studies applying this approach will be presented including data on feasibility, safety, usability, and effectiveness related to real-world walking outcomes. Potential applications will be discussed. Next, we will highlight emerging developments in soft robotics to prevent freezing of gait. Our wearable garment uses cable driven actuators and sensors, generating assistive moments concert with biological muscles. Small amounts of mechanical assistance augmenting hip flexion have the potential to avert freezing episodes. We will provide video demonstrations revealing applications of soft robotic apparel to prevent freezing of gait during straight line walking, turning and within personalized hot spots.

S.01.3 - A tactile cueing device to improve gait automaticity in Parkinson's disease

Martina Mancini [1], Francesca Alcala' [1], Carla Silva-Batista [1], Laurie King [1], Fay Horak [1], Pablo Burgos [1], William Liu [1]

[1] Oregon Health & Science University

Background and aim: A well-recognized hallmark of healthy walking is automaticity, defined as the ability of the nervous system to successfully coordinate movement with minimal use of attention-demanding, executive resources. It has been proposed that many walking abnormalities in people with Parkinson's disease (PD) are characterized by a shift in locomotor control from healthy automaticity to compensatory, executive control. We recently developed a personalized (triggered by the subject's own walking pattern), step-synchronized tactile stimulation on the wrists to improve the quality of gait and turning in people with PD. The purpose of the current study is to determine the effects of a novel, personalized, tactile cueing system on gait automaticity (both in the laboratory and in daily life). We hypothesized that step-synchronized tactile cueing will reduce prefrontal cortex activity while walking (laboratory) and improve gait variability (daily-life).Methods: To determine the effects of cueing, 60 participants with PD from will be randomized into one, of two, cueing interventions: 1) personalized, step-synchronized tactile cueing and 2) tactile cueing at fixed intervals as an active control group. With a first version of the tactile cueing system, we organized a focus group with 4 individuals with PD, a caregiver, and the research engineer in charge of developing the system. We collected feedback on the wearability of the device, ease of use, strength of the vibration, and whether they had additional requests for the device. A second model of the system was then developed, and it is currently being used. In the laboratory, so far 8 individuals with PD have participated in the study and wore a fNIRS cap to measure cortical activity while walking without and with the tactile cueing. In daily life, the same individuals completed 3 weeks of daily life monitoring with the tactile cueing and instrumented socks to derive quality of gait and turning. Preliminary results and Discussion: The focus group resulted in a positive discussion and as a result, the second prototype of the system included a Off/On button to temporarily turn off the tactile stimulation when needed as well as watch like band for the wrists and an enclosure to attach the system to the shoe. In the laboratory, we observed an overall reduction of the prefrontal cortex activity, and increased primary sensory cortex activity, while walking with the cueing on compared to no-cue. We are in the process of analyzing the 3 weeks of daily life monitoring.

S.01.4 - Novel technologies for enhancing rehabilitation in Parkinson's disease: A co-designed app for falls reporting in people with Parkinson’s

Rosie Morris [1], Jason Moore [1], Michael Kelly [1], Jenni Naisby [1], Jill Wales [1], Natasha Ratcliffe [2], Gill Barry [1], Annee Amjad [2], Alan Godfrey [1], Gerry Standerline [3], Elaine Webster [3]

[1] Northumbria University, [2] Parkinson's UK, [3] Person with Parkinson's

Background:Falls commonly occur in people with Parkinson’s (PwP), which lead to reduced quality of life, increased caregiver burden and increased hospital admissions. Self-report falls diaries provide the current gold standard methodology for reporting falls incidence in PwP, and are used both in research and clinical practice. Although the gold standard, the current method of falls reporting requires a significant number of resources and relies on subjective retrospective reporting. Therefore, a more cost-effective and less burdensome method of falls reporting is required. As a solution, a smartphone app to report falls events and details around the fall incident is proposed. To ensure the app is fit for purpose for the end-user, stakeholder involvement in the process is required, such as PwP, healthcare professionals and researchers. Aim: To co-design and assess usability of a smartphone app for falls-reporting alongside PwP, healthcare professionals and researchers Methods and Results:The app prototype was co-designed alongside a working group of PwP and family members/carers of PwP. An iterative process was used to design a beta-version of the app that met functionality and usability criteria. Fifteen PwP were recruited via Parkinson’s UK to take part in assessing the usability of the app. Participants downloaded the app using a step-by-step guide and used it in their daily lives for 6 months. Participants were asked to record any falls or near-misses that occurred in this time. Following completion of the study, quantitative and qualitative data was collected to determine usability and future directions of the app. Over the six-month period, 84 events were logged which included 31 falls and 53 near-misses. Using the systems usability scale, the app generated a score of 75.8%, classified as good usability. Focus groups took place in 10 PwP and 11 healthcare professionals. Discussions from the focus groups determined that the app had good usability, there was good applicability to clinical practice and the app was determined to be useful as both a self-management tool for PwP and to be used alongside healthcare professionals in clinical practice. Limitations included technological issues due to the beta-prototype. Conclusions:This study established a co-design process to design a smartphone app for use in PwP. The app was found to be a useful tool for reporting falls both amongst PwP and healthcare professionals. The app was thought to be beneficial for supporting self-management, clinical care and research outcomes. Further technological development is required to improve usability. The app has potential for use in number of clinical populations at risk of falls such as Multiple Sclerosis, Stroke and frailty.

Symposium 2: Bridging robots and humans in balance control

S.02.1 - Data-driven approaches to enhance stability with wearable robots during perturbed walking

Aaron Young [1]

[1] Georgia Institute of Technology

New advanced wearable exosuits are capable of restoring function to individuals in the older adult population by reducing the metabolic cost of walking and restoring normative biomechanics. An important function of these devices is to timely and accurately recognize user intent and optimize the control to provide biomechanically appropriate assistance across multimodal task paradigms, especially during balance-impaired situations. For balance control, key challenges in the wearable robotics community include recognizing instability fast enough to intervene and determining effective intervention strategies that generalize across both a rich variety of balance-challenging events as well as diverse array of individual users. Our research has focused on data-driven approaches using deep learning to tackle these challenges with applications in lower limb balance control wearable robots. This talk will examine approaches for AI-driven personalization of controllers to unique subjects and generalizing controllers across a rich variety of real-world tasks. We are especially interested in applying these paradigms to novel balance assessment tools and augmentation for stabilizing gait using exoskeletons, and efforts in this area will be discussed. New open-source datasets that we have generated to facilitate research in this area will also be briefly discussed.

S.02.2 - Advancing balance assessment: Technology's role in evaluating dynamic tasks like cycling

Nuria Pena-Perez [1], Christina Kohler [1], Arend L. Schwab [2], Heike Vallery [1]

[1] RWTH Aachen, [2] Delft University of Technology

Human balance is a complex process that involves posture and equilibrium control, allowing us to maintain an upright position and prevent falls. Balance impairments, which can stem from sensory issues, poor motor control, or cognitive factors (e.g., attention deficits), are common in populations such as the elderly and post-stroke patients, affecting their ability to conduct daily activities and increasing their risk of falling.Traditionally, balance has been clinically assessed via observational test protocols, sometimes supported by technology such as force plates. These assessments aim to evaluate the functional implications of balance impairments across various tasks and investigate their underlying causes. Increasingly, new technology-based assessments, such as wearables or robotic systems, are being explored to provide clinicians with objective balance measures and to help assistive devices detect balance loss across a wider range of dynamic environments. With these tools, balance assessments can now consider additional balance scenarios, such as cycling—an activity that has traditionally been challenging to study due to the risks associated with outdoor practice.This presentation will examine tools and procedures designed to identify balance deficits during standing and walking, as well as discuss how balance deficits can be identified in other dynamic tasks, such as cycling, including an overview of a novel cycling simulator.

S.02.3 - Adaptation of Center of Mass kinematics and EMG activity to exoskeleton balance support

Edwin Van Asseldonk [1], Maura Eveld [1], Herman Van Der Kooij [1]

[1] University of Twente

Single-joint lower limb exoskeleton and exosuits have a large potential to improve mobility and stability in people with neuromuscular disorders by reducing the metabolic cost of walking and supporting balance. In this talk, I will present the development of a bio-inspired exoskeleton balance controller that mimics the human neuromuscular response to perturbations and demonstrate how this controller can assist humans in keeping balance. Furthermore, I will address how humans adapt to receiving exoskeleton balance support and the time scales over which these adaptations occur. Interestingly, these adaptations also affect the human sensorimotor transformations, driving balance responses, between center of mass movements and coordinated motor responses. I will discuss the implications of these findings considering the needed training to effectively use exoskeleton balance assistance.

S.02.4 - Exoskeleton motor learning and motor control in individuals with complete spinal cord injury

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Over the past decade, wearable exoskeletons have emerged as promising powered assistive devices for individuals with motor complete spinal cord injury (SCI), enabling them to stand and walk in both clinical settings and daily life. Step initiation in most exoskeletons is triggered by a shift in body weight toward the anterolateral direction of the opposite leg. However, individuals with motor complete SCI require an intensive training period to effectively control an exoskeleton and, even after training, walking with an exoskeleton remains a challenging task. While exoskeletons restore basic motor function, most lack the ability to detect and respond to postural instability, requiring additional support such as crutches or a walker. Moreover, individuals with motor complete SCI experience partial to complete loss of somatosensory information below the injury level, which complicates step initiation and balance maintenance. As a consequence, they rely on other sensory modalities, such as visual and auditory cues. However, these cues may be unreliable in noisy or visually complex environments.One solution is sensory substitution, where lost input from one system is compensated through another sensory modality. This approach has been widely explored to enhance motor control in users of limb prostheses. A qualitative study indicated that individuals with motor complete SCI prefer vibrotactile and discrete feedback to support weight shifting and step initiation.This presentation will offer detailed insights into motor learning with wearable exoskeletons in individuals with complete SCI, including their specific needs. It will further explore how discrete vibrotactile feedback affects exoskeleton motor learning and motor control, both under typical conditions and in environments with limited visual and auditory input.

Symposium 3: Reaching Consensus on Priorities for AI Applications for Fall Risk Management

S.03.1

Conor Wall [1]

[1] Northumbria University

S.03.2 - Wearable inertial sensors for fall risk assessment in community-living individuals: Preliminary findings and insights from a systematic review and individual participant data meta-analysis

Paola Di Florio [1], Pierpaolo Palumbo [1], Jose Albites-Sanabria [1], Luca Palmerini [1], Kimberley Van Schooten [2]

[1] University of Bologna, [2] University of New South Wales

Background and aim: Falls are a major public health concern, particularly among older adults and individuals with mobility impairments. According to the World Health Organization, falls are a leading cause of injury-related morbidity and mortality worldwide, often resulting in fractures and a loss of independence. Early fall risk assessment and prevention strategies are crucial to reducing fall-related risk and improving quality of life.Novel approaches of adopting wearable sensor technology have opened new possibilities for fall risk assessment. Wearable devices, such as accelerometers and gyroscopes, can continuously monitor daily and nightly movement patterns. These sensors enable objective measurements of digital biomarkers in the domains of gait and balance both in laboratory and real-world conditions. Furthermore, integrating artificial intelligence (AI) and machine learning with wearable data results in better accuracy of fall prediction models.Various predictive models and features have been explored. However, the optimal features, algorithms, and their predictive value across different populations remain uncertain.Methods: We are conducting a systematic review and individual-participant data meta-analysis to identify available datasets for wearable inertial sensor-based fall risk assessment and to determine the most predictive features for future falls. Results: We identified 48 available datasets from 60 papers that met the inclusion criteria: each dataset included at least 20 community-dwelling individuals wearing inertial sensors and collecting fall data using a prospective design. Across 23 countries, the number of participants ranged from 21 to 32,619 (median: 144.5, total: 56,150), each wearing between 1 and 10 inertial sensors (median: 1). The follow-up period ranged from 6 to 60 months (median: 12). Twelve datasets included only real-world data, 19 included only lab tests (e.g., chair standing, walk test, TUG, balance), while 17 contained both. The number of features associated with falls was 145 from real-world data, and 123 from lab tests data (Timed Up and Go, balance, and walk test). The distributions of the sample size, study design, predictive model, population, and settings are depicted in Figure 1. Data from twenty-two datasets are being shared.Conclusions: Based on preliminary findings (fig.1), we highlight the need for (1) large, diverse datasets to ensure robust and generalizable model training; (2) integrating existing evidence and expert consensus for optimal feature selection; (3) a shift from exploratory to confirmatory studies to validate predictive models in real-world settings; (4) developing AI-driven models that are adaptable across diverse populations and capable of assessing both fall risk and the effectiveness of targeted interventions; and (5) establishing standardized evaluation frameworks to enhance reproducibility, clinical applicability, and regulatory approval of AI-based fall risk assessment tools.

S.03.3 - Towards AI-driven Personalization in Home-Based Cognitive-Motor Exergame Training for Older Adults: a Conceptual Framework

Eleftheria Giannouli [1]

[1] ETH Zurich

As populations age, the prevalence of physical frailty, cognitive decline and fall-risk continues to rise, underscoring the urgent need for accessible and personalized interventions that can be delivered beyond clinical settings. Cognitive-motor exergame training—interactive activities that integrate physical movement with cognitive tasks—offers promising benefits not only for maintaining functional independence but also for preventing falls in older adults by targeting key cognitive and motor fall-risk factors. Yet, most existing programs remain rely on static protocols with personalization requiring considerable time and expert input.In this presentation, we introduce a conceptual framework for personalized home-based cognitive-motor training that has been developed and is currently being implemented in a fully manual manner. Within the context of an international multicenter randomized controlled trial, all aspects of personalization, including participant assessment, stratification, training adaptation, and monitoring are carried out by clinicians and researchers without technological automation.Building on these insights, we then outline how artificial intelligence (AI) could enhance this framework in the future. We explore potential applications of AI to automate key elements of personalization, such as adapting training intensity and complexity based on baseline assessments, in-game performance metrics, and perceived exertion.By presenting this two-step perspective, i.e. manual implementation followed by AI-enabled possibilities, we aim to provide a structured pathway toward scalable and individualized AI-supported fall prevention. The talk will highlight practical lessons learned from manual implementation, discuss technical and ethical considerations for AI integration, and reflect on the potential of such approaches to transform care delivery for frail older adults in home and community settings.

Symposium 4: I am my environment: Pushing the theories of adaptive locomotor control

S.04.1 - Stepping intentionally: The goal-directedness of walking

Jonathan Dingwell [1]

[1] Pennsylvania State University

When we walk, we do far more than simply "take steps without falling." We walk to reach a destination, to navigate fixed (e.g., furniture) and/or moving (e.g., other people) entities in our environment, and/or to achieve other important goals (e.g., remain upright, minimize energy, etc.). We enact these movements by taking steps. Indeed, taking steps forms the most basic definition of "walking": i.e., at each step, the walker must step some finite distance (step length & width) in some finite time (step time) (Dingwell et al., PLoS Comput. Biol., 2010). Thus, we must coordinate our steps to both achieve our objectives and maintain balance. Here, I will discuss these concepts and present evidence of what stepping movements can tell us about goals people try to achieve when "just walking" and when performing complex walking tasks. I will present a theoretical framework that yields mathematical models of goal-directed stepping in the sagittal (Dingwell et al., PLoS Comput. Biol., 2010) and frontal (Dingwell & Cusumano, PLoS Comput. Biol., 2019) planes. I will show how we use these to test falsifiable a priori hypotheses about how humans do (or do not) control their stepping movements. This framework extends to demonstrating how walkers make lateral maneuvers like lane changes (Desmet et al., PLoS Comput. Biol., 2022) and to walking on continuously winding paths (Render et al., J. Biomech., 2025). I will also discuss how the step-to-step regulation of where a walker steps is independent of the biomechanical / neuromechanical process by which those individual steps are executed (Patil et al., J. Roy. Soc. Interf., 2024): i.e., these principles apply to any biped (human, bird, robot, model, etc.). Lastly, for humans, I will argue that

this hierarchical control structure that arises from our conceptual framework of stepping regulation is consistent with the neurophysiological architecture of perception–action processes responsible for human motor performance (Drew & Marigold., Curr. Opin. Neurobiol., 2015).

S.04.2 - An ecological perspective on the interplay between the observer and the environment in controlling and adapting locomotion

Michael Cinelli [1]

[1] Wilfrid Laurier University

Affordances (opportunities for action) are starting point for ecological study of what humans perceive, what they learn and know, and how they decide to act (Turvey 1992). An affordance is the concept that shows a strong reciprocal relationship between the observer and the environment and the relationship between the mind and body. Such that, individuals must have the ability to use the resources within the environment to modulate locomotion in accordance with the changes of the environment. Additionally, online adaptive locomotion suggests that observers directly perceive affordances within the environment in relation to their body's size and capabilities and act accordingly. Visual information about an environment and knowledge about one's own capabilities allows individuals to perceive which actions are possible. Changes to an individual's body (i.e., aging, disease, injury, athletic training, etc.) may alter their action capabilities and therefore the individual must retune their perception of affordances to fit the environment. Using gap crossing studies in real world and virtual environments challenge individuals' perception-action integration capabilities, such that their perception of passability affects their crossing behaviours. If an individual perceives a gap as 'not passable', they must adapt their gait (speed or choose a new path) or their body configuration (shoulder rotation). However, the specific optical variables that specify if a gap is passable and whether the accuracy of the variable is affected by changes to an individual is not fully understood. Analyzing gaze behaviours, manipulating visual information, and changing properties of gap while measuring gap crossing behaviours have shed light on perceptual information needed to directly affect affordances.

S.04.3 - Adaptive locomotor control in populated environments

Anne-Hélène Olivier [1], Julien Pettré [2]

[1] University of Rennes, [2] INRIA, Rennes University

Navigating public spaces is a daily activity that requires the generation of locomotor movement while accounting for our goals, individual characteristics, and the presence of other people in the environment. To successfully interpret and interact with the surrounding social context, pedestrians must integrate multisensory information with both verbal and non-verbal communication cues. This ability allows them to infer the intentions of nearby individuals, anticipate their movements, and adapt their own behavior accordingly. A comprehensive understanding of the mechanisms governing these interactions is essential to addressing major societal challenges. From health and road safety to computer science, this knowledge supports advancements such as the assessment and training of functional abilities to promote autonomy, the design of inclusive urban spaces that ensure harmonious coexistence among different users, and the development of realistic crowd simulations to populate virtual worlds. This presentation delves into adaptive locomotor control in populated settings, with a particular focus on collision avoidance tasks. Drawing on experiments involving dyadic pairwise collision avoidance and crowd navigation in both real and virtual environments, it emphasizes the role of anticipated collision risk—defined by predicted crossing distance and time to collision—as a central control variable in social navigation. Evidence will be presented through behavioral variables, including pedestrian trajectories and gaze activity in relation to the interaction neighborhood. Considerations regarding the generalizability of these findings across different populations will also be discussed. The talk will also explore future directions for assessing physical collision risk in complex social environments.

S.04.4 - Conceptualizing Visuo-locomotor adaptive control

Bradford Mcfadyen [1], Anne-Hélène Olivier [2]

[1] Université Laval-Cirris, [2] University of Rennes

Following the first three presentations, this supplementary talk will attempt to conceptualize visuo-locomotor adaptive control by combining two recent models from the literature (Maffei et al., 2017, Proc Biol Sci; Yang et al., 2023, Front Comput Neurosci) that use an Active Inference framework. The active Inference framework assumes that action manifests predictions through a perceptual inference of sensory input using a generative model of beliefs about future states and policies to minimize surprise during such action. This talk is founded in the idea that the individual is in a symbiotic relationship with their environment and thrives by combining proactive and rapid reactive control in order to maximize negentropy (i.e., opposing entropy to minimize system disorder) all based on the senses as the primary intermediary for both perception and action. The conceptual hybrid model, while still under development (BJ. McFadyen/A-H. Olivier), is intended to further catalyse discussion with both the symposium panelists (S. Rietdyk and L. Vallis) and the audience.

Symposium 5: Worth the Effort? Rethinking Best Practices for Co-Developing Technology-Enhanced Training Approaches

S.05.1 - Key methodological learnings from 'Brain-IT' on personalized exergame-based training with biofeedback breathing in neurocognitive disorders

Eling De Bruin [1], Patrick Manser [2]

[1] OST St.Gallen & IBWS ETH, [2] Karolinska Institutet

INTRODUCTION: Effective measures for slowing disease progression in mild neurocognitive disorder (mNCD) are warranted. Physical training, ideally with integrated cognitive tasks (motor-cognitive training), may represent the predominant non-pharmacological intervention to mitigate cognitive decline in mNCD and is recommended for secondary prevention.OBJECTIVES: We outline the development steps and some key findings regarding the process of creating an innovative intervention approach. We then critically reflect on key methodological learnings from the 'Brain-IT' project that co-designed, developed, and evaluated an individually tailored training concept for secondary prevention of mNCD.METHODS: We methodologically refined the Multidisciplinary Iterative Design of Exergames - Framework integrating recommendations from the UK Medical Research Council guidance. Main methodological novelty was the introduction of a preparatory phase dedicated to focusing and guiding co-design through determination of a set of design requirements based on the integration of the findings from three pillars. These three pillars included: (1) existing empirical scientific evidence; (2) research on the perspectives from individuals with mNCD; and (3) multidisciplinary healthcare professionals and experts from the exergaming industry.RESULTS: Applying this methodology resulted in a novel training concept targeting relevant mechanisms of action to alleviate the pathological state in mNCDs by combining exergame-based training with integrated adjunctive neuromodulation techniques (Vagus nerve stimulation via heart rate variability biofeedback breathing). 'Brain-IT' training was feasible, usable, safe, and highly accepted by mNCD older adults. We confirmed efficacy of 'Brain-IT' training in improving global cognitive performance as well as immediate and delayed verbal recall. The training could effectively slow down cognitive decline in comparison to usual care and 55 % of participants showed clinically relevant improvements.CONCLUSION: While the methodology effectively guided our iterative co-design, development, and evaluation, our most important methodological learning was that the contextual phase did not sufficiently consider requirements of involved healthcare institutions on an organizational level. We propose that the elaboration of design requirements be extended to implementation requirements to align the subsequent "generative" (co-design) and development with the needs of healthcare institutions. This to ensure all relevant aspects facilitating implementation, scalability, and sustainability are considered. Moreover, we identified the need for: (i) more specific recommendations to harmonize interests of different contributors; (ii) clarifying the level of involvement of different interest holders, and (iii) harmonizing the interpretation and implementation of the recommended methodological steps.

S.05.2 –

S.05.3 - Co-develop-IT^2: co-design, development, and evaluation of serious individually tailored technology-enhanced training approaches - methodological guideline development study

Patrick Manser [1], Lotte Hardeman [2], Andreas Wallin [3], David Moulaee Conradsson [1], Breiffni Leavy [1], Franziska Albrecht [1], Melvyn Roerdink [2], Jean-Jacques Temprado [4], Eling De Bruin [5], Erika Franzén [1]

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INTRODUCTION: Applying digital health technologies (DHTs) for health promotion and disease prevention is recommended by official bodies like the World Health Organization. User-centered co-design with patient and public involvement (PPI) is considered best practice for developing such interventions. While well-established frameworks are available to broadly guide such procedures, there is a need to better focus and guide the co-design process by preceding contextual research. Moreover, more specific guidance on additional methodological steps for the validation of DHT components and to facilitate their implementation, scalability, and sustainability would benefit the research community.OBJECTIVES: We present a consensus-based refined methodological guideline (called Co-Develop-IT2) that delineates best practices for each step along the way of collaboratively contextualizing, co-designing, developing, and evaluating (gamified) DHT-enhanced training approaches.METHODS: The Co-Develop-IT2 guideline was developed through biweekly meetings of the authors between August 2024 and February 2025, combined with written elaboration, feedback, and revisions between the meetings to gradually develop a consensus on the best practice recommendations.RESULTS: The Co-Develop-IT2 guideline consists of eight phases. It is aimed at multidisciplinary teams of experts coordinating projects on serious DHT-enhanced training concepts and related DHTs. It is applicable to any type(s) of end-user(s), exercise type(s), intended context(s) of use (e.g., primary healthcare, telemedicine, community health services), and overarching goal(s) (e.g., health promotion, primary through tertiary disease prevention). The guideline refines previous methodological frameworks and introduces five distinct preparatory phases preceding generative co-design and development. These novel phases are dedicated to (i) harmonizing interests and clarifying the level of involvement of all contributors (particularly between research, industry, healthcare, and end-users), (ii) aligning co-design procedures with expectations and requirements of relevant interest holders, (iii) collaboratively delineating clear strategies to monitor project progression, and (iv) facilitating implementation, scalability, and sustainability of the solutions to be

developed.CONCLUSION: Concerns have been raised about whether the costs of collaborative research practices outweigh the benefits for health research. With the Co-Develop-IT2 guideline, we make a first proposal on best practice recommendations for how participatory research and PPI may be efficiently implemented to benefit the establishment of DHT-enhanced training concepts. We advocate for continued refinement and consolidation of the guideline to help advance the field towards finding a good balance between the benefits and increased costs of collaborative research practices to getting the most out of such research projects for advancing health research.

S.05.4 - Park-MOVE: Moving towards precision rehabilitation through co-design, development and evaluation of an exergame-based training concept for individuals with Parkinson's disease

Breiffni Leavy [1], Andreas Wallin [2], Patrick Manser [1]

[1] Karolinska Institutet, [2] Karolinska Institute

INTRODUCTION: Innovations in digital health technologies have attracted significant interest as tools to advance healthcare. In people with Parkinson's disease (PwPD), exergame-based training has shown particularly promising for preventing disease progression. The Co-Develop-IT2 guideline proposes new best practice recommendations for each step along the way of collaboratively contextualizing, co-designing, developing, and evaluating digital health technologies enhanced training approaches specifically.OBJECTIVES: In this presentation, we will outline and reflect on whether the application of the Co-Develop-IT2 guideline is feasible to apply and effective in guiding a project aimed at iteratively co-design and develop a novel individually tailored technology-enhanced training concept for PwPD.METHODS: According to the Co-Develop-IT2 guideline, the project will be structured in 8 phases. In this presentation, we will focus on phases 0 - 4. Phase 0 was dedicated to building a project framework, identifying and recruiting relevant interest holders to participate in a project reference committee, and collaboratively agreeing on specific project sub-goals and feasibility progression criteria to justify proceeding to the next phases. Phase 1 involved identifying existing guidelines and evidence-based recommendations for the overall goals of the project and/or principles or frameworks that the project can build upon. This is achieved through a narrative synthesis of literature. As a next step, the groundwork for the co-design and development process will be elaborated based on the integration of the findings from three pillars: narrative synthesis of published scientific evidence together with perspectives from the intended primary end-users (PwPD, planned), as well as perspectives from intended secondary end-users and other relevant stakeholders (ongoing). RESULTS: As of today, we are implementing phase 0 to 3 of the Co-Develop-IT2 guidelines. We have put together a core project team and a project reference committee and are currently working on agreeing on project goals and progression criteria. We have synthesized the literature and are now performing focus groups interviews with secondary users and other relevant stakeholders, e.g., healthcare

professionals, relatives, and industry representatives. Semi-structured interviews with PwPD are planned for the fall. CONCLUSION: Until now, the Co-Develop-IT2 guideline has given structure and guidance to the projects, although, minor adaptions have been necessary within the framework of the guidelines. The guideline appears to fulfil its main purpose of giving guidance in establishing digital health technologies enhanced training concepts, albeit flexible enough to adapt to different contexts and conditions.

S.05.5 - Co-development of augmented-reality home-based motor-cognitive exercises for individuals with Parkinson's disease

Melvyn Roerdink [1]

[1] Vrije Universiteit Amsterdam

INTRODUCTION: The rising prevalence of chronic conditions, such as Parkinson's disease, and the growing demand on the healthcare system underscore the need for accessible and innovative care solutions. One way to improve accessibility to treatment is through home-based interventions that augment in-clinic care. In this regard, digital health technologies that allow for remote supervision of home-based interventions are promising tools to improve accessibility of, and adherence to, treatment.OBJECTIVES: In this presentation, we will reflect on the development of augmented-reality exercises, and the potential merit of the Co-Develop-IT2 guidelines for further development of motor-cognitive exercises within an established public-private partnership between the Vrije Universiteit (VU) Amsterdam and Strolll Limited.METHODS: The Co-Develop-IT2 guideline outlines 8 phases. This presentation will focus on the integration of phases 0 and 1 in the further development of motor-cognitive exercise. To implement the guidelines' recommendations in phase 0, we will establish a new workflow, dividing the overall project goal into manageable subgoals and (re-)defining the role of the core project team and interest holders' representatives. In phase 1, we will narratively synthesize the evidence-based recommendations for motor-cognitive training as one of the core pillars informing the subsequent phases.RESULTS: As part of phase 0, the roles of the core project team and other interest holders were thoroughly discussed, harmonized and documented. The project was guided by shared decision-making of the core project team and interest holders' representatives in every phase. As part of phase 1, we established a collaboration between researchers and researcher-clinicians of VU Amsterdam, KI Stockholm, ETH Zurich, RWTH Aachen University and USR Milano to narratively synthesize the evidence-based recommendations for motor-cognitive training, to identify research and implementation gaps, and to elaborate on how these could be resolved. These recommendations will guide future co-development.CONCLUSION: The Co-Develop-IT2 guideline has provided structured guidance on the involvement and harmonization of the core team and other multidisciplinary interest holders, although some modifications were needed to meet with the already established working dynamics of the core team in previous projects.

Symposium 6: Leveraging peripheral stimulation strategies for neuromodulation of reactive balance responses

S.06.1

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S.06.2 - The priming effects of mechanical vibrations on trip-like stance perturbations in healthy adults

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Background and Objective: Mechanical vibration affects balance and gait, with its impact varying based on intensity and timing (1). Perceptual vibrations negatively impact steady-state gait by altering gait kinematics, such as increasing hip and ankle flexion. However, these responses may enhance clearance during trip-like perturbations. This study, therefore, investigates the priming effects of mechanical vibration on clearance, stability, and compensatory mechanisms of trunk and lower limbs during forward balance loss.Methods: Twenty healthy young adults (13 females, 24 ± 5 years) received perturbations while standing a treadmill (ActiveStep treadmill system) to induce forward balance loss (backward acceleration, 21 m/s^2, 0.02 m displacement). Prior to balance loss, participants received three randomly distributed vibration conditions on their recovery stepping leg: no vibration, and vibration of the triceps surae (ankle), or quadriceps (quads) at 60 Hz for 3 minutes. Recovery responses were recorded using the Qualisys motion capture system to assess measures related to clearance, stability, and compensatory kinematics. Outcome measures included step length and height, the center of mass relative to base of support (COMx) at lift-off and touchdown, sagittal trunk and lower limbs angles (2). Linear mixed models with Holm-adjusted posthoc comparisons evaluated the vibration effects.Results: The analysis (Figure 1) showed that ankle and quads vibration compared to no vibration significantly increased step height (Quads: 0.028m, SE=0.007, $p<0.001$; Ankle: 0.026m, SE=0.006, $p<0.001$) and positioned the CoMx (Quads: 0.118, SE=0.047, p=0.028; Ankle: 0.096, SE=0.045, p=0.034) and trunk forward (Quads: 2.762°, SE=0.890, p=0.002; Ankle: 2.723°, SE=0.848, p=0.002) at lift-off. At touchdown, the position of CoMx (estimate=0.126, SE=0.043, p=0.006) and trunk (estimate=4.505°, SE=1.263, $p<0.001$) remained forward after ankle vibrations, while lower limb angles only altered after quadriceps vibration (Thigh: 3.075°, SE=1.299, p=0.035; Shank: -2.30°, SE=0.818, p=0.009; Foot: -3.352°, SE=1.255, p=0.015). Step length did not differ between conditions. Conclusion: Vibratory priming of the triceps

surae and quadriceps muscles resulted in a more anterior loss of balance shown by a forwardly shifted, more flexed upper body position during lift-off – consistent with previous research (4). These postural changes are associated with reduced stability and a higher risk of falls, particularly during trip-like perturbations (3). This suggests that while somatosensory perception remains relatively unaffected, proprioceptive pathways showed some disturbance in young adults resulting in compensations via hip/trunk strategies after ankle vibration and lower limb adjustments after quadriceps vibration. Future research should examine these compensatory effects across age groups, as aging may impair proprioception, affecting step initiation and balance recovery even more.Acknowledgement and funding: Funds and facilities were provided by the European Union with YUFE4postdoc fellowship (EU Horizon Europe MSCA cofund, grant 101081327), by the Fulbright Scholarship Program and the University of Illinois at Chicago.References: 1) Xie, H., et al (2023) Gait & Posture; 2) Asghari, M., et al. (2024). Heliyon; 3) Grabiner MD et al (2021) Front Sports Act Living; 4) Wang & Bhatt (2022). Biomechanics

S.06.3 - Investigating vestibular contributions to compensatory stepping reactions via galvanic vestibular stimulation

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The vestibular system contributes to maintaining upright posture and balance by sensing posture verticality through head orientation relative to gravity. However, the specific role of the vestibular system in reactive balance control, specifically compensatory stepping reactions – a primary strategy used to recover balance after unexpected perturbations – is less understood. Galvanic vestibular stimulation (GVS) is a powerful, non-invasive technique used to investigate vestibular function. By delivering electrical currents through surface electrodes placed over the mastoid processes, GVS alters the firing rate of vestibular afferents via the eighth cranial nerve. This creates an illusory vestibular sense of head motion in one direction, resulting in a compensatory postural lean in the opposite direction. This technique provides valuable insights into the vestibular system's role in balance control.This presentation will explore three studies that combined GVS with whole-body support-surface perturbations to investigate vestibular contributions to compensatory stepping reactions. These studies examine how altered vestibular input via GVS influences outcomes including step scaling, whole-body motion, and stability in both the mediolateral and anteroposterior directions. Next, we will discuss the integration of vestibular feedback with step mechanics, focusing on the methodological implications of applying GVS either orthogonally or in alignment with the direction of whole-body perturbation, and how these configurations influence reactive balance. These distinctions aim to illustrate the complexity of disentangling the integration of the whole-body perturbation from vestibular effects in assessing compensatory stepping reactions. Finally, we will address remaining gaps in the current understanding and propose future research directions to further elucidate vestibular contributions to reactive balance. These include refining GVS protocols for balance paradigms, investigating vestibular contributions in more ecologically valid/real-word settings, and exploring clinical applications for populations with impaired balance, such as older adults or individuals with vestibular disorders.

Symposium 7: Disentangling real-world signatures of locomotion in ageing and neurodegeneration: from disease-specific early signs to decreased functional mobility

S.07.1 - Turning characteristics during everyday gait reflect fall risk in older people

Kimberley Van Schooten [1], Martina Mancini [2], Kim Delbaere [3]

[1] University of New South Wales, [2] Oregon Health & Science University, [3] Neuroscience Research Australia; University of New South Wales

Background and aim: Falls are a major issue among older people, with one in three experiencing a fall each year. Identifying those at risk of falling remains challenging, as traditional assessments often fail to capture the complexities of the real world. Turning movements during everyday walking may provide valuable insight into fall risk. This study explored whether specific turning characteristics in daily life are linked to future falls.Methods: We collected one week of real-world movement data from 720 community-dwelling older people using a trunk-worn inertial sensor (DynaPort MoveMonitor). Participants were then followed for 12 months to track fall incidents. Turning parameters expressing the duration, angular displacement and velocity, jerk and walking cadence were extracted and associated with fall incidence rates.Results: Several turning features were associated with higher fall risk. Faster turn rates during short (0.5-1 sec), medium (1-2 sec) and long turns (2-4 sec) were associated with increased fall incidence. Higher angular displacement over short and long turns and lower jerk during long turns were also associated with more falls. In addition, greater variation in turn duration (medium and long turns), higher variation in peak angular velocity (short turns) and lower variation in cadence (short and medium turns) were associated with a higher fall incidence. Conclusions: Turning characteristics during everyday gait are associated with falls in older people. These insights support the potential of wearable sensors in daily life to identify fall-risk profiles and inform prevention strategies.

S.07.2 - Real-world mobility monitoring across dementia subtypes: applications in diagnosis and post-diagnostic support

Riona Mc Ardle [1]

[1] Newcastle University

Although dementia is commonly understood as a neurocognitive disorder, it is also associated with marked changes in physical mobility that often begin years before a formal diagnosis. In line with international consensus, physical mobility refers to the ability to move freely and safely—an essential component of functional independence. A substantial body of research demonstrates that mobility impairments, particularly changes in gait measured in controlled environments such as clinics or gait laboratories, can serve as early indicators of cognitive decline during normal ageing and help differentiate between common dementia subtypes at the time of diagnosis. However, two key gaps remain. First, access to controlled gait assessment is limited by the need for specialised equipment, space, and expertise. Second, there is a lack of objective data on how mobility changes after a dementia diagnosis.Real-world mobility monitoring using wearable sensors offers a promising solution to these challenges. First, it enables objective assessment of gait and other important aspects of mobility in everyday settings, removing the need for specialist equipment or clinical environments. This improves accessibility and inclusivity, particularly for individuals who may not be able to attend clinic-based assessments. Second, by continuously capturing mobility data over time, these methods provide valuable insight into how mobility changes across the course of dementia. Therefore, real-world mobility monitoring could inform earlier and more accurate diagnosis, monitor disease progression, and support more tailored interventions.This presentation will first provide examples of research into the applications of real-world mobility monitoring to improve differential diagnosis of discrete dementia subtypes: Alzheimer's disease, Lewy body disease, and Posterior Cortical Atrophy. These subtypes are often underdiagnosed or misdiagnosed due to overlapping symptoms and limitations of current diagnostic tools, particularly in early stages. Early evidence of signatures of real-world mobility impairment between dementia subtypes will be presented, and challenges in utilising real-world mobility monitoring for this purpose will be discussed. Following diagnosis, people with dementia commonly live with under-recognised and under-served mobility problems, which accelerate their trajectory to dependency and disability. This talk will draw on work exploring the use of real-world mobility data to understand people's mobility needs after diagnosis—highlighting how mobility changes over time, what factors influence mobility loss at individual, social, and environmental levels, and how these insights can inform the development of interventions to support independence, wellbeing, and quality of life in the years following diagnosis.

S.07.3 - Signatures of real-world mobility in Parkinson's disease

Lisa Alcock [1]

[1] Newcastle University

Parkinson's disease (PD) is the 2nd most common neurodegenerative disorder affecting 6 million worldwide. The vast majority of people with PD report mobility limitations [1]. Clinical scales are the gold standard for evaluating motor symptoms, including gait and balance. However, they are susceptible to subjectivity and lack sensitivity. With extensive lab-based research, the tools (device, protocol, analytics) have been developed and validated, and our understanding of outcome selection is advanced. There is evidence to support the clinical utility of gait addressing multiple clinical applications in PD: supporting the diagnostic process [2], identifying individuals at risk (i.e. of falling [3]), tracking disease progression [4], patient stratification [5] and evaluating response to treatment (i.e. levodopa [6]). Evidence supporting the clinical utility of real-world gait and more broadly – mobility, is now emerging.In this talk, real-world mobility signatures from cohort studies of people with PD are presented (ICICLE-Gait [7], Mobilise-d Clinical Validation Study presented (www.mobilise-d.eu)). An infinite number of digital mobility outcomes (DMOs) may be obtained when monitoring mobility continuously over consecutive days. DMOs reflecting different domains of mobility (i.e. gait, turning, physical activity), data aggregation approaches (daily, weekly), and outcome measure type (temporal-spatial, signal-based) are considered. Outcome selection is heavily dependent on the clinical application. This talk will review recent advances in our understanding of the clinical utility of real-world mobility monitoring in people with PD. Evidence supporting the use of real-world DMOs for patient stratification, as a marker of disease severity and progression, and to identify those at risk is reviewed. Gaps in our current understanding are highlighted and recommendations for future work provided. References: [1] Oveisgharan 2021 PLOS ONE [2] Zolfaghari 2023. ACM Comput Surveys [3] Creaby & Cole 2018. Park Rel Dis [4] Wilson 2020 Front Aging Neurosci [5] Mirelman 2022. Neurol [6] Smulders 2016. Park Rel Dis [7] Galna 2015 Mov Dis

S.07.4 - Signatures of real-world walking behavior in cerebellar ataxia

Winfried Ilg [1]

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Gait disturbances are often the initial signs of cerebellar diseases and a significant disabling feature during the course of disease. It has been shown in laboratory-based assessments that measures of spatio-temporal variability allow to characterize the specificities of ataxic gait. The transfer of spatio-temporal variability measures for quantifying ataxic gait impairments into real life is hereby complicated by the fact that real-life gait is inherently far more variable for both healthy controls and cerebellar patients26 and that patients are free to use various compensation strategies, thus increasing heterogeneity of walking patterns. Thus, variability measures may lose their accuracy for characterizing ataxic gait changes in real life. In this talk, I will discuss the challenges and potentials of real-life motion assessments in cerebellar ataxia. I will present methods for the longitudinal analysis of gait and turning movements in different disease stages. In particular, the methods consist of (i) distinguishing ataxia-induced motor variability from variability inherent in real-life walking and (ii) incorporating contextual and environmental factors when comparing longitudinal recordings of movements at different time points. Matching of longitudinal walking bouts (baseline and follow-up) is performed according to macroscopic characteristics of walking behavior, namely the bout length and number of turns. Our recent research indicates that the progression of ataxia-related gait impairment can be reliably tracked in real-world walking by analyzing sessions tailored for gait characteristics affected by environmental factors. Real-world gait measures identify longitudinal changes in early disease stages over short periods, surpassing clinical scores and laboratory-based assessments. These findings imply enhanced sensitivity and ecological validity for real-world gait evaluations. Turning movements are more challenging in terms of dynamic balance than straight walking because they require more anticipatory postural adjustments and trunk-limb coordination strategies. In a recent study, we showed that a measure used to quantify dynamic balance during turning in real life - lateral velocity change (LVC) - is sensitive to pre-ataxic stages and shows strong correlations with self-reported balance confidence in daily life as measured by the ABC score ($r > 0.65$). Thus, measures of dynamic balance during turning appear to be particularly sensitive for detecting subtle changes in ataxia and should be included in studies of pre-ataxic and early disease stages.The observed ataxia-sensitive measures of gait and turning in different stages of cerebellar ataxia will be compared with those identified in the other population discussed at the symposium.The talk ends with pointers for future research questions on real-life walking behaviour, such as walking with head movements or walking under stress or fatigue.

Symposium 8: Fear in motion: Exploring psychological factors behind falling in older adults and neurodegenerative conditions

S.08.1 - Breaking the vicious cycle: Why all falls and fear of falling must be prevented

Taylor Takla [1]

[1] Wayne State University

Falls are a leading cause of injury and loss of independence in older adults and individuals with neurodegenerative diseases. While some argue that not all falls result in harm and that a certain level of fear of falling (FOF) may be protective, prior literature suggests that both falls and FOF contribute to a vicious cycle of physical decline and psychological distress. This presentation will take the position that all falls and FOF are inherently harmful and should be primary targets of rehabilitation and prevention efforts. Even such “harmless” falls can have serious consequences. Beyond the risk of physical injury, falls often lead to psychological problems such as increased anxiety, loss of confidence, and increased activity curtailment. These factors can ultimately lead to deconditioning, increased dependence, and heighten the risk for future falls, reinforcing a vicious cycle of decline. Similarly, FOF, regardless of whether it stems from a prior fall or not, is associated with reduced mobility, social isolation, and poorer health outcomes.If rehabilitation efforts prioritize only preventing physically injurious falls, while tolerating FOF to a certain degree, we risk overlooking the profound psychological and functional consequences of both. This presentation will argue that all falls should be viewed as harmful, not just due to immediate physical injuries, but because of their potential to undermine confidence, restrict activity, and worsen long-term health and quality of life outcomes. Therefore, interventions should aim not only to improve balance and strength, but also to actively eliminate FOF rather than viewing it as an unavoidable or potentially beneficial aspect of aging or neurodegenerative disease. By addressing both the physical and psychological consequences of falls and FOF, rehabilitation efforts can more effectively break the cycle of avoidance, inactivity, and increased fall risk. This, in turn, can promote greater mobility, confidence, and quality of life in older adults and individuals with neurodegenerative diseases.

S.08.2 - Rethinking falls and fear of falling in neurodegenerative diseases: A critical examination of context and physical activity

Nora Fritz [1]

[1] Wayne State University

Background: Falls and fear of falling (FOF) are prevalent in neurodegenerative diseases (NDD) and older adults, with significant negative impacts on physical and emotional well-being. However, the current consensus that FOF and falls are always negative outcomes warrants reexamination. Objective: To challenge the conventional view that all falls and FOF are detrimental, and to discuss the importance of considering context and physical activity in the assessment and intervention of falls in NDD. Methods: A critical review of the literature will be presented, highlighting the complexities of falls and FOF in NDD, and the need for nuanced approaches to measurement and rehabilitation. Results: We will argue that not all falls are created equal, and that the context of the fall (during challenging activity vs. in-home) and the level of physical activity engaged in by the individual with NDD are crucial factors to consider. Furthermore, we will discuss the potential benefits of a moderate level of concern about falling as a protective mechanism that encourages cautious behavior and fall risk reduction strategies. Discussion: By highlighting the complexities of falls and FOF in NDD, we emphasize the need for a more nuanced understanding of these constructs. By considering the context of falls, physical activity levels, and the potential benefits of a moderate level of concern about falling, we can work towards developing more effective assessments and interventions that

prioritize quality of life and physical well-being for individuals with NDD. Ultimately, this reevaluation of falls and FOF has the potential to lead to improved outcomes and a better understanding of how to tailor rehabilitation interventions to address the unique needs of individuals with NDD.

S.08.3 - How fear of falling and participation may be impacted by misalignment of perceived and actual balance ability

Jason Longhurst [1]

[1] Saint Louis University

Evidence suggests that beyond the influence of physiologic factors, perceptual and psychological factors play an important role in falls and fall related behaviors. This portion of the symposium will focus on the role of perceptual and psychological factors in falls, fear of falling, and avoidance behaviors. Notably recent work suggests that self perception of balance and its misalignment with one's actual balance ability is a stronger indicator of fall risk than measures of balance ability. This degree of misalignment, or discordance, has been shown to be strongly related to perceptual and psychological variables (e.g., balance confidence, anxiety, depression). This talk will explore the potential impact of discordance on the development of fear of falling and its consequences on activity participation, including physical activity restriction and risk taking behaviors. We will present discordance as both a predisposing factor that secondarily leads to falls and as a potential maladaptive response to a fall related event. Through these experiences individuals employ a recalibration process in which they repeatedly modify their conception of their balance abilities which then directly shapes their daily balance-related behaviors. Consequently, balance discordance plays a prominent role in framing decisions regarding participation in activities that may challenge an individual's balance. Lastly, we will present where balance discordance may fall within select theoretical models of fear falling and falls.

S.08.4 - From confidence to fear: New insights into emotional factors related to falls

Toby Ellmers [1]

[1] Imperial College London

It is well accepted that emotional factors, such as fear of falling, can be both a cause and consequence of falls. But recent research has revealed that these factors might not be uniformly maladaptive to balance – and may even enhance safety for certain individuals. Adding further complexity to this issue, a myriad of terminology exists to refer to overlapping concepts (e.g., fear/concerns about falling, balance confidence, falls efficacy etc.). This talk will first present recent developments from this research area. This will include clear definitions of these different emotional constructs, descriptions on how they do (or do not) affect balance and falls, and ways that these different constructs can be easily measured. Mechanisms through which these factors may be maladaptive or adaptive to balance will also be discussed. It will then present a unifying conceptual framework that seeks to bring together these different constructs into a single, harmonised model.

S.08.4 - How fall-risk may be impacted by misalignment of perceived and actual balance ability

Daniel Peterson [1]

[1] College of Health Solutions, Arizona State University, Phoenix, AZ, USA

Aside from non-modifiable factors such as age and previous falls, the strongest predictors of future falls are related to physical and cognitive ability. These include balance ability, strength, cognition, and others. However, perceived ability may also contribute to fall-risk. This portion of the symposium will first outline how the interaction of actual and perceived ability levels, together, can provide conceptually relevant information for falls and fall risk. Recent work from our group and others have quantified this concept by determining the concordance (or discordance) between people's actual and perceived ability level. This quantification can extend the idea of confidence by as "high" or "low" confidence to over-, under-, or appropriate- confidence levels. Recent data indicate that this measure is functionally relevant as it relates to both fall-risk and self-reported health status in people with neurological conditions.The talk will also discuss how discordance (defined above) may influence fall-risk in the moments leading up to a balance-challenging task. For example, inappropriate over- or under-confidence in mobility could influence both whether a person chooses to execute a potentially risky task as well as how it is executed (e.g., how attention is allocated during the task). Together, this information can provide an additional perspective to understand how perception, in addition to physical and cognitive ability may influence fall risk. In addition, it provides additional hypotheses to probe fall risk, as well as possible targets for interventions targeting those at-risk for falls.

Symposium 9: Measures, measures, measures… and what about the outcomes?

S.09.1 - The art of translating digital outcomes into clinically relevant insights

Charalampos Sotirakis [1]

[1] University of Oxford

Wearable sensors such as inertial measurement units and smartwatches have become popular in clinical research for movement disorders. They can provide objective, continuous and unobtrusive assessments of motor symptoms, complementing the

subjective evaluations by clinicians. Wearable sensor data have become useful allowing the quantification of various kinematic characteristics such as the area of postural sway when standing, stride length, duration, upper limb range of motion (ROM) and variability when walking. Research has used kinematic characteristics to estimate the risk to develop diseases such as Parkinson's and Multiple Sclerosis (MS) before diagnosis, to track motor symptom progression over time, as well as to create biomarkers of specific motor symptoms. One important aspect to consider is the clinical construct being used, but another is the outcomes provided by the wearable sensors. The ambulance of the kinematic characteristics requires careful selection to identify the ones that are more important, given the disease's clinical profile, taking into account the principles of biomechanics and motor control theories. Importantly, the selection and engineering of these features require further scrutiny to ensure robust, explainable, and clinically trustworthy outcomes. In this talk we will discuss the current methodologies for kinematic feature extraction and selection in wearable sensor-based systems, emphasizing the need for standardization and interpretability to advance clinical applications in movement disorder management.

S.09.2 - Using wearable sensors in clinical practice, are we there yet? Applications to evaluate, monitor, and support clinical decision making

Luca Palmerini [1], Ilaria D'ascanio [1], Jose Albites-Sanabria [1], Paola Di Florio [1], Pierpaolo Palumbo [1], Lorenzo Chiari [1]

[1] University of Bologna

In the last years, wearable sensors have been widely used in research for augmenting ("instrumenting") and commonly used clinical tests, such as the Timed Up and Go test, traditionally measured with a stopwatch. These tests are usually augmented by adding one or more inertial wearable sensors, in order to objectively evaluate mobility performance and impairment, through automated analysis (signal processing, machine or deep learning...) of the extracted data. These augmented tests have the clear potential to provide clinicians and researchers with objective measures of gait, mobility, and balance characteristics that can support clinical practice and decision making. However, despite the abundance of scientific evidence and articles that show that it is indeed possible to extract clinically relevant information with this methodology in different fields (e.g. motor impairment in Parkinson's disease, fall risk in the elderly), those instruments are still not widely used in standard clinical practice, with a limited clinical uptake (out of the research areas) of this technology. In this presentation I will provide an overview of the research and evidence to date, highlighting gaps, limitations, and promising results in using this technology in clinical settings, to evaluate, monitor, and support clinical decision making. I will focus on the search for best outcomes from these tests for different populations and applications. Finally, i will present our research to extract and analyze the best clinically relevant outcomes from these tests in several populations, including older adults at a higher risk of falls, people with lower limb amputations, and people with Parkinson's disease.

S.09.3 - From structural health monitoring to patients with Multiple Sclerosis: Does predictive maintenance work in gait?

Alex Stihi [1], Matthew Jones [2], Elizabeth Cross [2], Claudia Mazza [3], Timothy Rogers [2]

[1] University of Oxford, [2] University of Sheffield, [3] Indivi

Structural Health Monitoring (SHM) is a relatively well established process for management of engineering systems such as bridges and wind turbines which relies on continual monitoring and decisions based on analysis of data collected from the assets over their lifetime. The goal is to replace scheduled regular maintenance tasks with a more proactive system based on the currently inferred "health-state" of that system. The goals of SHM range from detection of a problem to its classification, localisation and quantification, finally looking towards prognosis for making objective cost-informed decisions about the correct course of action. It is interesting to consider if these ideas can be cross-fertilised to applications in human health enabled by increased levels of available data from free-living (or in SHM "in-service") conditions. This talk will consider how and if ideas from engineering disciplines can be applied in the case of patients with multiple sclerosis. Two key examples will be shown where wearable sensor data, combined with machine learning analysis of the collected data are able to provide insights into the patients' condition from gait data. This will include the application of auto-regressive models for individuals and a hierarchical Gaussian process regression to capture shared functional relationships within patient groups, i.e. similar gait trends among all healthy control examples. Finally, some of the challenges of this approach will be explored considering the differences in application between monitoring of an engineering system such as a wind turbine and understanding data collected from a human.

S.09.4 - Progression vs intervention – two sides of the same medal or two different problems? Examples from gait and beyond

Silvia Del Din [1]

[1] Newcastle University

Digital mobility measures derived from wearable devices provide an objective means to quantify gait and mobility impairment and could serve as primary or secondary outcomes in clinical trials. The selection of appropriate digital mobility measures requires ensuring technical validity, feasibility, and clinical utility. Regulatory approval mandates robust evidence supporting digital mobility measures' clinical relevance, with guidance now available to facilitate this process [1].Parkinson's disease (PD), the second most common neurodegenerative disease, presents with heterogeneous motor and non-motor symptoms that impact mobility. Given the progressive nature of PD and the need for personalized monitoring, digital mobility measures offer significant potential in clinical practice and research [2]. This symposium's talk will address the promises and challenges of digital mobility measures to be recognised actual "digital mobility outcomes" (DMOs) in PD. To do so, "digital measures" need to: (i) support early diagnosis by identifying prodromal markers and individuals at risk of disease (e.g., gait variability and asymmetry, arm swing), (ii) track disease progression by detecting changes over time (e.g., pace of gait),(iii) aid in patient classification and prognosis (e.g., falls risk prediction),(iv) evaluate treatment efficacy, including responses to drug treatment and non-pharmacological intervention (e.g. exercise, multimodal),(v) be meaningful for people with PD and linked to their quality of life [3, 4]. Clinical validation of DMOs involves assessing convergent, discriminant, and predictive validity. Selective DMOs have shown to correlate with standard clinical measures such as the Movement Disorder Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS III) and mobility-related endpoints. DMOs can distinguish between patient subgroups (e.g., fallers vs. non-fallers) and predict key clinical outcomes such as time to first fall. The relevance of DMOs needs to extend beyond research settings: they must be meaningful to patients, addressing mobility impairments that significantly impact quality of life. For example, patient and stakeholder engagement has identified gait and balance impairments as priority areas for intervention, reinforcing the value of DMOs in clinical decision-making [3].As the field advances, the integration of DMOs into clinical trials and routine practice will require continued collaboration among researchers, industry, regulatory bodies, and patient communities. Establishing standardized methodologies and ensuring digital mobility measures become DMOs that are fit for purpose will be essential for their successful adoption in PD and other neurological conditions. [1] Goldsack et al., Digital biomarkers, 2021.[2] Rochester et al., Digital biomarkers, 2020.[3] Alcock et al., Gait, balance, and mobility analysis, Elsevier 2024.[4] Mancini et al., npj Parkinson's disease 2025.

Symposium 10: Mobile brain-body imaging: What have we learnt about the neural control of human balance and gait?

S.10.1 - A SWOT analysis of mobile brain-body imaging (MoBI) with high-density EEG

Daniel Ferris [1]

[1] University of Florida

Using high-density electroencephalography (EEG) and wearable sensors can provide valuable insight into the control of human movement in health and disability. Like any research tool, MoBI has its advantages and disadvantages that are not always appreciated. This presentation will present a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) of the technology and methodology as it stands today. Strengths include the ability to measure high temporal resolution changes in brain activity in a range of real world tasks, the relatively low cost compared to other brain imaging modalities, and the uniqueness of the insight provided. Some of the weaknesses include the problems with artifacts and signal processing pipelines, and the time it takes to prepare participants. Opportunities include new means of recording electrocortical activity such as dry sensors, 3D printed ink e-tattoo sensors, and subdermal electrodes. Threats to the technology come from a lack of rigorous validation, unwillingness to question experimental results, and a lack of gold standard signal processing approaches. In addition, the presentation will consider how MoBI may contribute to gait and posture research in the next decade or two.

S.10.2 - Brain imaging of whole body movement with wearable MEG

Meaghan Spedden [1], George O'neill [2], Tim Tierney [2], Stephanie Mellor [2], Gareth Barnes [2]

[1] UCL Queen Square Institute of Neurology, [2] University College London

Background and aim:Understanding how the brain supports naturalistic, whole-body movement requires neuroimaging methods that can capture dynamic brain activity without constraining the body. Recent advances in wearable optically pumped magnetoencephalography (OP-MEG) provide a promising solution, enabling non-invasive, high-resolution imaging during natural movement.Methods:I will introduce this novel imaging modality and describe how it enables source-localised brain imaging during naturalistic, whole-body actions. I will outline the experimental paradigms used to acquire OP-MEG data during visually guided stepping and dance, and explain how these recordings are used to reconstruct the spatial and temporal dynamics of cortical activity.Results:I will present evidence of robust, movement-related neural activity localised to primary motor and sensorimotor regions during both stepping and multi-limb dance. These results demonstrate the viability of reconstructing cortical sources during complex, dynamic behaviour using OP-MEG. I will also discuss ongoing methodological challenges, including movement-related artefact rejection and the integration of behavioural state information with neural data in naturalistic contexts.Conclusions:These advances highlight the potential of OP-MEG as a high-fidelity method for capturing the spatial and temporal dynamics of brain activity during natural movement. This opens new avenues for studying motor control in ecologically valid contexts, with broad applications across neuroscience and clinical research.Acknowledgements and funding:This work was funded by a Wellcome Technology Development Grant and supported by the Discovery Research Platform for Naturalistic Neuroimaging funded by the Wellcome.

S.10.3 - Cortical dynamics of reactive balance control in health and disease

Vivian Weerdesteyn [1]

[1] Radboud University Medical Center

Human bipedalism comes with particular challenges to stability. To maintain upright stability while executing a wide range of dynamic activities of daily living, the brain plays a critical part in signaling potential losses of balance and orchestrating an appropriate response to prevent us from falling. Unsurprisingly, fall risk is greatly elevated in people with brain disorders, such as stroke or Parkinson's disease. Previous research has indeed demonstrated associations between global brain function and the risk of falling, but such correlations provide little insight into the precise brain mechanisms of recovering from loss-of-balance in health and disease. Excitingly, advances in mobile brain-body imaging now allow us to unravel the complex computational and decision-making processes that our brain must perform when a fall is imminent – and how these are impacted by aging or disorders of the brain. In our recent work, we used high-density EEG to record the temporal dynamics of the cortex following external balance perturbations in healthy young and older individuals, and in people with stroke and Parkinson's disease. In this talk, findings from two key cortical areas will be presented. The supplementary motor area exhibits a characteristic broadband power increase that peaks shortly after perturbation onset (<200 ms). Our results demonstrated weaker alpha power with aging, whereas people with Parkinson's disease showed relatively weaker theta power. The primary motor areas show a prominent beta power decrease during execution of a reactive stepping movement, which was found to be attenuated in people with stroke with residual leg motor impairment. Relationships with biomechanical and muscle synergy outcomes will be presented to help interpret these findings and discuss implications for rehabilitation.

Symposium 11: Exergames for health: randomized controlled trials and systematic review evidence for the effects on physical and cognitive functioning, brain modulation, and informing the designing for healthy and clinical populations

S.11.1 - The smart±step trial - preventing falls with home-based exergame training in older people

DL Sturnieks[1 2], C Hicks[1], SR Lord[1], [2]

[1]Falls, Balance and Injury Research Centre, Neuroscience Research Australia, [2]Faculty of Medicine and Health, University of New South Wales

Background: Exergames show great promise for fall prevention by integrating the training of both cognitive and motor functions that are known fall risk factors. Gamified training can facilitate exercise adherence through engaging, progressively challenging, goal-directed tasks. We developed the smart±step in-home computerised gaming system with eight games that can be played by stepping on an instrumented mat.

Method: A 3-arm randomised controlled trial involving 762 community-living older people tested the efficacy of the smart±step step training on preventing falls compared to a minimal-intervention control. In the same trial, we also tested the efficacy of seated cognitive training, using the same games, compared to control. Intervention participants were asked to undertake two hours of training per week for 12 months and reported falls monthly.

Results: No serious adverse events were reported. Average weekly training duration was 80±47 mins for exergame step training and 95±43 mins for cognitive training. The step training group reported significantly fewer falls compared to control (IRR=0.74, 95%CI=0.56-0.98) and had a reduced proportion of fallers RR=0.75 (0.61–0.92). The cognitive training group was not significantly different to control in rate of falls (IRR=0.86, 95%CI=0.65-1.12) but did have a reduced proportion of multiple fallers RR=0.63 (0.42-0.94).

Conclusions: Home-based exergaming step training is a safe and efficacious method of preventing falls in older people living in the community and has good potential for scalability. Some fall prevention benefits were also found for seated cognitive training. Further work has successfully implemented smart±step into aged care homes and rehabilitation clinics across Australia. Current studies are testing the effects of smart±step to reduce symptom burden in 180 people with chemotherapy-induced peripheral neuropathy and to address balance and mobility impairments in 86 people who have had a stroke

S.11.2 - Improving gait disorders with exergaming in Parkinson’s disease : Clinical and neurophysiological effects

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Gait and balance disorders, including freezing of gait (FOG), are among the most disabling motor symptoms in people with Parkinson’s disease (PD). These symptoms tend to worsen over time and become resistant to pharmacological and surgical treatments, contributing to increased fall risk, loss of autonomy, institutionalization, and healthcare burden. Although rehabilitation can partially alleviate gait and postural impairments, its efficacy relies on sustained engagement—often limited in traditional settings. To address these challenges, we have developed a home-based rehabilitation program using a custom-designed exergame, Toap Run, combining physical activity with an immersive virtual environment. This intervention leverages motion-capture technology to guide full-body, task-specific movements, enriched by real-time visual and auditory feedback. Sessions were progressive (15 to 45 minutes), conducted 2–3 times per week over a 6 to 9-week period. Patients in the active training group completed on average 18 sessions and performed over 1,200 full-body movements per session. Clinically, the exergame intervention led to significant improvements in gait performance: step length increased, double stance duration decreased and anticipatory postural adjustments improved. There was also a reduction in axial motor scores and in overall gait and balance disability scores. A neuroimaging substudy using resting-state fMRI revealed specific training-induced brain modulations with an increased connectivity between cerebellar locomotor regions and basal ganglia, and decreased connectivity within attentional and default mode networks. These changes suggest a partial restoration of automatic motor control and reduced reliance on cognitive compensation mechanisms. Altogether, our findings demonstrate that exergaming is a safe, engaging, and could be an effective approach to improve gait and balance in PD, while promoting functional brain reorganization. This home-based solution offers a scalable, personalized alternative to conventional rehabilitation.

S.11.3 - Feasibility and Effectiveness of Home-Based Exergames for Cognitive-Motor Training in Older Adults: Evidence from a Pragmatic RCT and Systematic Review

Julia Seinsche [1], Ilaria Carprinella [2], Maurizio Ferrarin [2], Eling De Bruin [3], Eleftheria Giannouli [4]

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Home-based exergaming is emerging as a promising solution to improve physical and cognitive health in older adults while addressing accessibility barriers in outpatient rehabilitation. This presentation will synthesize findings from a pragmatic international randomized controlled trial (RCT) and a systematic review, with a focus on feasibility, user engagement, and site-specific outcomes of cognitive-motor training via exergames.The RCT included 127 community-dwelling older adults (≥60 years) across Switzerland, Italy, and Cyprus, who participated in a 10-week, remotely supervised stepping exergame program. Results indicated excellent adherence (101.4%), low attrition (11.8%), and high user enjoyment (mean score: 69.1/100). Cognitive improvements were most notable in response inhibition (Go/No-Go test, $p = .02$). While the intervention proved feasible and safe, its impact on physical function varied by location and was likely influenced by training dosage.Complementary findings from a systematic review (18 studies, $n = 1125$) further support the effectiveness of home-based exergames in enhancing a broad

spectrum of physical and cognitive functions. Stepping exergames demonstrated particular efficacy for cognitive gains, though heterogeneity in intervention protocols and outcome measures limited the strength of conclusions. Notably, studies varied widely in training duration, supervision models, and technological platforms, highlighting the need for more standardized approaches.Together, these findings underline the potential of telerehabilitation-supported exergames as an accessible and engaging modality for promoting healthy aging. However, to achieve clinically meaningful improvements—particularly in non-acute populations—optimized training load and personalization of difficulty progression are essential.

S.11.4 - Leveling up the exergame: Merging scientific evidence with user-centered design

Anna Lisa Martin-Niedecken [1]

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Exergames, which are digitally mediated games requiring physical movement for interaction, are gaining increasing recognition as valuable tools in the fields of health promotion, rehabilitation, and sport science. They offer a unique opportunity to integrate physical, cognitive, and motivational components into a single, engaging intervention. A growing body of empirical research, including randomized controlled trials and systematic reviews, has demonstrated the potential of selected exergames to improve motor skills, cognitive functioning, emotional well-being, and adherence to physical activity, particularly among older adults and clinical populations. Despite these encouraging findings, substantial challenges remain. A significant number of existing exergame applications show limited alignment with validated training concepts or lack meaningful integration of user needs and behavioral engagement strategies. Often, such applications are developed without sufficiently interdisciplinary collaboration, resulting in poor usability, inadequate personalization, and limited motivational appeal. Consequently, their potential effects on physical, cognitive, and psychological health outcomes are frequently constrained. To ensure that exergames achieve both efficacy and real-world impact, it is essential to follow user-centered, evidence-based, and iterative development processes. This involves interdisciplinary collaboration among experts in game design, sports and movement science, psychology, rehabilitation, and human-computer interaction. Co-design methodologies, involving stakeholders from the outset, allow developers to systematically incorporate contextual factors, usability considerations, and target-group-specific training requirements. Iterative prototyping and evaluation cycles enable continuous refinement and validation. Technological advancements, including extended reality, wearable motion tracking, and artificial intelligence, provide additional opportunities to enhance immersion, adaptivity, and personalization. These technologies, when grounded in scientific principles and implemented with care, can substantially increase the effectiveness and sustainability of exergame-based interventions. Scalability, modularity, and inclusivity are also key design considerations to ensure applicability across diverse user groups and settings, such as home-based rehabilitation, fitness training, outpatient clinics, schools, and community-based health programs. Exergames that succeed in balancing training efficacy with engaging design have the potential to overcome barriers to participation and support long-term behavior change. By combining interdisciplinary scientific research with participatory and interdisciplinary development strategies, exergames can evolve into powerful tools for promoting health and well-being. Future progress in this field will depend on sustained cross-sector collaboration and a shared commitment to innovation that is both user-centered and scientifically grounded.

Symposium 12: Relevance of real-world digital mobility outcomes for quantifying disease progression and therapeutic response in Parkinson's disease and atypical parkinsonian syndromes

S.12.1 - Towards digital mobility as outcome measures in Parkinson's disease

Alison Yarnall [1], Lisa Alcock [1], Heiko Gassner [2], Lynn Rochester [1], Jeffrey Hausdorff [3], Anat Mirelman [4], Christian Schlenstedt [5], Alice Nieuwboer [6], Pieter Ginis [6], Walter Maetzler [7], Anja Frei [8], Judith Garcia-Aymerich [9], Clemens Becker [10]

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Parkinson's disease (PD) is the fastest growing neurological condition in the Western world, with over 8.5 million people estimated to be affected worldwide. Over the last 30 years, the global burden has more than doubled due to the ageing population, optimised diagnosis and management of motor disease. PD can thus be considered an age-associated condition, where gait disorders and their consequences – most notably falls – are common manifestations.Existing tools to assess PD outcomes, including associated gait and mobility loss, are based on performance, patient self-reporting and one-off assessments (using rating scales such as the Movement Disorder Society – Unified Parkinson's Disease Rating Scale (MDS-UPDRS)); these are resource intensive and lack sensitivity, which limits therapeutic development and clinical management. The fluctuating nature of PD further reduces reliability and validity due to the intermittent nature of assessment.Gait impairment is observed in the prodromal period, and deteriorates over time. Gait can thus be used to monitor progression in PD and is sensitive to change in both laboratory and real-world settings, with some evidence that it may be more sensitive to change than using established gold standard instruments such as the MDS-UPDRS. However, significant gaps remain in the current literature, with validation of existing digital tools to measure gait and mobility required, in larger and generalisable data sets, to enable evolution of these tools to clinical trials and clinical care.The aim of the Mobilise-D study was to address these gaps by developing and validating digital mobility outcomes (DMOs) to objectively measure daily living mobility and gait using a body worn sensor in individuals living with chronic conditions, including PD. The Mobilise-D Extension study provided an age- and gender-matched control group to inform progression in normal ageing and diversity and record change in digital healthcare technology assessments and offered an additional follow up timepoint for PD participants. In this talk, the goal is to provide an initial characterisation of real-world mobility of the Mobilise-D PD cohort, with a comparison of DMOs in PD vs. controls. Some preliminary data on disease progression will also be presented.

S.12.2 - Dynamic fall risk in people with Parkinson's disease: Utility of real-world digital mobility outcomes

Lisa Alcock [1]

[1] Newcastle University

Falls are a major concern for people with Parkinson's disease (PD). Up to 90% of people with PD fall at least once every year [1], 67% of falls are associated with injury and 35% with fracture [2]. Effective fall prevention requires an understanding of how to evaluate risk. Falls aetiology is complex, dynamic and multidimensional, varying between individuals, and within individuals over time. Such a heterogeneous group requires a personalised approach to management. The vast majority of falls in people with PD occur during walking [4] – highlighting the link between gait and falls. We can therefore use insights gained from discrete measures of gait (the way we walk) to identify and mitigate fall risk. Previous fall prediction models including lab-based measures of gait have yielded encouraging results (Area under the curve =0.63-0.80) [5-7]. Remote monitoring of mobility over consecutive days generates vast amounts of information reflecting real-world challenges to mobility and may enhance existing fall prediction models. In this talk, real-world mobility signatures of a large cohort of people with mild-moderate PD (n=600; Hoehn & Yahr I-III) from the Mobilise-d consortium will be presented (www.mobilise-d.eu). Demographics, functional mobility, clinical outcomes and real-world mobility over 7-days were obtained every 6-months for 2 years. Prospective falls were recorded using monthly falls diaries. Participants were stratified at baseline based on retrospective fall history over 12-months into the following groups: non-fallers (n=387), single fallers (n=92) and recurrent fallers (n=121). Confounding factors such as a history of injurious falls, being prescribed fall-risk increasing drugs (FRIDs) and polypharmacy are explored with respect to real-world DMOs at baseline. Existing fall prediction models are reviewed and the utility of real-world DMOs for fall prediction will be explored. Refs: [1] Allen 2013 Par dis [2] Paul 2017 Eur J Neurol [3] Montero-Odasso

2023 Age & Ageing [4] Castro 2023 Mov Dis Clin Prac [5] Cole 2010 Mov Dis [6] Paul 2013 Mov Dis [7] Lord 2016 Mov Dis

S.12.3 - Daily variations of mobility at home: does it relate to Freezing of Gait in Parkinson's disease?

Christian Schlenstedt [1], Jonas Müller [2], Pieter Ginis [3], Heiko Gassner [4], Lisa Alcock [5], Paul-Julius Fritz [2], Clemens Becker [6], Moran Gilat [3], Lynn Rochester [5], Alison Yarnall [5], Anat Mirelman [7], Jeffrey Hausdorff [8], Alice Nieuwboer [3], Walter Maetzler [9]

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Background and aim: Freezing of Gait (FOG) in Parkinson's disease (PD) is a disabling symptom which is associated with falls, loss of mobility and reduced quality of life. Its occurrence and severity increases when the disease progresses. Gait of freezers has been investigated in detail in laboratory settings, but little is known about how the symptom relates to fluctuations of mobility in the home environment.The aim of this study was to investigate whether daily fluctuations of mobility (walking activity and gait) differ between people with PD with and without FOG and to compare mobility during hours with and without diary-based self-reported FOG. Methods: This is a sub-study of the Mobilise-D clinical validation study, a large European-based longitudinal study. In this sub-analysis, data of n=165 individuals with PD, assessed at the University Kiel, Germany, were included. The occurrence of FOG was assessed on an hourly basis for 7 days with diaries. Daily life mobility was assessed for the same period with a wearable sensor (MoveMonitor, McRoberts and AX6, Axivity) worn on the lower back. Mobility and gait features were calculated from the domains amount, pattern, pace and rhythm with previously validated algorithms [1, 2].Results: A total amount of n=1057 diaries were analyzed from the baseline assessment. FOG most often occurred during the early morning and the afternoon, but data were highly heterogeneous on an individual basis. Freezers and non-freezers did not differ in gait features averaged over the day (p>0.05). However, we found significant group-by-time interactions with freezers being less active during the morning hours and increasing the amount of mobility from morning to noon while being more active from afternoon to evening hours compared to non-freezers. Freezers made significantly less turns and tended to walk slower and with reduced strides during hours with compared to hours without FOG. Discussion: Self-reported FOG most often occurred during the early morning. Fluctuations in mobility differed between freezers and non-freezers, with freezers tending to be less mobile during the morning but more active during the evening. Impaired gait features during hours with FOG might be caused by the symptom or might be a compensatory strategy to avoid FOG. 1. Kirk, C., Kuderle, A., Mico-Amigo, M.E., Bonci, T., Paraschiv-Ionescu, A., Ullrich, M., Soltani, A., Gazit, E., Salis, F., Alcock, L., Aminian, K., Becker, C., Bertuletti, S., Brown, P., Buckley, E., Cantu, A., Carsin, A.E., Caruso, M., Caulfield, B., Cereatti, A., Chiari, L., D'Ascanio, I., Garcia-Aymerich, J., Hansen, C., Hausdorff, J.M., Hiden, H., Hume, E., Keogh, A., Kluge, F., Koch, S., Maetzler, W., Megaritis, D., Mueller, A., Niessen, M., Palmerini, L., Schwickert, L., Scott, K., Sharrack, B., Sillen, H., Singleton, D., Vereijken, B., Vogiatzis, I., Yarnall, A.J., Rochester, L., Mazza, C., Eskofier, B.M., Del Din, S.Mobilise, D.c., Mobilise-D insights to estimate real-world walking speed in multiple conditions with a wearable device. Sci Rep, 2024. 14(1): p. 1754, doi: 10.1038/s41598-024-51766-5.2. Mico-Amigo, M.E., Bonci, T., Paraschiv-Ionescu, A., Ullrich, M., Kirk, C., Soltani, A., Kuderle, A., Gazit, E., Salis, F., Alcock, L., Aminian, K., Becker, C., Bertuletti, S., Brown, P., Buckley, E., Cantu, A., Carsin, A.E., Caruso, M., Caulfield, B., Cereatti, A., Chiari, L., D'Ascanio, I., Eskofier, B., Fernstad, S., Froehlich, M., Garcia-Aymerich, J., Hansen, C., Hausdorff, J.M., Hiden, H., Hume, E., Keogh, A., Kluge, F., Koch, S., Maetzler, W., Megaritis, D., Mueller, A., Niessen, M., Palmerini, L., Schwickert, L., Scott, K., Sharrack, B., Sillen, H., Singleton, D., Vereijken, B., Vogiatzis, I., Yarnall, A.J., Rochester, L., Mazza, C., Del Din, S.Mobilise, D.c., Assessing real-world gait with digital technology? Validation, insights and recommendations from the Mobilise-D consortium. J Neuroeng Rehabil, 2023. 20(1): p. 78, doi: 10.1186/s12984-023-01198-5.

S.12.4 - Effects of tailored intense physical exercise in the hospital and patients' daily life in Parkinson's disease and atypical parkinsonian disorders. A multicenter, double-blind, randomized controlled trial

Victoria Sidoroff [1], Hamid Moradi [2], Gaelle Prigent [3], Stefano Sapienza [4], Frank Jagusch [1], Isabelle Teckenburg [5], Marzieh Asalian [2], Nina Hergenröder-Lenzner [5], Marijus Giraitis [4], Eva-Tabea Schoenfeldt-Reichmann [6], Jean-Pierre Ndayisaba [1], Georg Goebel

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Background and Aim:Gait and mobility impairment are pivotal signs of parkinsonism, and they are particularly severe in atypical parkinsonian disorders (APD) including multiple system atrophy (MSA) and progressive supranuclear palsy (PSP). A pilot study demonstrated a significant improvement of gait in patients with MSA of parkinsonian type (MSA-P) after physiotherapy and matching home-based exercise, as reflected by sensor-based gait parameters. In this study, we aim to investigate whether gait-focused physiotherapy (GPT) and matching home-based exerciselead to a larger improvement in gait performance compared with a standard physiotherapy and home-based exercise program (standard physiotherapy, SPT). Methods: This study is a registered multicenter, double-blind, randomized-controlled trial (Mobility_APP, NCT04608604). Patients were recruited at the Movement Disorders Units of Innsbruck (Austria), Erlangen (Germany), Lausanne (Switzerland), Luxembourg (Luxembourg), and Bolzano (Italy). The study starts with one week of mobility monitoring using wearable sensors. Afterwards, patients were randomized into either the GPT or SPT group. Each group conducted daily inpatient physiotherapy over two weeks, followed by five weeks of unsupervised home-based

training. Finally, a one-week physical activity monitoring was repeated during the last week of intervention. Primary outcome is the change in gait speed (baseline to week 7) derived from sensor-based, standardized gait tests in the hospital. Secondary outcomes included mobility parameters derived from sensor-based recordings in daily life. Results: In total, 106 patients were recruited (33 MSA, 26 PSP, and 47 PD). Baseline characteristics reveal that APD patients showed a shorter disease duration compared to patients with PD. Participants with MSA and PSP featured more severe motor impairment, as reflected by higher MDS UPDRS III scores. They presented reduced gait velocity during gait analysis in the hospital, with higher variability and asymmetry in most sensor parameters. In daily life, apart from a lower step count per day, APD participants also showed less activity (locomotion vs. non-locomotion), lower intensity (cadence), and simpler mobility patterns. Disease-specific characteristics, differentiating MSA and PSP, were observed in both sensor and clinical parameters. Additionally, strong correlations were found between clinical scores and both sensor-based gait parameters in the hospital and patients' daily lives across all the groups. Further effects of exercise interventions will be presented at the conference. Conclusion: This study includes a large cohort of PD and APD patients and presents a comprehensive characterization of gait and mobility in patients with APD, assessed by gait tests in the hospital and mobility monitoring in daily life. Identifying potential differences in the effects between both exercise intervention arms is the subject of this analysis.

Symposium 13: Current and emerging approaches to improving balance and gait in vestibulopathy

S.13.1 - Gait impairments in patients with vestibulopathy

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The peripheral vestibular system, by detecting head accelerations, plays a crucial role in the multisensory control of balance. Vestibulopathy disrupts gait stability, thereby reducing quality of life and increasing the risk of falls. Investigating gait in patients with vestibulopathy is essential to better characterize these impairments in comparison to asymptomatic individuals. In this study, objective gait parameters— including spatio-temporal metrics, joint kinematics, gait standard deviation (gaitSD), and head movements—were assessed using a motion capture system. Patients exhibited significantly altered gait characteristics compared to controls. These findings provide valuable insights for evaluating the efficacy of vestibular implants, galvanic stimulation, and other rehabilitation strategies for vestibulopathy.

S.13.2 - Individualized rehabilitation therapy to improve gait and balance in bilateral vestibular hypofunction

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The standard treatment option for patients suffering from bilateral vestibular hypofunction (BVH) is Vestibular Rehabilitation Therapy (VRT). VRT as a concept is evidence based and includes adaptable combinations of exercises to improve the function of the vestibulo-ocular reflex (VOR), static and dynamic balance. International guideline for the use of VRT in peripheral vestibular dysfunction have been updated in 2022. Patients should receive a least 15 min of training per day and should do exercises at the limit of their individual balance abilities. However, with differences between countries and world regions, only a minority of patients currently gets this standard treatment.The overcome this shortcoming, several attempts have been made. Apps with feedback and supervision can be used to improve compliance. This also ensures the use of more individualized exercises. Motivation might be raised using exergaming and virtual/ augmented reality. There are some studies on the effects of interventions on balance. However, knowledge on optimal exercises to improve gait in BVH is sparse. We know that sensory afferent input is modified during the gait cycle and depends on gait speed. Exercises should be performed at different speeds and with varying demands. Biofeedback and telemedicine might help individualizing training further. For the future, the individual amount of vestibular loss (complete vs incomplete, semicircular canals, otolith function) should be considered in treatment planning. Further, many patients with chronic BVH also show functional dizziness (Persistent Postural-Perceptual Dizziness = PPPD) and use suboptimal strategies to control gait and stance. This must be diagnosed accordingly and addressed during treatment to pick the right patients for neuromodulation and invasive treatment options. We will summarize recent studies on the topic and look to future needs to further optimize VRT, either combined or not with other treatment approaches in peripheral vestibular hypofunction.

S.13.3 - Enhancing perceptual and postural function in bilateral vestibulopathy through low-intensity vestibular noise stimulation

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Bilateral vestibulopathy (BVP) results in chronic postural instability, increasing the risk of falls and diminishing patients' quality of life. Current treatment options offer limited compensation for lost vestibular function. In recent years, low-intensity noisy galvanic vestibular stimulation (nGVS) has emerged as a non-invasive therapeutic alternative. nGVS is presumed to utilize the phenomenon of stochastic resonance, wherein impaired sensory information transfer can be optimized in the presence of weak sensory noise interference, to enhance residual vestibular function. Here we outline available evidence

for the therapeutic efficacy of nGVS in BVP patients. A series of experimental studies compared the effects of nGVS versus sham stimulation on various aspects of vestibular function in BVP patients. Vestibular perceptual function, vestibular sensorimotor reflexes, static postural control, and dynamic gait performance were evaluated using psychophysical experiments and instrumented assessments of stance and gait. nGVS effectively normalized elevated vestibular perceptual and vestibulospinal reflex thresholds in BVP patients. This normalization translated into clinically relevant improvements in both static postural control and dynamic gait performance. The effectiveness of nGVS was particularly notable in individuals with measurable residual vestibular function, with patients exhibiting higher vestibular impairment experiencing the greatest benefits. Short-term application of nGVS did not result in any adverse effects. nGVS represents a promising non-invasive approach to address vestibular perceptual and sensorimotor impairments associated with BVP. Further research is needed to explore its long-term effects on daily mobility and fall prevention.

S.13.4 - Effects of the vestibulocochlear implant on balance and gait in bilateral vestibulopathy

Meichan Zhu [1]

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Background and aim: Bilateral vestibulopathy (BVP) often leads to, among many other symptoms, gait and balance issues and increased fall risk. The vestibulocochlear implant (VCI) is a neuroprosthesis that may offer a promising treatment for patients with severe BVP. This study aimed to explore the impact of different vestibular stimulation modes on gait and balance outcomes. Methods: The VertiGo! trial is a prospective, nonrandomized, single-center cohort study. The trial includes nine patients with severe BVP who demonstrated inadequate compensation despite conventional treatment. Nine patients received the VCI and were extensively tested in four testing weeks, the first providing reference data (no VCI stimulation) followed by three weeks each with different stimulation modes: (A) baseline stimulation combined with head motion-modulated stimulation, (B) reduced baseline stimulation combined with head motion-modulated stimulation, and (C) only baseline stimulation, without modulation. For the gait and balance assessments, patients walked at 0.6m/s, 0.8m/s, and 1.0m/s on an instrumented treadmill integrated in a 6-DoF motion platform (CAREN; Motek). Five walking conditions were evaluated: unperturbed walking in both lit and dark environments, along with three sizes of pseudorandom mediolateral platform sway perturbations. Coefficients of variation (CoV) were analyzed using 3D motion capture data for step time, step length, double support time and step width. Patients also completed the Mini-BESTest each week. Results: Step time, length and double support time CoV consistently reduced with increasing walking speeds across all walking conditions whereas step width CoV increased with increasing walking speeds across all walking conditions. Larger perturbations increased CoV consistently. The CoV in the reference mode and stimulation modes A, B and C varied across patients for all gait parameters with no consistent effect for any one stimulation mode (e.g., 5 of 9 patients had lower step time CoV and step length CoV for one stimulation mode but these did not always align with the modes with lower CoVs in the other parameters and the stimulation mode that benefited one patient was often not the mode that benefited another patient). Darkness usually increased CoV but no clear effect of a specific stimulation mode in darkness was found. In the Mini-BESTest, at least one stimulation condition total score was higher than the reference total score for 6 of 9 patients but these were distributed across the different stimulation modes.Conclusions: Walking speed, perturbations and stimulation modes can influence gait variability and balance performance. While specific stimulation modes may provide slight advantages during acute stimulation, individual responses exhibit considerable variability. The findings emphasize the importance of further investigating tailored stimulation. Investigation into potential differences between acute stimulation and ongoing stimulation is needed.

Symposium 14: Compensatory neural mechanisms in the prefrontal cortex: attentional resources for gait and balance in aging and mild cognitive impairment

S.14.1 - Retention rate in motor adaptation: A biomarker of mild cognitive impairment

Katrin Sutter [1], Leonie Oostwoud Wijdenes [2], Robert van Beers [3], Jurgen Claassen [4], Roy Kessels [5], Pieter Medendorp [2]

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Alzheimer's disease (AD) initially manifests with impairments in declarative memory, while non-declarative memory functions remain relatively intact. Traditionally, motor adaptation has been viewed as a non-declarative process; however, recent findings indicate that it encompasses both fast, declarative and slower, non-declarative adaptive mechanisms. This insight led us to propose that AD would specifically disrupt the fast, declarative aspect of motor adaptation while preserving the slower component. To test this hypothesis, we studied 20 early-stage Alzheimer's patients (diagnosed with either amnestic mild cognitive impairment or mild dementia) and 21 matched control participants. They engaged in a reach adaptation task that involved spontaneous recovery following sequential exposure to opposing force fields. We assessed adaptation through error clamps and calculated an adaptation index (AI). Both groups demonstrated

spontaneous recovery, although the patients exhibited a slight reduction in overall adaptation. The AI's time course was analyzed using a hierarchical Bayesian two-state model, which characterizes each dynamic state by its retention and learning rates. The model indicated that AD specifically affected the fast adaptive process, leaving the slower process intact. Notably, the retention rate of the fast process was significantly lower in the patients compared to controls, confirming that the memory associated with the declarative, rapid process is compromised in AD. The preserved slower process, which relies less on error correction, supports clinical approaches that focus on errorless learning for individuals with dementia. These findings refine theoretical models of motor learning while highlighting potential translational applications in neurorehabilitation.

S.14.2 - Cognitive contributions to walking in older adults

Shuqi Liu [1], Andrea Rosso [1], Andrea Weinstein [1], Emma Baillargeon [1], Gong Tang [1], Helmet Karim [1], Gelsy Torres-Oviedo [1]

[1] University of Pittsburgh

Walking is typically governed by automatic processes involving structures like the basal ganglia, which are vulnerable to age-related functional decline. This study posits that older adults increasingly depend on cognitive mechanisms to compensate during walking, with the effectiveness of this compensation influenced by cognitive health. To investigate, we examined young adults (n=12), older adults without mild cognitive impairment (MCI) (n=12), and older adults with MCI (n=7) in two cognitively demanding aspects of walking: attentional control of gait and locomotor savings.Attentional control of gait was assessed via prefrontal cortical activation during dual-task walking. Results indicated that older adults with MCI exhibited significantly higher reliance on attentional control compared to their cognitively healthy counterparts ($p=0.03$), who themselves showed a trend toward greater reliance than young adults ($p=0.07$). Locomotor savings, measured as performance improvements following repeated exposure to split-belt walking (where legs move at different speeds), revealed diminished savings in MCI participants (n=2) compared to older adults without MCI ($p=0.067$), who performed worse than young adults ($p=0.005$). Furthermore, among older adults, greater attentional control during walking was positively associated with enhanced locomotor savings ($r = 0.50$, $p = 0.02$), suggesting that attentional compensation may facilitate adaptive walking mechanisms in aging but is unnecessary for younger individuals. Data collection continues to explore this relationship in MCI participants. Our ongoing work will identify neuroimaging evidence linking these behavioral markers with connectivity between basal ganglia, cerebellum, and cerebral networks.In summary, findings demonstrate that cognitive compensation during complex walking tasks is both necessary and advantageous for healthy aging but becomes restricted in individuals with MCI, an early indicator of Alzheimer’s disease and related dementias.

S.14.3 - Gait adaptation and modulation deficits in older adults with and without cognitive impairments

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Motor-cognitive interactions are impaired in neurotypical aging and in individuals with mild cognitive impairments. We will discuss the results from recent and ongoing studies focusing on gait dysfunction and functional mobility deficits in older adults. The first study investigates locomotor adaptation in individuals with Alzheimer's Disease (AD) and mild cognitive impairment (MCI) compared to healthy older adults (HOA). Our results indicated a significant decrease in locomotor adaptation and gait-cognitive dual-task capacity in older individuals with MCI and AD compared to HOA. Furthermore, we found an association between the magnitude locomotor adaptation and cognitive test scores, suggesting that greater cognitive impairment is associated with reduced walking adaptability in response to split-belt perturbations. The second study explores the effects of aging and MCI on the ability to modulate spatial, temporal, and spatiotemporal gait features during overground gait in older adults, in the context of music- and dance-based therapies. We compared gait performance during novel rhythmic movement sequences between HOA and MCI groups. We found that individuals with MCI showed reduced accuracy in spatiotemporal gait modifications compared to HOA. Additionally, exciting new results (unpublished) from our lab show differences between young and old adults in corticospinal excitability (measured using transcranial magnetic stimulation) during varying levels of balance and cognitive challenges, providing further support for a reorganization of attentional and motor cortical resource allocation in older adults without and with cognitive impairment. Overall, these studies highlight the link between cognitive impairments and gait / balance dysfunction in older adults, and suggest that improved understanding of these cognitive-motor impairments and their underlying neural mechanisms can aid early detection and inform intervention design to improve functional mobility in older adults with cognitive impairments.

S.14.4

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Symposium 15: Perturbation-based balance training – the way to go in falls prevention?

S.15.1 - Effects of trip and slip training on daily-life falls and neuromuscular mechanisms

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Background and Aim:

Perturbation-based balance training (PBT) is an effective strategy for reducing falls in older adults by replicating the biomechanical and neuromuscular demands of real-world balance threats. However, the extent to which PBT must be task-specific to maximise effectiveness remains unclear. This work investigates how different PBT modalities influence neuromechanical adaptations, the degree of skill transfer across perturbation types, and their real-world impact on fall rates. The primary aim was to determine whether trip and slip training—highly representative of real-life falls—offers superior protection against daily-life falls compared to other forms of PBT.

Methods:

We examined three distinct PBT approaches: (1) treadmill-based belt accelerations, (2) an 8-metre custom walkway delivering trips and slips, and (3) low-cost reactive step training using manual perturbations. Experimental studies compared gait, kinematic, and neuromuscular adaptations between treadmill- and walkway-based PBT. The primary clinical evidence comes from the SafeTrip trial, a randomised controlled trial of 111 community-dwelling older adults (≥65 years) who underwent walkway-based trip and slip training. Falls and fall-related injuries were prospectively tracked over 12 months using weekly SMS surveys.

Results:

Each modality induced significant but task-specific adaptations in gait, balance and muscle responses. Limited transfer of reactive balance skills was observed between different perturbation types. Participants exposed to trip and slip training on the walkway demonstrated a 57% reduction in fall-related injuries over 12 months compared to controls. These outcomes were underpinned by enhanced neuromuscular responses, including quicker activation of key lower-limb muscles and more effective reactive stepping strategies.

Conclusion:

These findings highlight the importance of high task-specificity in PBT and support the use of trip and slip training to reduce fall risk in older adults. While alternative modalities also yield benefits, those that replicate the mechanics of actual trip and slip events appear most effective for injury prevention. Future directions should prioritise the development of accessible, scalable, and task-specific PBT solutions suitable for clinical and community settings.

Keywords:

Falls prevention, perturbation-based balance training, ageing, task-specificity, reactive balance, neuromechanics, trip, slip

S.15.2 - Reactive balance in standing improves following participation in Reactive-Based Perturbation training performed on a perturbation bicycle

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BackgroundPerturbation-based balance training (PBT) is an effective regime that reduces fall rates dramatically by triggering and improving balance recovery skills, usually during walking and standing. However, high physical demands involved in RBT pose an accessibility challenge for many older adults. In addition, controlling trunk movements consistently reflects effective reactive stepping thus worth to be trained. AimWe aimed to investigate if PBT during seated hands-free stationary cycling, which specifically challenges trunk reactive responses, improve reactive and proactive balance control measures in standing.MethodFifty-six community-dwelling older adults, 70+ years of age, walking independently without assistive devices were recruited. They were randomized to a two-arm parallel-group, single blinded randomized controlled trial with concealed allocation, blinded assessors and data analyzers, with intention-to-treat analyses. The two groups performed twenty sessions of seated stationary cycling, 20 minutes each, over 12 weeks, while performing concurrent cognitive tasks: one group, cycling hands free, received perturbations with real-time implicit sensorimotor feedback (PBT n=29) while the other, standard cycling training (SCT, n=27) cycled using hands and did not receive perturbations.Outcome measures The primary outcome measures were the reactive balance measures in standing, e.g., single-step threshold, multiple-step threshold, and the probability of stepping. Secondary outcomes were proactive balance, including the voluntary stepping Test, and 6-Minute Walk Test (6MWT). Measures were taken at baseline and immediately post interventions.Results The group-by-time interactions indicate that perturbation training improved balance reactive responses i.e., increased single- and multiple-step thresholds in mediolateral perturbations (p=0.001, effect size [ES]=0.88, and p=0.001, ES=0.64, respectively) and multiple-step threshold in anteroposterior perturbations (p=0.022, ES=0.34), anddecreased the probability of stepping compared to standard cycling training. Perturbation training also resulted in faster voluntary step reaction (p=0.011, ES =-0.84) and foot contact times (p=0.037, ES =-0.56). Both groups significantly improved their 6MWT results. An additional analysis will be introduced in the symposium where we will present analysis of trunk and arm reactive responses to unannounced perturbations while standing pre versus post interventionConclusionOlder people can generalize balance skills acquired through reactive balance training in sitting into improvement in reactive and proactive balance measures in standing. Registration clinicaltrials.gov, NCT03636672, https://clinicaltrials.gov/study/NCT03636672 Key words: Fall prevention; Older adults; Balance control; Reactive balance; Proactive balance; Perturbation-based balance

training Key points: Generalization of skills: Older adults transferred balance gains from seated cycling to fall resistance in standing.Optimized training: Adapting perturbation training to neuromotor capacities enhances real-life applicability.

S.15.3 - Training at the limit of balance control on a perturbation treadmill to prevent unrecovered falls in geriatric patients with and without cognitive impairment (TRAIL) – a study protocol

Jessica Koschate-Storm [1], Christian Werner [2], Michael Schwenk [3], Ulrike Trampisch [4], Jochen Klenk [5], Rainer Wirth [4], Clemens Becker [6], Tania Zieschang [7]

[1] University of Oldenburg, [2] Agaplesion Bethanien Hospital Heidelberg, [3] University of Konstanz, [4] Marien Hospital Herne, [5] Ulm University Medical Center, [6] Heidelberg University, [7] Carl von Ossietzky University of Oldenburg

BackgroundIn Germany, ≥6 Mio. older persons fall each year. About 25% of falls are unrecovered, situations in which the person needs help to get up after the fall. While established exercise-based fall prevention programs can decrease fall rates by 24% [1], gait adaptability training (GAT) was reported to reduce fall rates by 42% [2]. Perturbation-based balance training (PBT) as one form of GAT, has previously been directed towards older adults with a low fall risk, although fall related injuries usually affect populations with high fall risk. So far PBT has not been conducted in fall-prone geriatric populations. Furthermore,the high-risk group of older adults with cognitive impairment (CI) has not been sufficiently studied in falls prevention in general [1] as well as in GAT. AimThe aim is to confirm the effectiveness of PBT on a treadmill, to reduce falls in a fall-prone geriatric population with and without CI. MethodsIn this multi-center assessor-blinded, randomized controlled trial, PBT on a treadmill (intervention group: n=198) is evaluated against conventional treadmill walking without perturbations (control group: n=198). Geriatric patients aged ≥70 yrs, with a prospective fall risk of ≥40% and the ability to walk ≥70m in the 2-minute walk test will be enrolled following informed consent. Cognitive status is assessed using the Montreal Cognitive Assessment, with scores below 25 points indicating cognitive impairment. All participants will complete nine training sessions with six sets of 2.5 min walking each (intervention group with 24-40 perturbations per session). PBT intensities are adjusted progressively to challenge the limits of balance control, as this is likely the most effective training approach. The primary outcome is the rate of unrecovered falls within 12 months after the intervention. Unrecovered and recovered falls will be documented with fall calendars combined with monthly telephone interviews and third-party confirmation. The primary efficacy endpoint, unrecovered fall rate within 12-months, will be compared between groups by a multi-level Poisson regression model at a two-sided significance level of 5% with the study centre and the randomization block as random effect.ResultsBased on pilot studies and the available literature, we expect a reduction of ≥50% in unrecovered falls during the following year in the PBT group. Considering the promising results of former exercise interventions with people with CI [3], a similar reduction of unrecovered falls is expected. ConclusionThe

short duration, pragmatic frequency, high and individualized intensity, task specificity, as well as safety of PBT will improve the treatment of the rapidly growing group of fall-prone older adults. The effectiveness of PBT in older adults with CI will be particularly valuable for inclusive fall prevention on a larger scale.

S.15.4 - Influence of reactive balance training program characteristics on reactive balance control and fall risk: A systematic review and meta-analysis

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Introduction- Diverse Reactive Balance Training (RBT) programs have been developed for fall prevention. While these programs have shown to be effective for preventing falls, there is significant variability in intervention characteristics (e.g., perturbation type, and training volume and intensity) and in study findings. Intervention effectiveness is likely dependent on features of the intervention; however, little is known about the optimal way to deliver RBT. This systematic review and meta-analysis aimed to determine the optimal intervention characteristics for RBT for improving reactive balance control and preventing falls in daily life. Methods- We searched MEDLINE ALL, Embase, Physiotherapy Evidence Database and Cochrane for randomized controlled trials of RBT that reported on a measure of reactive balance control and/or falls in daily life. The following details were extracted from the data: study population; intervention characteristics (number, duration, and frequency of sessions; type, intensity and number of perturbations; description of the control intervention; and program duration); reactive balance outcomes pre- and post-intervention, and number of falls in daily life post-intervention. Risk of bias (RoB2) and certainty of evidence (GRADE) assessment were completed. Exploratory meta-regressions probed the influence of study components on reactive balance control and falls in daily life.Results- Thirty-two studies were included; 25 reported a reactive balance outcome, and 19 reported falls in daily life. For reactive balance control, there were concerns of bias from selection of reported results (20/25), and low risk of bias from randomization (19/25), missing data (24/25) and outcome measurement (21/25). Falls in daily life had high or some concerns of bias in outcome measurement (12/19) and selection of reported results (15/19); there was low risk of bias for missing data (18/19) and deviations from the intended interventions (15/19). Meta-regression found RBT programs that included manual perturbations were associated with reduced fall rate compared to the reference (waist pull perturbations; rate ratio: 0.45; 95% confidence interval: [0.22, 0.91], p=0.042). There were no other significant relationships between any other training parameters and fall rate or reactive balance control. Quality of evidence (GRADE) was low for both reactive balance control and falls in daily life.Discussion- While there was some evidence for ideal perturbation type for fall prevention, we were unable make any definitive conclusions regarding optimal RBT characteristics. High variability in training protocols between studies and under-reporting intervention characteristics prevented comprehensive analysis of existing studies. Future RBT studies should provide more descriptions of training protocols and include head-to-head comparisons of different training parameters (e.g., perturbation types or intensities).

Symposium 16: The use of large-scale virtual reality systems for basic and clinical research of gait and posture

S.16.1 - Studying integrative processes of cognitive, motor and affect competencies in health adults using virtual reality

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Interactions between cognitive processes, interpretation of sensory stimuli, affective state and motor actions constitute natural human perception and behavior. However, experimental set-ups designed to delineate multifactorial behavior associated with these interactions are limited. The main drive of this project is the notion that a more holistic approach is needed to study natural human perception and behavior. Rather than isolating each of the human competencies, all functional domains, which are constantly interacting with one another, should be addressed in an integrated manner utilizing multimodal technology-based paradigms.Herein we use a unique mobile activity paradigm introducing validated neurocognitive evaluation during virtual immersive scenarios which require complex multi-motor skills such as walking, visual searching, and gross manual movements. Specifically, we used a virtual reality (VR) adaptation of the Color Trails Test (CTT), which assesses sustained visual attention (SVA) and divided attention (DA), utilized in a large-scale VR with incorporated treadmill to perform while walking. The mobile VR-CTT paradigm, thus, allows to study head-hand motor coordination and gait patterns in the context of executive function in a manner which allows incorporating some of the environmental richness of real-world interaction during precision measurement. Head and hand kinematics data is obtained from a motion capture system placed around the participant and gait parameters are collected from force plates embedded in the treadmill belts, i.e., allowing to characterize motor behaviors. Furthermore, we aim to characterize how these manipulations on cognitive-motor integrations influence affective responses as reflected by the reactivity of the autonomic nervous system (ANS). To that end we also collect physiological data i.e., heart rate (by means of electrocardiogram – ECG) during tests.The entrance of virtual reality (VR) paradigms to the behavioral neuroscience arena offers the unparalleled ability to characterize and modulate, within a rigorously controlled, yet ecological, environment, the inter-relationship among human cognitive, affective, and motor systems, in the effort to delineate integrative perception-action behaviors.

S.16.2 - Effects of age and physical activity on adaptation of kinematic and spectral gait parameters to optic flow perturbation

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Background and aim: Advanced age is associated with an increased reliance on visual information to maintain walking balance, but physical activity (PA) may mitigate this dependence through the preservation of proprioceptive and vestibular function. In this study, we exploited large-scale virtual reality to examine whether age-related effects in responses to optic flow perturbation are modulated by PA.Methods: Sixty participants (divided into four groups of 15: young active, young inactive, old active, and old inactive) walked for 14 minutes: 3 minutes of unperturbed baseline, 8 minutes with optic flow perturbations, and 3 minutes unperturbed. The participants walked through a virtual hallway displayed on a 180° semi-curved screen in front of the treadmill, which moved in the anteroposterior direction at a belt-speed-matched velocity. A mediolateral perturbation signal, composed of three sinusoids, was superimposed on the existing projection, to perturb the optic flow. Positional data was recorded from markers on the sacrum and heels, along with ground reaction forces, to measure step width (SW) and mediolateral margins of stability (MoS). To quantify whether the mediolateral body-sway was related to the perturbation signal, we computed the power spectral density (PSD) of the mediolateral movement of the sacrum marker and its coherence with the perturbation signal, both evaluated at the dominant frequency of the perturbation signal (0.250 Hz). To assess the interaction between age and PA on responses to optic flow perturbation, repeated measures ANOVAs were conducted: (1) comparing baseline (last 60 steps of baseline) and early perturbation (first 60 steps of perturbation), and (2) comparing early perturbation and late perturbation (last 60 steps of perturbation). Pairwise comparisons with Bonferroni correction were used when interaction effects were found.Results: The optic flow perturbation initially elicited higher SW (36.8%), MoS (56.6%), and PSD (1017.1%) (all $p<0.001$, figure 1). In addition, PA modulated age-related effects on PSD from baseline to early perturbation ($p=0.026$), as older active adults showed 57.6% higher PSD than older inactive adults ($p=0.010$), while young active and inactive adults did not differ. With prolonged exposure to the optic flow perturbation, SW and PSD decreased 11.9% and 43.1%, respectively, towards baseline levels (both $p<0.001$). The effect of PA on PSD differed between age groups, with older active adults showing 48% higher PSD compared to older inactive adults ($p=0.031$). Again, young active and inactive adults did not differ. Furthermore, the coherence increased by 112.1% from early to late perturbation ($p<0.001$) and inactive adults showed 120.5% higher change of coherence across phases compared to active adults ($p=0.038$).Conclusion:

These findings suggest that PA negates age-related declines in adapting to optic flow perturbations, highlighting its role in enhancing adaptive capacity across age groups.

S.16.3 - Gait assessment through the GRAIL system in children with Cerebral Palsy during Agilik exoskeleton training

Roberta Nossa [1], Giorgia Malerba [2], Eleonora Diella [1], Riccardo Riboni [1], Luca Molteni [1], Valentina Grasso [1], Mattia Chiappini [3], Cristina Maghini [1], Fabio Alexander Storm [1], Emilia Biffi [1]

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Cerebral Palsy (CP) is the leading cause of motor impairment in children, frequently leading to reduced mobility. A common gait abnormality in CP is crouch gait, marked by excessive bending of the knees, increased inward movement of the hips, and altered ankle positioning. Therapeutic interventions, such as locomotor training and robotic-assisted gait therapy, have been shown to enhance motor function in children with CP.The Agilik exoskeleton (Bionic Power Inc., Vancouver, Canada) is a motorized device designed for children, comprising two customized Knee-Ankle-Foot Orthoses (KAFOs), each featuring a brushless actuator at the knee. These actuators are capable of generating up to 12 Nm of torque at the knee joint, facilitating both flexion and extension during different walking phases. The system utilizes force-sensitive resistors in the footbed and measures knee angular velocity to identify the patient's gait phase, enabling the motor controller to deliver personalized torque, which is adjusted for each patient through the Agilik software.A pre-post single-group study is underway at IRCCS Medea to evaluate the effectiveness of Agilik in children with crouch gait due to CP (NCT05746871, Ethics Committee approved - Prot. N.75/22—CE, 28/12/2022). After initial assessment, children undergo 10 sessions of Agilik training with a physical therapist. In addition to demographic and functional outcomes (e.g., six-minute walking test, Gross Motor Function Measure), comprehensive multistep gait analysis is performed before and after training during level-ground, uphill, and downhill walking using the GRAIL (Gait Real-time Analysis Interactive Laboratory, Motek, the Netherlands). This system is equipped with an optoelectronic system, a motion platform with integrated force plates, a treadmill, and a 180° screen for virtual reality-based exergames. After training, gait assessments are also conducted while walking with Agilik in the 3 conditions. Data are analyzed with custom algorithms in Matlab to extract gait features.To date, 8 patients (4 M, mean age 12.3±3.4) have been enrolled. Results are available for two patients (1 male). No significant changes were observed in knee and hip range of motion (ROM) during level-ground, downhill, and uphill walking between the pre- and post-assessments. In contrast, when comparing walking without and with Agilik at T1, both patients showed improvements in knee ROM during level-ground (78%), uphill (48%), and downhill (49.4%) walking. Interestingly, one patient also demonstrated increased hip ROM across all walking conditions (139%, 43.5%, and 48.6%, respectively).

S.16.4

Will Young [1]

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O.01: Coordination of posture and gait in PD

O.01.1 - Limb coordination in Parkinson's disease patients with freezing of gait

Marco Romanato [1], Saoussen Cherif [2], Mathieu Yeche [2], Edward Soundaravelou [1], Déborah Ziri [1], Carine Karachi [1], Brian Lau [1], Marie-Laure Welter [3]

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Background and aim: Freezing of gait (FOG) is one of the most disabling motor symptoms in patients with Parkinson's disease (PD). FOG has been associated with asymmetry in the lower limb walking pattern, indicating a disruption of limb coordination. While dopaminergic (DOPA) medication and subthalamic nucleus deep brain stimulation (STN-DBS) has been shown to improve FOG in a significant number of PD patients, their effects on limb coordination in PD patients with FOG has not been thoroughly investigated. The study aims to determine a comprehensive representation of limbs coordination capable of discriminating effects of DOPA and STN-DBS, and to investigate how this is deteriorated in patients with FOG, in relation to clinical evaluations.Methods: We recorded full-body gait kinematics in 18 PD patients (mean age = 61.6 years, FOG questionnaire (FOG-Q) = 26.8) in four conditions: pre-surgery OFF-DOPA and ON-DOPA, and post-surgery with STN-DBS OFF and ON. Marker accelerations of 19 anatomical landmarks were used to construct a cross-correlation matrix then represented as a topological network, where nodes denoted anatomical landmarks, and directed weighted links denoted cross-correlations values. Nodal connectivity (i.e., the sum of the weighted links of a single joint) was computed and interlimb connectivity metrics derived: homolateral, contralateral, lower and upper interlimb. Multilinear regression models were used to fit the coordination metrics to predict clinical scales (i.e., gait and balance score (GABS) or FOG-Q) outcomes. Results: Pre-surgery, homolateral and contralateral connectivity significantly improved with ON-DOPA compared to OFF-DOPA, resulting in a smoother and more coordinated gait pattern. Post-surgery, STN-DBS has a similar effect on these variables. Pre-surgery, lower limb connectivity is improved with ON-DOPA, while, post-surgery, with STN-DBS ON improved upper limb connectivity (Figure 1). Multilinear regression models showed that lower limb connectivity pre-surgery OFF-DOPA is predictive for GABS improvement post-surgery ($R = 0.6$, $p = 0.007$, R2model = 0.44, pmodel = 0.02). Contralateral connectivity post-surgery ON STN-DBS, negatively correlates with GABS in the same treatment condition ($R = -0.57$, $p = 0.02$, R2model = 0.52, pmodel = 0.02), and with FOG-Q score ($R = -0.49$, $p = 0.01$, R2model = 0.68, pmodel = 0.02).Conclusions: Both DOPA and STN-DBS treatments enhanced interlimb coordination during walking. However, DOPA seems to be mainly effective on the lower limb connectivity, while STN-DBS has a main effect on the upper limb connectivity. A higher contralateral interlimb connectivity with STN-DBS ON results on lower scores of GABS and FOG-Q. As increasing literature is reporting an existing functional neural

coupling between arm and legs in physiological gait, our findings suggest that the dissociation on the treatment response on the coordination of the lower and upper limb could be an underlying mechanism of FOG.

O.01.2 - Characterising anticipatory postural adjustments in turning: A comparison between healthy older adults and people with Parkinson's disease

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Background and Aim Anticipatory postural adjustments (APAs) play an important role in preparing the body for voluntary movements, by stabilising posture and facilitating subsequent movements [Crenna & Frigo, 1991]. While APAs have been extensively studied in gait initiation, limited research has focused on APA during non-linear movements, despite their prevalence in daily activities [Glaister et al., 2007]. This study aims to address this gap by characterising APAs in turning and exploring differences between healthy older adults and people with Parkinson's disease (PD). We also explored whether people with PD exhibit asymmetries in APAs when turning towards their most versus least affected side.MethodsWe recruited 22 people with PD (8 self-reporting freezing of gait) and 17 healthy older adults in this cross-sectional study. Participants performed a series of uncontrived 360° turns embedded in a complex walking task designed to reproduce key features of daily activities. Only turns preceded by at least three seconds of quiet posture were included in the analysis. Turns preceded or including a freeze event were excluded. APAs and first step characteristics were recorded using motion capture and force plates. APAs features (i.e. duration, amplitude, and trajectory), and first-step characteristics were extracted. APAs were normalised for the base of support and centre of pressure trajectories were time normalised to allow the comparison of waveforms through coefficients of multiple correlation (CMC). Characteristics of turns (i.e. direction and stepping leg) were recorded. Statistical comparisons were made between the groups and within the PD group for turns initiated with the most versus least affected side.Results APAs before turning had similar features to those observed in gait initiation, with both imbalance and unloading phases overall present before the movement. APAs in turning showed a high variability (CMC=.22). People with PD demonstrated significantly smaller spatial features of unloading APAs (.7cm±.3cm p=.008) and shorter steps (8cm±8cm p=.021) compared to healthy controls (13cm±.7cm; 14cm±8cm, respectively). There were no significant differences in APAs based on the side of initiation in the PD group, though a preference to turn towards the least affected side using the most affected leg as the standing leg was observed (Table 1).Conclusions These findings suggest that APAs during turning resemble those seen in gait initiation and are significantly reduced in people with PD. This reduction may contribute to the turning difficulties often experienced by this population. The lack of asymmetrical differences in APAs, but clear preference for a particular turning strategy,

offers new insights into motor behaviour of people with PD. This has potential implications for monitoring disease progression and designing rehabilitation interventions, emphasizing the need to tailor strategies to address turning challenges people with PD face in their daily life.ReferencesCrenna & Frigo (1991), 10.1113/jphysiol.1991.sp018616Glaister et al. (2007), 10.1016/j.gaitpost.2006.04.003

O.01.3 - Investigating foot placement control as a mechanism of gait instability in Parkinson's disease

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Gait impairments in Parkinson's disease (PD), commonly characterized by reduced gait speed, shorter step length, and increased variability, are well known and associated with unstable gait. Although these descriptive measures are already used for predicting fall risk, the actual mechanisms underlying gait instability in PD remain not fully understood, limiting our abilities to design effective gait interventions. During walking, the centre of mass (CoM) is positioned high above a small base of support. Therefore, feedback control of CoM movement is required to avoid that any deviations of CoM movements lead to a fall. Healthy individuals can effectively correct deviations in CoM movement by stepping in the direction of the deviation, where over 80% of the variance in mediolateral foot placement can be predicted from the CoM state [1]. In contrast, stroke patients demonstrate a reduced ability to appropriately control foot placement of the paretic limb [2]. This raises the question of whether a similar deficit in foot placement control exists in individuals with PD, potentially explaining their increased fall risk.To address this, the present study aimed to investigate whether foot placement control is impaired in PD. A dataset with Forty-seven people with PD (mean age: 60 years, mean PD onset: 9 years) and 46 healthy subjects (mean age: 66 years) was reanalysed in this study. Participants performed 10 minutes of continuous overground walking at self-selected, comfortable walking speed in a laboratory setting while 3D kinematics were collected using an optical motion capture system. We quantified foot placement error in both the medio-lateral and anterior-posterior direction, defined as the deviation of the foot placement predicted based on the CoM kinematic state and the actual placement.Preliminary results indicate that individuals with PD exhibit significantly larger foot placement errors compared to healthy controls (Figure 1). In medio-lateral direction, foot placement errors were 1.87 ± 0.46 cm for PD participants compared to 1.30 ± 0.22 cm for controls ($p < 0.001$). Similarly, anterior-posterior foot placement errors were 2.30 ± 0.83 cm for PD participants versus 1.72 ± 0.68 cm for controls ($p < 0.001$).Our results suggest that feedback control is impaired in people with PD, as indicated by a less accurate coordination between foot placement and CoM kinematics, which appears to be consistent across both anterior-posterior and medio-lateral movement directions. Another novel aspect of this study is the use of overground walking data, providing a more naturalistic context for analysing foot placement control in PD. Understanding the mechanism underlying decreased gait stability in PD is particularly important for developing more effective gait interventions targeting this specific deficit. However, further research is needed to identify how impaired sensorimotor integration in PD affects the successful execution of this foot placement strategy. [1] Wang Y, Srinivasan M, Biol. Lett.10:20140405.[2] Dean JC, Kautz SA. J Rehabil Res Dev. 2015; 52(5):577-90.

O.01.4 - Effect of intensity personalization on wearable systems for real-time freezing of gait prevention in Parkinson's disease

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BACKGROUND AND AIM: Cueing has been shown to help reduce the occurrence and duration of freezing of gait (FOG) episodes for people with Parkinson's disease (PD). However, rhythmic cues can exacerbate FOG if not synchronized with the person's walking cadence. Additionally, continuous cueing may lose its effectiveness over time as users become accustomed to the cueing. To address these challenges, selective cueing, which adapts the cue in real time, may prevent habituation and more effectively mitigate FOG. METHODS: Our previous work introduced a wearable smart-cueing device designed to mitigate FOG. The current study aimed to test different cueing intensities to personalize the system for individual users. Fifteen participants walked a freeze-inducing path 30 times using the FOG prevention device. Data from eight participants included sufficient FOG episodes to allow for drawing conclusions. The device used a machine-learning model to process plantar-pressure data to detect FOG in real time and trigger a sensory cue. For every set of 10 trials, the device was set to low, medium, and high intensity based on each participant's response to the cue. A within-participant design was used to assess changes in FOG time per trial (FTPT) between trials with cueing on and trials with cueing off for each intensity. FTPT with the device off was subtracted from FTPT with the device on, meaning that negative values are desirable. Percentage differences relative to FTPT with the device off were also calculated. RESULTS: With the least beneficial device setting for each person, participants averaged a 1.0 s increase (+22.0%) in FTPT. However, with the optimal setting for each person, there was a 1.0 s reduction (-16.7%) in FTPT. Half of the participants had an increase in FTPT while the other half had a decrease in FTPT at higher intensities. Also, all participants except two had less difference in FTPT between medium and high intensity compared to between low and medium intensity. CONCLUSIONS: Cueing intensity affected the device's ability to mitigate FTPT. For most participants, the device's effectiveness plateaued at medium intensity. The start of the plateau could signify the most effective and minimally invasive device setting for a participant that has reduced freezing with the device on. However, the reason for the split in the population between increased and decreased FTPT is unclear. Further analysis of the differences between the groups, such as presentations of FOG and PD, may further our understanding of FOG itself. ACKNOWLEDGEMENTS AND FUNDING: This research was funded by Weston Family Foundation through its Weston Brain Institute, Microsoft Canada, Waterloo Artificial Intelligence Institute and Network for Aging Research at University of Waterloo, Natural Sciences and Engineering Research Council of Canada (NSERC), Ontario Ministry of Colleges and Universities, and University of Waterloo.

O.01.5 - Enhancing fall risk assessment in Parkinson's disease using ai-driven contextual gait analysis

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Enhancing Fall Risk Assessment in Parkinson's Disease Using AI-Driven Contextual Gait Analysis Jason Moore1, Alan Godfrey1 1 Department of Computer and Information Science, Northumbria University, Newcastle Upon Tyne, U.K.Background and AimsFree-living gait assessment for fall risk in Parkinson's disease (PD) often relies on inertial measurement units (IMUs) to quantify temporal and spatial gait characteristics. However, that method alone lacks critical contextual data which may lead to an overestimation of fall risk due to random environmental factors e.g., obstacles. This study integrates IMU with wearable eye-tracking glasses and AI-driven computer vision (CV) and aims to enhance free-living gait assessment by providing contextual (environment) and behavioural (gaze) insights for a more informed (multi-modal) fall risk assessment.Methods:Seven participants with PD were equipped with a waist-mounted IMU and wearable eye-tracking video glasses for a 3-hour free-living assessment. IMU data (100Hz, ±8g) were processed with validated algorithms to derive gait characteristics (e.g., step time variability). Video data were analysed using a validated fine-tuned YOLOv8 model trained on 3,085 annotated home-environment images. The model detected and anonymized sensitive objects (e.g., blurred/obfuscated people's faces) while identifying environmental obstacles and participants' gaze patterns (e.g., what the participant was looking at while they walked). Synchronizing IMU-derived gait variability with environmental context enabled absolute clarity between intrinsic gait irregularities or natural adaptations to extrinsic surroundings (e.g., obstacles).Results:IMU data alone suggested several high fall-risk bouts, evidenced by elevated step time variability (e.g., 0.20s) within those bouts compared to other bouts with general low variability (e.g., 0.01s). However, when examined with contextual descriptions from the YOLOv8 model, these high-risk bouts were explained by natural adaptive responses to environmental challenges, such as navigating stairs, avoiding pets, or interacting with obstacles. Eye-tracking (gaze) data confirmed a natural response as participants focused on e.g., hazards, obstacles or other people, reducing the perceived number of high-risk events. For example, during the preliminary analysis of 10 gait bouts, 4 instances of possible heightened fall risk were identified using accelerometer-based gait characteristics alone. However, three of these instances were dismissed when contextualized through the proposed CV methodology. For example, (i) where gait variability increased briefly a period of stair ambulation was observed (ii) a decrease in step time but increase in gait variability was contextualised as navigation around a household pet and (iii) an increase in step time asymmetry (0.09s vs. 0.01s) was explained by the participant look at and stepping over clutter on the floor. This demonstrates how contextual analysis minimizes false positives (of elevated fall risk) by identifying natural compensatory behaviours rather than pathological gait disturbances.Conclusions:The integration of IMUs with wearable video glasses and AI-driven CV significantly reduces perceived high fall-risk events by providing explainable gait variability and accounting for natural environmental adaptations. This approach enhances the accuracy of free-living gait assessment to inform fall risk and could enable more personalized interventions while preserving privacy. Ongoing research is recruiting more participants with PD and growing the generalisability of the model to validate this method in larger cohorts and refine workflows to unify gait and contextual data for robust risk profiling.Words: 483

O.01.6 - Discordance between balance ability and perception predicts falls in Parkinson's disease: A coordinated analysis and replication

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Background and Aim: Discrepancies between perceived and actual balance abilities, or discordance, have been linked to functional outcomes, including falls. Despite this, there is still limited understanding of how to quantify this mismatch and its connection to relevant outcomes. This study aimed to explore a novel method for measuring concordance and discordance between balance performance and perception and examine its association with falls in individuals with Parkinson's disease (PD).Methods: Data from 244 participants with PD were pooled from five prior studies. The extracted variables included age, sex, Activities-Specific Balance Confidence scale (ABC) (perceived balance), Timed Up and Go (TUG) (balance performance), Movement Disorder Society Unified Parkinson Disease Rating Scale (MDS-UPDRS) part III scores, and retrospective falls (6- or 12-months). Data validation across studies was ensured. Discordance was quantified as the difference between the predicted ABC, based on TUG performance, and the reported ABC. This was also analyzed in a separate sample of 171 participants with PD.Results: Two discordance calculation methods were evaluated: simple linear regression and segmented regression. No significant differences were found between the two approaches (p=0.520), so simple linear regression was used in the subsequent logistic regression analysis. Discordance emerged as the only significant predictor of fall history (OR:0.98, p=0.003), after adjusting for age, MDS-UPDRS part III, sex, and TUG. The results indicate that individuals with more negative discordance (under-confidence) had higher odds of being classified as a faller. Including discordance

in the logistic regression improved predictive accuracy by 58%. These results were confirmed in replication analyses.Conclusions: Discordance between actual and perceived balance was found to be significantly related to fall history in people with PD. Clinicians and researchers should consider addressing this mismatch between perception and ability as a modifiable factor to target and reduce fall risk. Future research should identify which factors are related to discordance and may be secondary targets to holistically address fall risk while maximizing physical engagement and participation among people with PD.Acknowledgements and Funding: The authors acknowledge the support of the Saint Louis University Applied Health Research Council, the Irma Ruebling Endowed Research Fund, the Michael J. Fox Foundation (under Grant #008373), Department of Veterans Affairs Grant RX001075, NIH, NIA Grant R01AG006457, and NIH, NICHD grant R25HD105583-03.

O.01.7 - Diurnal variations in gait quality in isolated REM sleep behaviour disorder

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Background: Isolated REM sleep behaviour disorder is a parasomnia that is considered to be a strong marker of α-synucleinopathies such as Parkinson's disease (PD) and dementia with Lewy bodies (DLB). Although individuals with iRBD can appear normal with respect to PD or DLB symptoms, previous research has shown subtle motor deficits in gait and balance are present in this population. In healthy older adults, and patients with Alzheimer's and Parkinson's disease, diurnal variations in gait and posture have been observed, showing patterns where gait and posture may be better in the morning/afternoon compared to the evening. In Alzheimer's disease, for example, this may be due to the sundowning effect. Given that iRBD can present with motor abnormalities, the purpose of this study is to assess whether there are any diurnal changes in gait quality during daily life in iRBD relative to healthy controls. Methods: 13 participants with iRBD (64.4 ± 8.5 years, 10 M) and 19 healthy controls (61.5 ± 9.2 years, 5M) were included in this study. Participants completed at home gait monitoring while wearing three IMUs, two in custom made socks and one at the lumbar spine (Clario). We included the hours of 8 AM to 8 PM to ensure sufficient gait bouts for analysis. Spatiotemporal gait characteristics included cadence, gait speed variability, stride length, and stride length variability. To investigate diurnal changes in gait patterns between groups, linear mixed effects models were used with subject as a random factor and time of day and group as fixed factors. Results: There was a group by time effect for stride length variability, where variability increased throughout the day in the iRBD group, with greater variability in the later afternoon/evening hours of 4-6 PM ($p = .014$) and 6-8 PM ($p = .028$), but not in the HC group. There was a main effect of group for gait speed ($p = .022$) and cadence ($p = .0034$), with lower cadence and gait speed in the iRBD group

compared to the control group. Conclusions: Changes in gait were observed over the day in iRBD, with measures such as stride length variability increasing towards the evening. Although fatigue was not quantified and sleep quality not yet analysed it may be possible that sleep disruption as a result of iRBD or fatigue can influence daytime gait patterns. Additionally, the overlap between sleep and locomotor neural circuitry may also play a role. Acknowledgements and funding: Parkinson Foundation Visiting Scholar Award

O.01.8 - From increased heart rate to stride variability: How short physical exertion can influence free walking in Cerebellar Ataxia

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BACKGROUND AND AIM:As in many neurological movement disorders, patients with cerebellar ataxia report an increase in gait impairment during physical activity, fatigue, and stress. This important patient-reported observation is not reflected in clinical gait analysis at present, and these particularly critical periods are not specifically examined in current motion analyses in patients' everyday lives either.The aim of this study is to investigate how short periods of physical activity (stair climbing) with corresponding increases in heart rate affect ataxia-sensitive gait measures during free walking using a multimodal approach combining wearable motion and heart rate monitoring.METHODS:We evaluated gait changes in 32 individuals with degenerative cerebellar disease (SARA: 7.3±5.1; age: 45.4±14.7) and 10 age-matched healthy controls. Gait was quantified using three body-worn inertial and barometric sensors, along with an ECG chest strap, during 10 minutes of free walking. This included a fixed sequence of straight walking, climbing a flight of stairs and walking uphill one floor, and returning. Movement analysis focused on ataxia-sensitive lateral step deviation (LSD) as well as gait speed (GS) in relation to heart rate (HR). Episodes involving stairs and inclines were identified through changes in the barometric signal and excluded from the analysis. The first free-walking segment was classified as rested (FWr), the segment immediately following the stairs and inclines as exerted (FWe), and the final segment as mildly fatigued (FWf).RESULTS:Comparisons between ataxic subjects and healthy controls revealed higher effect sizes during exerted state (e.g. LSD, FWe: $r = 0.52$, FWf: $r = 0.57$) compared to rested state (e.g. LSD, FWr: $r = 0.33$). Lateral step deviation indicated a moderate correlation with heart rate (HR) during the fatigued phase (FWf: $R=0.38$). Notably, in the moderately impaired subcohort (n=17, SARA>7, determined via median split), correlation was higher ($R_{mod}=0.51$). During the exerted walking phase (FWe), gait speed (GS) showed a negative correlation with HR (GS: $R=-0.36$; $R_{mod}=-0.58$), whereas no correlation was observed during FWr or FWf. In contrast, healthy controls displayed no significant correlations in ataxia-sensitive measures or gait speed across conditions.CONCLUSIONS:In this study, we found a significant relationship between heart rate and quality of ataxic gait. When walking after physical exertion, subjects

exhibited slower gait speeds and increased ataxia-specific spatiotemporal variability (LSD) compared to when they were rested. These findings suggest that physical exertion and fatigue may exacerbate gait symptoms, particularly in the later stages of the disease. Since fatigue is a common and critical aspect of daily life, it is essential for future therapy evaluation studies to examine patients' gait under fatigued conditions as well, in order to obtain a real-world estimate of treatment efficacy.

O.02 : Aging and the brain

O.02.1 - Association between mobility function and aperiodic EEG components in older adults

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Background and Aim: Mobility function declines with age to the extent that walking speed is often considered the sixth vital sign. Currently, there are no clear neurological mechanisms behind this decline, which limits early diagnoses and intervention. Measures of electrocortical dynamics using electroencephalography (EEG) may provide insight into mobility decline with aging. Components of EEG spectral power change with aging, cognitive impairment, and psychopathology. Prior work focuses on oscillatory behavior, but recent research has shown a differentiation in the aperiodic behavior (exponent and offset) of the power spectral densities (PSDs) of EEG across different age groups. Previous studies of aperiodic activity were only conducted sitting at rest, which may limit our understanding of age-related effects on PSDs during motor tasks. The aims of this study were to 1) quantify the correlation between aperiodic EEG and preferred walking speed and age in older adults and 2) compare recordings taken at rest and while walking on uneven terrain.Methods: 59 participants aged 74 ± 6 years (23 M / 36 F) walked on a custom treadmill with four different levels of unevenness at their preferred walking speed. We recorded EEG using a 120 electrode, custom-made, dual layer EEG cap. We used independent component analysis and source localization to retain brain sources before separating PSDs into periodic and aperiodic components (Figure 1A). We computed a linear mixed effect model with fixed effects for age and preferred walking speed and a random effect of condition (rest, flat, low, medium, or high terrain). Results: We observed a significant relationship between speed and aperiodic offset in all brain regions, with a higher preferred speed corresponding to a lower aperiodic offset (Figure 1B; $p < 0.025$; slope range: [-1.8, -0.4]). We also observed a relationship between age and periodic offset, but it was 10x smaller than the speed effect and only statistically significant in the left posterior parietal and sensorimotor regions (Figure 1C; slopes: 0.04 and -0.13, respectively). The relationship between aperiodic exponent and age or speed were much smaller, with the strongest relationship between preferred speed and occipital lobe aperiodic exponent ($p < 0.005$; slope: -0.64). There was no random effect of condition on the aperiodic exponent or offset (covariance estimate = 0), suggesting similar relationships at rest and across walking conditions. Conclusion: Our results indicate there are differences in the aperiodic behavior of cortical processing associated with preferred walking speed in older adults. This study provides the first evidence that aperiodic EEG is associated with mobility function in older adults. Future work may consider how other metrics of mobility and more cognitively challenging tasks correspond to aperiodic fit. Acknowledgements and Funding: This work was supported by U01AG061389, P30 AG028740, and T32AG062728.

O.02.2 - Interstride spectral power in theta band eeg is correlated with mediolateral excursion in both older and younger individuals walking at a range of speeds

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Mobile brain imaging with high-density electroencephalography (EEG) provides insight into how brain electrical activity changes with walking conditions. EEG theta band power (4-7 Hz) may represent sensory processing and increased motor demand (Richer 2024). EEG theta power is shown to correlate with loss of balance, walking on an inclined surface, and step-length asymmetry (Jacobsen 2024). The goal of this study was to determine if EEG theta band power is correlated with pelvis mediolateral (ML) excursion on a step-to-step basis, in both older and younger adults walking at a range of treadmill speeds, to further elucidate the involvement of EEG theta in sensorimotor processes. We hypothesized that stride-to-stride changes in gait kinematics would be correlated with changes in EEG theta power such that larger deviations in pelvis excursion would result in greater theta power synchronization. We collected high-density EEG data from 31 younger adults (Age 24 +/- 4 years) and 59 older adults (Age 74 +/- 5.7 years) with a range of mobility functions. Participants walked on a treadmill at 4 speeds (0.25, 0.50, 0.75, 1.0 m/s). Electrocortical activity was interpolated from the scalp level EEG using independent component analysis and subject-specific conductivity head models. For each gait cycle, we averaged the power within the theta (4-8 Hz) band. Step-to-step pelvis ML excursions were derived using shoe insole force sensors, that marked gait events, and an IMU positioned on the lower back. We applied a linear mixed effects model using ML excursion, treadmill speed, and their interactions as fixed effects with subject-specific random intercepts. We considered only models with significant interaction terms to ensure EEG power was being driven by the ML excursion and not solely the treadmill speed.Participants had an average of 907 +/- 152 strides in total. As hypothesized, we found that EEG theta power was correlated with ML excursion and treadmill speed in brain areas involved in sensorimotor and attentional control: sensorimotor (SM), posterior parietal (PP), mid cingulate (MCC), supplementary motor area (SMA), premotor cortex (PMC), and occipital (Occ). Further, EEG theta power had greater synchronization with larger step-to-step pelvis deviations in SM, Occ, PMC, PP, and SMA, especially at faster speeds.Previous research suggests that deviations in kinematic walking parameters are associated with greater theta spectral power and walking condition. Our findings confirm that for both older and younger individuals walking at a range of speeds, greater deviations in pelvis position correspond with greater theta spectral power in brain areas involved in sensorimotor and attentional processing. Also, we show that at faster speeds, ML excursion trends have more positive slope-terms, which may indicate increased attention to gait control at faster speeds.This study was supported by the National Institute of Health (U01AG061389)

O.02.3 - Age-related reduction in the contribution of the supplementary motor area (SMA) to the perturbation-evoked balance N1 during standing

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Background and aim: Electroencephalography (EEG) studies have repeatedly identified a pronounced cortical response after perturbations to standing. The evoked N1 potential, a large negative deflection approximately 150ms after the perturbation, has been linked to sensory-driven error processing. The N1 is maximum at central midline electrodes, and the supplementary motor area (SMA) has been proposed as the source accounting for most of the signal variance. However, a systematic analysis of the sources contributing to the N1 is currently missing. Understanding variations in cortical contributions to the N1 may inform our understanding of greater behavioral variability and more complex cortical engagement patterns observed in older adults in mobility related tasks. Methods: We analyzed 64-channel EEG data from older (n=20) and younger adults (n=28) during backward support-surface translations. The data were decomposed and source localized using adaptive mixture independent component analysis and equivalent dipole fitting. For each participant, independent components (ICs) identified as representing brain activity were back-projected to the channel level. The N1 amplitudes at electrode Cz were quantified using three approaches that differed in the number of brain ICs that were back-projected to electrode Cz: 1) all ICs, 2) the IC that contributed most, and 3) two ICs that contributed most to the N1. Results: We found clear N1 potentials at central electrode Cz with larger amplitudes in younger (mean amplitude for all ICs: -28.0 µV, SD: 12.1) compared to older adults (mean amplitude for all ICs: -19.5 µV, SD: 7.4). In younger adults, the Cz N1 amplitude was primarily attributable to a single IC (mean difference to all ICs < 1%), localized in or near the SMA in 27 out of 28 participants. A more distributed source location pattern was found in older

adults, where in eight participants, ICs outside the SMA contributed the most to the N1. In addition, in older vs younger adults, there was a larger difference in N1 amplitudes between the back-projected signal from all ICs and that from only the first IC. This difference was reduced from 10% to 2% when the second highest IC contributing to the N1 was added to the back-projection and mostly driven by a subgroup of older adults (n= 7). For these seven older adults, we did not find a consistent location for the second source.   Conclusion: Our findings highlight the role of the SMA as the major source contributing to the perturbation-evoked N1, measured at central electrode positions, in younger adults. However, we found a more diverse source localization pattern in older adults where the SMA was not always the primary source, and in many cases two sources contributed substantially to the N1. These findings may reflect compensatory cortical engagement in aging and could help to explain the frequently observed variability in cognitive and balance performance among older adults.

O.02.4 - Effect of perceived postural threat on prefrontal cortex activity during walking in older people with and without fear of falling

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BACKGROUND AND AIM: Little is known of the neural underpinnings of the attentional load of older people with fear of falling (FoF) during walking. Emerging research has shown that maladaptive behaviours related to excessive fear of falling during balance and walking tasks have been attributed to re-allocation of attentional demands towards the concerning elements. Additionally, older people reporting fear of falling had increased prefrontal (PFC) activity and worse walking and secondary task outcomes during dual-task walking paradigm. To date, there have been no studies that have involved a fear-inducing paradigm. Therefore, here we investigated how a perceived postural threat affects neural activity in the prefrontal cortex (PFC) during simple walking in older people. We hypothesised that compared to older people without FOF, those with FOF would exhibit higher PFC activity and walk slower [1], while perceiving a postural threat. METHOD: Fifty-seven healthy older people (mean (SD) age 74.5 (4.3) years, (n=40 women) were categorised as having low (n=37) or high (n=20) FOF (<23 and ≥23 on the Falls Efficacy Scale-International) and fitted with a mobile brain imaging system (functional near-infrared spectroscopy, fNIRS). Participants performed walking trials at self-selected speed, before and after viewing a video of older people encountering unexpected trips on the same walkway (postural threat stimulus). RESULTS: Both groups walked significantly slower after viewing the video. A group by condition interaction ($p<0.05$) pointed to reduced PFC activity in post-video walk compared to pre-video walk in high FOF and no change in low FOF. CONCLUSIONS: After being exposed to a

threatening stimulus, all older people walked slower whilst those with high FoF also had reduced PFC activity compared to pre-threat trials. Since the PFC is considered a centre for executive functions, these results suggest that in a situation of perceived postural threat and simple walking, older people with fear of falling might disengage from the threatening element, contrary to our hypothesis. Further research should aim to understand the reallocation of cognitive functions in older people with high FOF, with various levels of walking complexity. Reference:1. Holtzer R et al. The effect of fear of falling on prefrontal cortex activation and efficiency during walking in older adults. Geroscience. 2019;41(1):89-100.

O.02.5 - Uneven terrain walking is associated with brain white matter characteristics in young and older adults with varying physical function

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Background: Age differences in brain white matter (WM) structures are more pronounced than those in gray matter and are linked to declines in mobility function. Many falls in older adults occur when they are navigating uneven terrains. Diffusion weighted MRI (dMRI) measures WM microstructure using metrics like fractional anisotropy (FA), mean diffusivity (MD), and radial diffusivity (RD). This study aims to (1) compare WM microstructure measures among young adults and older adults with higher or lower physical function, and (2) examine the relationship between WM microstructure measures and uneven terrain mobility.Methods: 22 young adults (Age: 22.45 ± 2.52 yrs.), 28 high physical functioning older adults (Age: 73.96 ± 4.97 yrs.), and 58 low physical functioning older adults (Age: 76.19 ±7.33 yrs.) participated in the study. We assessed physical function with the Short Physical Performance Battery (SPPB) and grouped older adults as high-functioning (SPPB ≥ 10) or low-functioning (SPPB < 10). Structural T1-weighted and dMRI scans were acquired. A bitensor fit was applied to the dMRI scans, allowing us to separate free water and tissue compartments in the brain, denoted as FAt, MDt, RDt (Pasternak et al., 2009). On a separate day, participants walked on a custom uneven terrain treadmill at flat, low, medium, and high levels of unevenness (Downey et al., 2022). We measured two behavioral outcomes: step duration coefficient of variation (COV) and self-reported stability score. We quantified the effect of uneven terrain using two approaches: the slope of a linear fit between step duration (COV) and terrain unevenness (Downey et al., 2022), and the difference between high and flat conditions for perceived stability rating. We quantified group differences in WM microstructure and then computed correlations with the behavioral measures.Results: We observed significant differences in the WM microstructure of the superior longitudinal fasciculus and corticospinal tracts, brain regions involved in motor control and sensory integration, between young (YA) and older (OA) adults. YA showed higher FAt and MDt but lower RDt values compared to OA. There was no significant difference in the WM microstructures between high and low functioning older adults. Additionally, we observed that greater step duration COV slope-term correlated with a lower FAt in the forceps minor. However, perceived stability rating changes between high and flat conditions did not correlate with WM microstructure.Conclusions: This study supports the role of WM integrity in mobility. Declines in WM microstructure may result in decreased mobility function in older adults, particularly as they are navigating uneven terrains. These findings suggest that WM alterations, especially in motor control and sensory integration pathways, may contribute to the increased fall risk observed in older adults.Funding: NIH U01AG061389, NSF Cooperative Agreement #DMR- 1644779 with FL, NIH S10 OD021726.

O.02.6 - Gait reserve and variability as predictors of dementia markers

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Background and aim: Functional reserve of a biological system is related to resilience; whereas resilience is the ability to recover from a stressor, reserve is the capacity. Operationally defined, a system's reserve is the capacity difference between baseline and maximal function. Narrowing of reserves occurs with aging, represents a restricted capacity to respond to challenges, and could lead to increased vulnerability to disease or injury. Furthermore, too much or too little variability in a system may also represent a loss of flexibility to respond to a challenge. When measured over time, trajectories of reserve and/or variability may hold the promise of the early identification of accelerated cognitive decline and/or pathology. It is currently unknown if gait reserve or variability, individually or in combination, are more predictive of markers of dementia. Methods: Ten middle-aged (59.3±4.3 yrs.; 3male) and 9 older (70.8±5.2 yrs.; 4male) adults completed a structural MRI for total hippocampal white matter volume, and a blood draw for plasma pTau181/total Tau and beta-amyloid42/40 (AB) levels. During a gait visit, participants walked at a self-selected speed with speed increasing every 30 sec to a max speed. Gait reserve was quantified as the difference in speeds. Spatiotemporal standard deviation was calculated from the walking trial. Linear multiple regression models were used to determine if reserve or variability were stronger predictors of dementia markers with age, sex, and BMI as covariates.Results: Smaller gait reserve was predictive of decreased hippocampal volume (p=.026). No other variables were predictive of volume. No measures were predictive of tau. In preliminary models, sex, gait reserve, and step length and stride velocity variability were individually predictive of AB. In a model including these variables, female sex (p=.009) and decreased stride velocity variability (p=.034) remained predictive of a smaller AB; gait reserve was nearly significantly predictive (p=.052) and step length variability was no longer predictive (p=.503). Step width variability was not predictive of dementia markers.Conclusions: Gait reserve was predictive of decreased volumes in line with reported association between slower max walking speeds and decreased brain volumes, including in the hippocampus. Although a variety of measures

were preliminarily associated with AB, only stride velocity variability remained predictive in the final model. Less variability was associated with a lower ratio in amyloid-beta, potentially demonstrating a smaller movement repertoire. Both step time and step length variability have been positively correlated with cerebrospinal AB. Potentially velocity is a stronger predictor of AB status as velocity incorporates both spatial and temporal components. These pilot data provide targets for future investigation into stride velocity variability and gait reserve trajectories in relation to dementia.Funding:TAMU CEHD R3 award

O.02.7 - The dose-response relationship between the electrical field of tDCS targeting left dlPFC and dual-task gait performance in older adults

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Background and aim: The dual-task walking performance has been linked to multiple health-related conditions (e.g., dementia) in older adults. Studies have demonstrated that bipolar (i.e., sponge-based) and multichannel (i.e., small electrode-based) tDCS to target the left dorsal-lateral prefrontal cortex (LEFT-DLPFC) can improve the dual-task walking performance. However, such effects of the multichannel and bipolar tDCS have not been directly compared, and the "dose-response" relationship between the on-target electric field (E-field) characteristics and the improvement of dual-task walking remain unknown.Methods: In this double-blinded, randomized, sham-controlled study, 29 healthy older adults (age: 75.83±5.84 years) completed four stimulation visits; on each they received one session of 20-minute multichannel and bipolar tDCS or sham stimulation targeting the L-DLPFC. Before and immediately after each stimulation, they completed single- (i.e., walking normally at preferred speed) and dual-task (i.e., walking while performing verbalized serial-subtraction-by-three task) walking assessment. The absolute change of dual-task cost (DTC) to walking speed from pre- to post-stimulation was obtained and used as the primary outcome in the following analyses. Eighteen of these participants completed one structural MRI scan. Their MRI data were used to estimate the on-target (i.e., LEFT-DLPFC) and off-target (i.e., RIGHT-DLPFC) normal component (En), a metric quantifying the E-field intensity.Results: No severe side effects or adverse event was reported. Compared to both sham conditions, multichannel and bipolar tDCS induced significantly greater reduction of DTC to walking speed (i.e., better performance); and such reduction was greatest after multichannel tDCS ($p=0.02$) (i.e., multichannel > bipolar significantly). Compared to bipolar, the on-target (i.e., LEFT-DLPFC) En in multichannel tDCS was significantly greater ($p<0.0001$). Linear regression models demonstrated that within the multichannel tDCS condition, but not within bipolar tDCS ($\beta=-0.36$, $p=0.16$), the magnitude of En over the L-DLPFC correlated with the absolute change in the DTC to gait speed ($\beta=-0.50$, $p=0.02$) (Figure 1). As such, within multichannel tDCS, participants who were exposure to greater En over the L-DLPFC

exhibited greater reduction in the DTC to gait speed; that is, greater improvement in walking performance. This correlation remained significant after adjusting for participant age, sex, and BMI, suggesting that such association were independent from the demographics of participants. Similarly, participants who were exposed to greater L-DLPFC En within multichannel tDCS, but not within bipolar tDCS (β=-0.34, p=0.36), exhibited greater reduction in the DTC to STV (β=-0.69, p=0.01), irrespective of stimulation condition.Conclusions: These findings demonstrated for the first time that the on-target dose of tDCS is associated with its effects on dual-task gait performance in older adults, suggesting that it is critical to appropriately augment the on-target dose of tDCS via novel neuro-modeling techniques, which will ultimately maximize its benefits for the functions in older adults.

O.02.8 - Reactive balance control may be regulated by different neural networks in older adults with mild cognitive impairment compared to cognitively intact adults: A resting state fMRI analysis

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Background and Aim: Older adults with mild cognitive impairment (OAwMCI) have impaired reactive balance control (motor responses to external perturbations) compared to cognitively intact older adults (CIOA), and 2-fold increased fall risk. Our recent study showed that reactive center of mass (COM) stability in OAwMCI was associated with resting state functional connectivity (FC) between the cerebellum and higher cortical networks. However, it is unclear if these neural networks might also regulate reactive balance control in cognitively intact adults. This exploratory analysis examined relationships between resting state FC and reactive COM stability in OAwMCI, CIOA, and young adults (YA).Methods: We included 10 YA (18-35 yrs) and 36 older adults (55-90 yrs), divided into OAwMCI (Montreal Cognitive Assessment (MoCA) 18-25, n=16) or CIOA (MoCA≥26, n=20). Functional magnetic resonance imaging (fMRI) was used to determine FC strength within/between atlases (cerebellum, vermis, parahippocampal gyrus, middle frontal gyrus, frontal pole, superior parietal lobe) and networks (default mode, sensorimotor, salience, dorsal attention, cerebellar) associated with reactive balance (using CONN software). A stance perturbation was used to determine reactive COM stability. We used Pearson's correlation coefficient (R2) to examine relationships between FC strength and reactive COM stability. Results: In OAwMCI, FC had the strongest correlations with reactive COM stability for default mode network–parahippocampal gyrus and dorsal attention network-superior parietal lobe (-correlation), and salience network-frontal pole and cerebellum-cerebellum (+ correlation) (R2=0.253-0.543), although FC strength in these regions had weaker correlations with reactive COM stability in YA and CIOA (R2=0.006-0.178). In YA and CIOA, FC between different regions had the strongest correlations with reactive stability, including cerebellum-middle frontal gyrus and dorsal attention network-cerebellum (-

correlation), and cerebellar network-vermis (+ correlation) (R2=0.136-0.638).Conclusion: Our results suggest that different neural networks may regulate reactive balance control in OAwMCI vs. adults with intact cognition. In OAwMCI, increased FC between motor areas and the default mode or dorsal attention network was associated with lower reactive COM stability, which could indicate altered ability to allocate attentional resources during reactive balance due to underlying executive function deficits. Further, reduced within-cerebellum FC was related to lower reactive stability in OAwMCI, which might impact perturbation perception and subsequent response triggering. Conversely, reactive COM stability in adults with intact cognition was more strongly related to FC between motor areas (cerebellum, vermis), which could indicate less reliance on neural networks which control cognitive/attentional resources when cognition is intact. Acknowledgements/Funding: R01AG073152, PI: Tanvi Bhatt

O.03: Falls: mechanism prediction and intervention

O.03.1 - Cortical modulation of reactive balance control for fall prevention: Changes in beta frequencies during motor adaptation to walk-slips in healthy adults

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BACKGROUND AND AIM: Cortical beta oscillations (13-30Hz) are postulated to represent sensorimotor processing of perturbations and planning of reactive balance responses. Studies showed that beta power scales with perturbation characteristics and age (higher power with higher magnitudes and in adults with low balance ability). Our recent study showed that individuals demonstrating a significantly high pre-post perturbation rise in sensorimotor beta power experienced a fall upon an unexpected walk-slip. However, it's unclear how the cortical control of reactive balance modulates with motor adaptation. Thus, we aimed to examin trial-to-trial changes in sensorimotor and frontal beta power during repeated walking slips.METHODS: 25 healthy adults (22 Rt dominant, 22±14yrs) experienced five slips (distance: 65cm) during walking. Electrocortical signals recorded using a 32-channel EEG were band pass filtered (10-40 Hz), followed by independent component analysis and artifact subspace reconstruction. Cortical outcomes included average beta power extracted during two bins – 400 ms pre- and post-slip onset at sensorimotor (C3-Cz-C4) and frontal (F3-Fz-F4) areas. Biomechanical outcomes included reactive stability (center of mass position and velocity) and limb support (hip

height) at recovery limb touchdown. Participants were divided into falls (>30% of weight detected post-slipping) and recoveries based on the novel slip (S1) outcome. A 2x2x5 repeated measures ANOVA was conducted to assess interactions between group, time and trial on sensorimotor and frontal beta power. RESULTS: 11 people fell during S1 and showed worse reactive stability and limb support than 14 people who recovered successfully ($p<0.05$). A group x trial interaction was seen on sensorimotor and frontal beta power. With no group differences in pre-perturbation power at S1 ($p>0.05$), falls demonstrated higher sensorimotor and frontal power post-perturbation than recoveries ($p<0.05$). At S2, there were no group differences in sensorimotor power but falls demonstrated higher frontal power post-perturbation than recoveries ($p<0.05$). During S3-S5, there were no group differences in any cortical and biomechanical outcomes ($p<0.05$). CONCLUSIONS: Higher sensorimotor and frontal beta power post-perturbation during falls than recoveries might suggest higher demand for recruitment of cortical resources for perturbation processing and planning of balance responses. No group differences in sensorimotor and frontal beta power with repeated perturbations suggests the rapid cortical ability to adapt/modulate outcomes regardless of the novel slip experience. Within the groups, reduction in sensorimotor and frontal power with repeated perturbations could be due to decreased reliance on the cortex for reactive balance recovery. Our findings likely suggest the physiological changes in cortical control of reactive balance with motor adaptation, future studies could examine age and pathology-related alterations.

O.03.2 - Preventing fall injuries in older people via reactive balance training using repeated trips and slips: The SafeTrip blinded randomised controlled trial

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BACKGROUND AND AIM: Fall injuries in older people are devastating and often caused by unexpected trips and slips. Conventional exercise programs have not addressed these common causes of falls. Here we demonstrate that a short course of perturbation balance training (PBT) using repeated trips and slips can improve responses to trips and slips and reduce fall injuries among older people. METHODS: A hundred and eighteen older people (65+ years) were randomised into an intervention or control group. The intervention group received three weekly PBT sessions on an 8-metre Trip and Slip Walkway followed by 3-monthly PBT booster sessions over one year (a total of 6 sessions), whereas the control group only received an educational booklet. Blinded staff assessed laboratory-falls induced by a trip and slip with a safety harness at baseline and one year. Number of falls and fall injuries were collected weekly for one year. RESULTS: Compared to controls, the intervention group had fewer laboratory-falls suggesting improved responses to trips and slips at one year. An intention-to-treat analysis showed a 57% reduction in fall injuries (rate ratio [RR]: 0.43, 95% confidence interval (CI): 0.19, 0.94) over one year, but not total falls. Findings also suggest a significant falls reduction within the first 3 months and greater benefit among those who completed at least three training sessions. CONCLUSIONS: PBT using repeated trips and slips can improve reactive balance and reduce fall injuries. Older people need at least three PBT sessions to reduce falls in daily life and re-training sessions are required to maintain a long-term effect of PBT. Fall prevention exercise programs should incorporate specific tasks to designed to protect older people from unexpected fall hazards in daily life.

O.03.3 - Baseline life-space mobility predicts falls in older adults with chronic stroke: a secondary analysis of a 6-month randomized clinical trial

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Background: Stroke reduces life-space mobility – an individual's ability to move beyond their home within their neighbourhood and beyond. Less life-space mobility is associated with frailty and cognitive decline – important risk factors for falls. Yet, no study has examined whether life-space mobility prospectively predicts incident falls among individuals with chronic stroke. Hence, we determined whether baseline life-space mobility predicts the rate of total falls among adults with chronic stroke. Methods: We conducted a secondary analysis of a single-blind randomized clinical trial, the Vitality study: a 6-month randomized controlled trial with a 6-month follow-up. We included 120 community-dwelling adults aged 55 years and older who experienced a stroke within the past 12 months. Participants were randomized 2:2:3 to receive a i) multi-component exercise program (EX) (n=34), a ii) cognitive and social enrichment activities program (ENRICH) (n=34), or a iii) balance and tone program (BAT; control) (n=52). Using an available case sample, a negative binomial regression model with total falls count as the dependent variable evaluated the main effect of the independent variable - baseline life-space mobility as measured by the Life-Space Assessment questionnaire - controlling for total exposure time, experimental group, and Fugl-Meyer total score (n=111). A sensitivity analysis was conducted for the BAT control group alone; the model controlled for total exposure time (n=47). Results: For the total sample (n=111), the rate of subsequent total falls was significantly predicted by baseline life-space mobility (IRR = 0.97; 95% CI [0.96-0.99]; p = .000). That is, for every 1 point improvement in baseline life-space mobility, there was a 3% reduction in falls rate. Sensitivity analyses for the BAT group (n=47) confirmed the findings with wider confidence intervals and the rate of prospective total falls was significantly predicted by baseline life-space mobility (IRR = 0.97; 95% CI [0.96-0.99]; p = .000). Conclusion: These findings suggest interventions aimed at improving life-space mobility should be considered as part of falls prevention strategies among adults with chronic stroke.

O.03.4 - Participatory evaluation of environmental fall risk factors

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BACKGROUND AND AIMOutdoor environments do not always allow for safe locomotion in older adults, leading to falls, with nearly 50% occurring outdoors. Environmental risk factors for falls remain under-researched and are often assessed using retrospective data prone to bias. Through participatory methods, this project aimed to identify environmental fall risks and explore the influence of age, fall history, and fear of falling on the perception of these risks.METHODSThe study included 28 participants, of whom 17 were over 60 years old and 9 had experienced a fall in the previous year. Participants used a mobile application to capture geolocated photographs of environmental fall risks during their walks. The photographs were collaboratively categorized, and data were analyzed using χ^2 tests to examine differences in perceptions based on age, fear of falling, and fall history.RESULTSA total of 314 geotagged photos of fall risk factors were collected, mapped, and categorized into seven categories, demonstrating the feasibility of this participatory approach to cover an area of 1km^2. The analysis revealed that perceptions of risk did not differ by age (χ^2 = 0.0902, p = 0.764) but were significantly influenced by fall history (χ^2 = 19.7, p = 0.003) and fear of falling (χ^2 = 31.4, p = 0.002). Specifically, participants with a history of falls or high levels of fear of falling were more likely to perceive inadequate signage and unsuitable materials as significant risks.CONCLUSIONSThese findings highlight the value of integrating citizen science into assessing environmental fall risks and the feasibility of using these methods to diagnose fall risks in cities. Moreover, they emphasize the need to consider individual differences, such as fall history and fear of falling, in evaluating and addressing these risks.ACKNOWLEDGEMENTS AND FUNDINGThis study was conducted with the support of the University of Caen Normandy through the Science & Society Award.

O.03.5 - The cost-effectiveness of the dutch in balance fall prevention intervention compared to exercise recommendations among community-dwelling older adults with an increased risk of falls: A randomized controlled trial

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Background and aim Falls among older adults are a growing public health issue and are associated with injuries and increased social costs. Therefore, implementation of effective fall prevention interventions is important. Given limited healthcare resources, evaluating the cost-effectiveness of these interventions is essential. Therefore, we aimed to evaluate the cost-effectiveness of the In Balance fall prevention intervention for community-dwelling older adults with an increased risk of falls compared to general

physical activity recommendations (control) from a societal perspective. Methods An economic evaluation was conducted alongside a twelve month, single-blind, multicenter randomized controlled trial. Participants were 264 non- and pre frail community-dwelling adults aged 65 years or older with an increased fall risk. We assessed costs from a societal perspective and effects included the number of falls, fall-related injuries, and Quality-Adjusted Life Years (QALYs) based on the EuroQol Five-level questionnaire (EQ-5D-5L) and the Adult Social Care Outcomes Toolkit (ASCOT). Missing data were handled using Multiple Imputation by Chained Equations (MICE). Incremental costs and effects were estimated using Seemingly Unrelated Regressions and used to estimate incremental cost-effectiveness ratios (ICERs). Results On average, In Balance was less expensive and more effective than control, but differences were not statistically significant. ICERs indicated dominance of the intervention for prevented falls (€-14,329 per prevented fall), prevented fall-related injuries (€-14,569 per prevented injury), and QALYs by EQ-5D-5L (€-168,265 per QALY gained) and ASCOT (€-135,797 per QALY gained). The probability of cost-effectiveness of In Balance compared to controls was 98% at a willingness to pay (WTP) of €0 per unit of effect gained. Conclusions Based on this study, we conclude that In Balance may be considered cost-effective compared to control. Future research should explore whether In Balance as part of a comprehensive fall prevention strategy is cost-effective.

O.03.6 - Human-object interactions and risk for head injury during video-captured falls in older adults

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BACKGROUND AND AIM: Falls elicit postural responses for avoiding injury that are shaped to the situational and environmental context of the fall. Age-related changes in these responses increase the likelihood for head impact and injury during falls (Robinovitch et al., Age and Ageing, 2022). Falls cause up to 80% of traumatic brain injuries in older adults (Fu et al., PloS One, 2017), and for older adults in long-term care (LTC), the head is the most common site of injury from falls (Komisar et al., BMC Geriatrics, 2022). We previously found that 81% of falls in LTC involved interactions with objects other than the floor (Shishov et al., BMC Geriatrics, 2024). There is lack of objective evidence on how older adults interact with environmental features during falls to avoid injury. In this study, we analyzed video footage of real-life falls by older adults in LTC to determine how interactions with environmental objects influence odds for head impact and injury.METHODS: We analyzed video footage of 1759 falls experienced by 584 residents in LTC. Using a structured questionnaire (Yang et al., BMC Geriatrics, 2013), we characterized interactions with objects during and after fall initiation, with a focus on hand contacts. We then used generalized estimating equations to test whether

interactions with objects during falls were associated with odds for head impact and documented head injury.RESULTS: Head impact and injury were less common in falls that involved intentional interactions with objects, but not in falls that involved unintentional contacts with objects. Specifically, holding objects at fall initiation (n = 898) reduced the odds for head impact (OR = 0.48, 95% CI = 0.35-0.67; p < 0.001) and head injury (OR 0.54 (0.36-0.80); p = 0.002). Successfully reaching to grasp an object after fall initiation (n = 285) also reduced the odds for head injury (OR 0.69 (0.48-0.98), p = 0.036). In contrast, unintentional hand impacts with objects did not affect the odds for head impact (p = 0.530) or injury (p = 0.204). Intentionally bracing against the floor or an object also did not affect the odds for head impact (p ≥ 0.296) or head injury (p ≥ 0.165).CONCLUSIONS: By linking video evidence of the circumstances of falls to documented injuries, our results show that older adults in LTC tailor their protective responses to environmental features in a manner that reduces their risk for injury. Doing so requires awareness of environmental features via visual mapping. In addition to their role in balance recovery, nearby objects that may be grasped or contacted following imbalance reduce the risk for head injury in the event of a fall, and contribute to safer movement environments for older adults in LTC.ACKNOWLEDGEMENTS AND FUNDING: Supported by operating grants from the Canadian Institutes of Health Research (AMG-100487, TIR-103945, and TEI-138295) and the AGE-WELL National Centre for Excellence (AW CRP 2015-WP5.2, AWCRP-2020–04).

O.03.7 - Age-related associations between parameters of balance recovery stepping, self-initiated stepping and gray matter volume

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Background and aim. To reduce the incidence of falls among old adults and improve treatment, a better understanding of the underlying neural mechanisms of postural control and specifically of balance recovery stepping responses to unexpected loss of balance is of paramount significance. Our aims were to explore age-related differences in balance recovery and self-initiated stepping responses parameters and gray-matter volume in specific region of interests (ROIs). Then, we explored the age-related associations between gray-matter volume in chosen ROIs and the parameters of recovery and self-initiated stepping responses. Methods. Ten young adults and 28 old adults performed a structural MRI brain scan and an assessment of balance recovery stepping responses to unexpected balance perturbations and self-initiated volitional stepping. Gray-matter volume was computed in 10 ROIs. Age-related differences in single-step threshold, parameters of the reactive stepping, volitional stepping responses and gray-matter volume were examined. These were followed by partial correlation

analysis of both age groups together, and in each age-group separately.Results. Old adults showed a longer total balance recovery time (1098.4ms±183.4 vs. 847.0ms±163.6, p=0.002), lower medio-lateral stepping threshold (5.14±1.8 vs. 9.00±2.8, p<0.001), longer voluntary step time and longer preparation time (1015.3ms±178.6 vs. 886.5±135.3, p=0.047 and 464.9ms±80.6 vs. 391.9ms±70.1, p=0.031; respectively) compared to young adults. Significant age-related reduction in gray-matter volume was observed in all ROIs (p <0.001), except for the brainstem (p = 0.01). The whole sample analysis of both age groups showed associations between longer balance recovery time and reduced gray-matter volume in prefrontal and cortical brain regions (-0.49 to -0.69), the putamen (r = -0.49, p=0.007) and the amygdala (r = -0.65, p>0.001). Lower stepping threshold was associated with reduced gray-matter volume in the putamen (r = 0.58, p=0.001), the brainstem (r = 0.45, p=0.013), superior frontal gyrus (r = 0.49, p=0.007) para-central gyrus (r = 0.49, p=0.007) and the cerebellum (r = 0.44, p=0.016). In the voluntary stepping parameters, reduced cerebellar gray-matter volume showed the most prominent associations with longer preparation time and voluntary step time (r = -0.64, p<0.001 and r = -0.53, p=0.003, respectively), while in the subsample of older adults these association were even slightly stronger (r = -0.69, p=0.001; r = -0.56, p=0.019, respectively). Conclusions. The associations found indicated age-related higher-level control, and basal ganglia-cortical loop involvement in balance recovery stepping responses. Reduced gray-matter volume in the putamen associated with lower step-threshold suggested an age-related reduced automaticity in changing recovery strategy. Future studies should further investigate possible structural volumetric changes due to effects of perturbation-based balance training.

O.04: Adaptation and coordination

O.04.1 - Linear and angular momentum are simultaneously controlled in walking

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Background and aim:Stabilizing bipedal gait is challenging, as is apparent from the incidence of falls in older and diseased populations. Previous studies on how gait is stabilized have considered control of linear momentum of the body center of mass (CoM) as a necessary condition for stable gait. The position of the center of pressure (CoP), or of the foot, relative to the CoM was often used as an indicator of corrections of the CoM state. However, mechanically, neither of these variables is directly related to changes in the CoM state, or in other words to horizontal ground reaction force (GRF). Instead, they do directly affect whole-body angular momentum (WBAM), which has also been suggested to be controlled in walking. We aimed to assess the validity of the CoP as a predictor of corrections of linear momentum of the CoM, and to assess if linear and angular momentum are simultaneously controlled. Methods:We used kinematic and kinetic data of 14 healthy adults walking on an instrumented treadmill at slow and normal speeds. For all trials, 200 gait cycles were analyzed. We estimated CoP locations from the GRF and CoM and WBAM time series from whole-body kinematics. Pearson's correlations between horizontal CoP to CoM distances and horizontal GRFs, which signify changes in linear momentum, were calculated. Subsequently data were normalized to stride time and models were fit to the data to predict horizontal GRFs from preceding CoM position and velocity deviations from the averaged gait cycle. Similar models were fit to predict the moments of the GRF from preceding WBAM deviations from the averaged cycle. Results:Linear and angular momentum follow quasi-periodic functions with similar periodicity and phase in the frontal and sagittal planes. The equations of linear and rotational motion for a system of linked rigid segments show that, in this case, the horizontal distance between CoP and CoM should negatively correlate with horizontal GRFs in the corresponding directions. Experimental data confirmed this, with all correlations < -0.90. This suggests that linear and angular momentum are simultaneously controlled to follow similar quasi-periodic functions. Preceding CoM state and WBAM predicted the ground reaction forces and moments along the sagittal and transverse axes. Model parameters were consistent between participants and gait speeds but differed between planes. Conclusion:The consistent, good fit of both models supports that linear and angular momentum are controlled simultaneously in walking. Angular momentum appears to be continuously controlled, while linear momentum control was phase-dependent with most correction occurring in early stance. Future studies should consider both linear and angular momentum control as necessary conditions for stabilization of gait. Interestingly, previous studies on suggest that perturbations may elicit actions to control linear momentum at the expense of an increased deviation in linear momentum or vice versa.

O.04.2 - Visual information influences how people regulate lateral stepping while walking on curved paths

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BACKGROUND AND AIM: The goal-directed nature of walking involves regulating foot placements to achieve specific tasks, like following a defined path. We use the Goal Equivalent Manifold framework to explore how individuals adapt lateral stepping to different environmental conditions. Navigation is influenced by perceptual, cognitive, and contextual salience, which interact to guide attention and motor planning. Here, we examined the relationship between perceptual salience and lateral foot placement during walking on straight and curved paths. Specifically, we quantified how variations in environment richness and path color contrast affect lateral foot placement during walking on such paths. By examining how perceptual salience impacts stepping

regulation, this study bridges the gap between perception and action, enhancing our understanding of visual contributions to locomotion.METHODS: 28 participants (age 26.16±4.23) walked along straight and curved 0.45m wide paths projected on a 1.2m wide treadmill. Each path was presented in both high (HC) and low contrast (LC) color combinations in each of two virtual environments: a forest (Rich) and an open plain (Sparse). We calculated within-trial means and standard deviations of head pitch angle. We calculated step width (w) and lateral body position (zB) relative to the walking path at each step. We computed error-correction slopes to quantify the degree to which deviations from the average w and zB were corrected on the next step where slope values of -1 indicate perfect correction.RESULTS: Participants significantly reduced mean Head Pitch when navigating curved paths ($p<0.001$). On straight paths, they tilted their heads further down with less variability in Sparse environments ($p\leq0.028$). They also tilted their heads further down on LC paths ($p=0.03$). Stepping showed that participants corrected zB deviations more in Sparse environments ($p<0.001$) and less on LC paths ($p<0.001$), while maintaining consistent w corrections across Environment Richness and Path Contrast levels ($p\geq0.167$). On curved paths, Head Pitch was tilted further down on LC paths ($p=0.021$) and showed less variability in Sparse environments ($p=0.011$). On LC paths, participants corrected zB deviations less ($p<0.001$) but w deviations more ($p<0.001$).CONCLUSIONS: On straight and curved paths, participants tilted their heads further down on LC paths. Even with this increase in attention toward the path, zB-regulation degraded, suggesting individuals were less able to maintain their position on the path when it is less distinguishable. Participants adapted their stepping in response to varying perceptual salience, highlighting the importance of the quality of visual information while walking. These insights contribute to a deeper understanding of how perception and action shape goal-directed motor behavior. This has implications for improving mobility in complex settings.FUNDING: NIH R01-AG049735 (JBD) and Sloan Foundation G-2020-14067 (ACR)

O.04.3 - POI more accurately reflects risk of instability while walking than the mean of MOS

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BACKGROUND & AIM: A smaller lateral Margin of Stability (MoSL) theoretically indicates that a person is “less stable”. However, averaging MoSL over multiple steps yields perplexing results [1,2]. Persons at high fall risk, or those subjected to perturbations, most often exhibit larger (supposedly more stable) mean MoSL, despite ostensibly being destabilized. Here, we address why. MoSL quantifies a margin (as a distance) from a threshold (MoSL=0) above which Hof’s stability condition holds. When people walk, most steps are stable; unstable steps are atypical or rare. Conversely, means (by definition) quantify typical events. By contrast, lateral Probability of Instability (PoIL) [2] quantifies, from a sequence of steps, the probability a walker will exhibit MoSL < 0 on any step, regardless of their mean MoSL. Hence, PoIL more accurately quantifies a person's risk of taking unstable steps. METHODS:PoIL is easily calculated from the mean, μ(MoSL), and standard deviation, σ(MoSL), of a sequence of steps [2] (Fig 1A-B). We simulated PoIL calculations across a range of μ(MoSL) and σ(MoSL) values to demonstrate how misinterpretations can arise from calculating μ(MoSL) alone. We reanalyzed data of Onushko [3], where 15 healthy adults (7F/8M; age 21.3±1.4 yrs) walked with no perturbations (CTR), mediolateral (ML1-3) or roll-pitch-yaw (RPY) perturbations. We also reanalyzed data of Richards [4], where 13 older adults (9F/4M; 78.7±6.6 yrs), walked with no perturbations (BASE), then with visual perturbations during early (EARL) and late (LATE) adaptation, and again with no perturbations (POST). For each trial, we used published μ(MoSL) and σ(MoSL) to compute PoIL. We ran one-factor ANOVAs between conditions for μ(MoSL), σ(MoSL), and PoIL for each dataset. RESULTS: In Onushku [3] (Fig 1C), μ(MoSL) counter-intuitively increased ($p<0.001$) with increasing perturbation magnitude. However, σ(MoSL) also increased ($p<0.001$). This drove PoIL to increase, indicating (correctly) greater chance of taking unstable steps with larger perturbations. In Richards [4] (Fig 1D), μ(MoSL) counter-intuitively did not change ($p=0.601$) despite destabilizing perturbations. However, σ(MoSL) initially increased ($p<0.001$) before decreasing. This drove PoIL to increase, indicating (correctly) greater chance of taking unstable steps when first experiencing perturbations. CONCLUSIONS: Unlike mean MoSL, PoIL is directly consistent with the mechanical principles underlying Hof's original MoSL derivation, and yields results consistent with expectations (Fig 1C-D; [2,5]). PoIL is easy to compute and can help resolve many long-standing paradoxical interpretations in the current literature. Caveats for proper interpretation of PoIL (e.g., [5]) will also be discussed. FUNDING: NIH R01-AG049735 & R21-AG053470 References: [1] Watson et al., BMC Musc Disord 2021; [2] Kazanski et al., J Biomech 2022; [3] Onushko et al., PLoS ONE 2019; [4] Richards et al., JNER 2019; [5] Render et al., J Biomech 2024.

O.04.4 - Reliability and discriminative validity of the Walking Adaptability Ladder Test in an adult population

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BackgroundWalking adaptability is important for safe community ambulation. Few clinical tests exist to measure walking adaptability and they often have ceiling effects. We previously developed the walking adaptability ladder test (WALT) for children, a dynamic task requiring continuous foot placement adaptation using an adapted agility ladder with continuously changing step target size. We here aim to test if the WALT is also reliable and valid in an adult population. MethodIn total, 51 healthy adults (HC) were purposively sampled to span a 20-85yrs age range. Participants performed the single (one foot in each target) and double run (both feet in each target) of the WALT as fast and accurate as possible (Figure 1) during two sessions, approximately 14 days apart (M1 and M2). Test execution during M1 and M2 was recorded on video and scored post-hoc regarding the time taken, with an additional 1-sec penalty for each error. For interrater reliability, two independent raters scored M1. For intra-rater reliability, M1 was scored twice by the same rater. For test-retest reliability, M1 and M2 were scored by the same rater. All raters were blinded to previous scores. We used intraclass correlation coefficients (ICC) to evaluate reliability. We also determined the smallest detectable change (SDC). Discriminative validity was evaluated in two ways. First, the association with age was examined using Pearson's correlation for the healthy adults, followed by a linear regression analysis to test whether the association with age was independent of comfortable walking speed. Second, we compared an existing dataset of WALT scores of 34 people with hereditary spastic paraplegia (HSP) [1] to the HC data, using a linear regression model with age as covariate.ResultsMean WALT scores in the heathy adults were 12.5s (sd 3.2s) for the single run and 22.9s (sd 5.8) for the double run. WALT score on the double run was marginally (1.2s) but significantly lower (i.e. better) at M2 compared to M1 ($t(50) = 2.87$, $p=0.006$). ICCs for interrater and intra-rater reliability of the single and double run varied between 0.94 and 0.99. Test-retest ICCs were 0.90 (single run) and 0.84 (double run), with SDCs of 3.0 and 5.7 seconds, respectively. WALT scores increased significantly with advancing age (single: $r = 0.60$, $p<0.001$; double: $r = 0.69$, $p<0.001$), which was independent of comfortable walking speed ($p>0.05$). WALT scores in HSP were on average 10.9s (se 1.90, $p<0.001$) higher for the single run and 17.5s (SE 2.5, $p<0.001$) higher for the double run (i.e. worse) than HC.ConclusionOur results indicate that the WALT is a reliable tool to assess walking adaptability in healthy people. Moreover, the test showed good discriminative validity, as we could detect changes in walking adaptability due to aging or neurologic gait impairments. This suggests the utility of the WALT for the evaluation of training programs targeting walking adaptability.

O.04.5 - The contribution of vestibular and proprioceptive information to trunk stabilization varies between postural tasks and walking speeds

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Background:Sensory information is integrated based on its reliability to estimate an internal model of the body in relation to the environment. This integration ensures the capability to compensate for the loss or interruption of input from one or more sensory modalities. Moreover, reliability and utility of sensory information may depend on the task performed, and consequently the contribution of sensory modalities may vary across postural tasks [1] [2]. In this study, we investigated whether and how the vestibular and proprioceptive information contributes to trunk stabilization in different postural tasks, and in walking at different speeds. Methods:Healthy adults (n = 12, 20.9 ± 4.1 years) performed a range of tasks in a random order: sitting, standing on the right foot or both

feet, and treadmill walking at five speeds: 0.8, 2.0, 3.2, 4.3 and 5.5 km/h. During these tasks, participants were exposed to ten epochs of either a step-like electrical vestibular stimulation (EVS, with the amplitude of 1 mA), or unilateral muscle vibration (MV, 80 Hz) on the right paraspinal muscle at the level of the second lumbar vertebra. Each epoch consisted of 5-seconds stimuli with 10-seconds intervals. Ground reaction forces were recorded to identify the gait events. The averaged mediolateral displacement of the marker at the sixth thoracic level (T6) in the global coordinate was used to evaluate the responses to sensory stimulation. One sample t test compared to 0 was used to evaluate the effect of stimuli. One way ANOVA was used to compare the difference in response across postural tasks and walking speeds. Results:MV induced significant mediolateral displacement of the T6 marker to the left during unipedal standing ($p = 0.03$), and to the right during bipedal standing ($p = 0.03$) and sitting ($p < 0.01$), with a larger effect observed in sitting ($p < 0.01$). No significant displacement was induced by EVS during unipedal standing ($p = 0.33$), bipedal standing ($p = 0.64$), or sitting ($p = 0.53$). During walking, both EVS and MV induced significant leftward T6 displacement at all walking speeds. The effect of MV ($p = 0.03$) and EVS ($p < 0.01$) varied with speeds. The effect of stimuli increased with speed from 0.8 to 3.2 km/h and then decreased at higher speeds for MV, while for EVS, it increased with speeds till 4.3 km/h then decreased at 5.5 km/h. Conclusions: Responses to vestibular and proprioceptive stimulation vary across postual tasks and walking speeds. The similarity of EVS and MV-induced responses between unipedal standing and walking suggests a similar contribution of these sensory information in stabilization control, which differs from the other postures. The decreased impact of sensory stimuli at higher walking speeds suggests that stablization of faster walking relies less on feedback control. Reference[1] Peterka RJ (2002). J Neurophysiol 88, 1097–1118.[2] Asslander L., et al. (2016). J Neurophysiol 116, 272–285.

O.04.6 - Cortical dynamics underlying initiation of rapid steps with contrasting postural demands

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Background: Rapid visuomotor transformations for initiating reflexive, goal-directed leg movements are presumably mediated by subcortical structures, but their expression was shown to be modulated by postural task demands (Billen et al., 2023; Nonnekes et al., 2010). When stepping under high postural demand, reflexive visuomotor transformations were suppressed and followed by prominent recruitment of anticipatory postural adjustments (APAs), suggesting cortical involvement in the modulation of reflexive stepping and APA expression. In the current study, we aimed to gain insight into this context-dependent top-down modulation in preparation of, and during fast, goal-directed steps.Methods: Using an emerging target paradigm (Billen et al., 2023) (Figure 1A), we investigated the associated cortical dynamics prior to and during rapid goal-directed step initiation in twenty-one young, healthy individuals while recording electroencephalography, surface electromyography and ground-reaction forces. We adopted two contrasting postural conditions (in separate blocks of 75 trials each) by manipulating the step eccentricity: stepping anterolaterally from narrow stance (low postural demands), and anteromedially from wide stance (high postural demands). Due to the blocked design, postural demands were known in advance, but stepping leg was only determined following target appearance (randomly left or right). We performed independent component analysis and time-frequency statistics to reveal differences in cortical activity between conditions. Results: In anticipation of target appearance, we observed modest differences in preparatory cortical dynamics between conditions, with stronger alpha and lower beta power suppression under high compared to low postural demands (Figure 1B). Shortly following target appearance, we observed stronger theta/low-alpha power enhancement in the supplementary motor area during step initiation under high postural demands. This was paralleled by a stronger alpha and beta power decrease in primary motor (Figure 1B), parietal and occipital clusters during initiation (but prior to foot-off) of steps under high postural demands. Conclusions: Together, our findings point towards greater cortical involvement prior to and during step initiation under high postural demands as compared to more reflexive, stimulus-driven steps under low postural demands. This notion may be particularly relevant for populations where postural control is impaired by age or disease, as more cortical resources may need to be allocated during stepping, potentially limiting their ability to flexibly adapt and interact with the dynamic daily-life environment.Funding: This work was supported by a Donders Centre for Medical Neuroscience (DCMN) grant to BDC and VW.

O.04.7 - Whole-body reaching: Strategy classification in healthy adults during bimanual and unimanual lifting

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BACKGROUND AND AIM. Collecting objects from the floor is a daily activity that lowers the center of mass, increasing instability and fall risk. This study aims to classify descent strategies in healthy adults during bimanual lifting with parallel feet and unimanual lifting in a semi-tandem stance and describe them through key biomechanical parameters as the first step toward developing an ecological and quantitative fall risk assessment pipeline. METHODS. The LG-MIAR dataset was used, where twelve healthy participants (30.7±6.1 years) lifted a box (600g) from the floor with both hands and parallel feet five times and lifted a cylindric object (400g) with the dominant hand in a semi-tandem stance for five times. Data were collected using eight cameras (SMART-D, BTS Bioengineering, 200Hz) and one force plate (4060-08, Bertec, 200Hz) (Fig. 1.a). The task was segmented based on the center of mass (COM) vertical (VT) velocity. The descent strategy was classified using K-means clustering on trunk and knee flexion at the maximum lowering of the subject. Three main biomechanical parameters were compared among the strategies and the tasks: VT and antero-posterior (AP) COM displacements and the AP center of pressure (COP) displacement. All were normalized to the 3D distance between the COM and the object at the start of the task. Margins of stability (MOS) were computed as the distance between the center of gravity and the base of support boundaries. RESULTS. Five subjects were excluded due to markers occlusion during either task. The unsupervised clustering identified three strategies in both tasks. Strategy 1 featured primarily trunk flexion, Strategy 2 primarily knee flexion, and Strategy 3 a combination of both. One subject with 4 repetitions displayed Strategy 1 in both unimanual and bimanual tasks. Two subjects with 8 repetitions in the unimanual task and 4 subjects with 15 repetitions in the bimanual task displayed Strategy 2. Four subjects with 17 repetitions in the unimanual task and 4 subjects with 12 repetitions in the bimanual task displayed Strategy 3. Five subjects used the same strategy in both tasks, while two switched between Strategies 2 and 3. MOS, clusters distribution, and the COM and COP displacements are depicted in Fig. 1.b-d. CONCLUSIONS. Bimanual and unimanual lifting from the floor could be grouped in the same three descent strategies in young healthy subjects. COM and COP displacements for each strategy showed similar characteristics in the two tasks. The strategy seems to impact on stability, particularly in the unimanual task. ACKNOWLEDGMENTS AND FUNDING. This research was co-funded by Fondazione del Monte di Bologna e Ravenna, Fondazione Cassa di Risparmio di Bologna, and the Italian Complementary National Plan PNC-1.1 “Research initiatives for innovative technologies and pathways in the health and welfare sector” D.D. 931 of 06/06/2022, “DARE - DigitAl lifelong pREvention” initiative, code PNC0000002, CUP: B53C22006450001.

O.04.8 - Exoskeleton balance support alters the relationship between CoM kinematics and reactive ankle muscle activity

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Background and Aim Humans adjust their ankle muscle activity (EMG) proportionally to deviations in their center of mass (CoM) movements in response to balance perturbations. While this EMG-CoM relationship is well documented for unassisted gait, it remains unclear how this relationship holds or changes with exoskeleton balance assistance. Will humans consider the action of the exoskeleton when generating their ankle muscle activity in response to CoM changes? Here, we study how sensorimotor transformations change with exoskeleton balance assistance.MethodsThirteen able-bodied participants walked on a treadmill while attached at the pelvis to a robotic pusher and wearing ankle exoskeletons (see Fig 1A). They performed 6 walking trials, each with 15 pushes at 8%, 12% and 16% body weight in block-randomized order. During trials 2-5 the ankle exoskeleton assisted the participants for every push by providing a plantarflexion torque. This assistance was timed such that it occurred faster than the human response. Reflective markers and an infrared motion capture system were used to derive CoM movements, and muscle activity was recorded. We analyzed the sensorimotor transformation in response to the perturbations by fitting a linear relationship between CoM state (position and velocity) at 150 ms after the push and the soleus muscle activity 60 ms later (physiological delay) for all pushes in each trial. ResultsSoleus muscle activity increased consistently with each of the CoM states in all trials (see Fig 1B, for CoM deviation). However, the slopes of the linear fits were significantly lower during trials with exoskeleton balance assistance compared to those without (see Fig. 1C) and this effect was evident from the first trial with assistance. This decrease in slopes indicates that with exoskeleton assistance participants generated less muscle activity in response to the same deviation in COM state. ConclusionsThe sensorimotor transformations involved in human balance control during walking changed when receiving exoskeleton balance assistance. This suggests that humans can take into account the action of an exoskeleton when generating their motor response to counteract perturbations. Acknowledgements and funding This work is part of the research program Wearable Robotics with project no. P16-05, which is partly funded by the Dutch Research Council (NWO).

O.05: PD assessment & interventions

O.05.1 - Identifying meaningful digital mobility outcomes in Parkinson's disease for regulatory approval: A focus on underserved groups

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Background and Aim: Parkinson's disease is characterised by motor symptoms, including progressive mobility impairments e.g. slower gait speed. These can be measured precisely using wearable technologies, resulting in digital mobility outcomes (DMOs). The Mobilise-D consortium produced a set of technically and clinically valid DMOs, with the aim of regulatory qualification for clinical trials. Regulatory bodies now require evidence of meaningfulness for clinical endpoint qualification, DMOs must demonstrate a clear connection to meaningful aspects of health. This evidence should include experiences of people commonly underserved in research and healthcare, e.g. ethnic minorities, oldest old (75+ years), those living rurally, or in deprived areas. This qualitative study aimed to explore the lived experience of mobility problems in people with Parkinson's to identify meaningful DMOs, focusing on underserved groups.Methods: Semi-structured interviews were conducted with people with Parkinson's to explore the

impact of their symptoms and mobility-related challenges on daily life. Content analysis identified and mapped participants' experiences onto symptoms and health impacts. Working alongside experts in Parkinson's disease, human movement science, digital health, and qualitative research, symptoms were mapped onto DMOs. The mapping process was visualised using Gephi. Preliminary findings were discussed in focus groups with people with Parkinson's and their carers from underserved groups to ensure they were reflective of lived experiences.Results: Sixty-four participants have been interviewed to date (2 ethnic minorities, 12 oldest old, 15 rural and 15 living in deprived areas). Preliminary findings (Figure 1) highlight how symptoms such as bradykinesia, shuffling, balance, and rigidity impact psychological wellbeing through decreased confidence and embarrassment, contribute to physical health events such as falls, and lead to functional limitations in completing personal care activities. Initial discussions with experts link these symptoms to discrete DMOs, suggesting that measures of walking speed, stride length, and step duration may be meaningful and reflective of psychological, physical, and functional health in Parkinson's.Conclusions: Our early findings support growing evidence that DMOs capture relevant, meaningful aspects of Parkinson's, this knowledge reflects the experiences of underserved people with Parkinson's. Our final analysis will provide recommendations for future DMO usage in clinical trials and contribute to applications for regulatory qualification. Involving people with Parkinson's throughout the research (priority setting, study design, data analysis) ensures the conclusions are relevant and reflect lived experiences. Engaging a multi-disciplinary expert group enhances the credibility of conclusions. This work informs methods to integrate patient experiences into digital health applications to capture meaningful outcomes.Acknowledgements and Funding: This work has been funded by the Michael J Fox Foundation

O.05.2 - Cueing-assisted gamified augmented-reality gait-and-balance rehabilitation at home for people with Parkinson's disease: A pragmatic randomized controlled trial implemented in the clinical pathway

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Background and aim. Physiotherapy is crucial for improving gait, balance, and falls risk in people with Parkinson's disease. Technology can enhance unsupervised therapy at home. Strolll AR is a gamified augmented-reality (AR) rehabilitation platform, providing personalized therapeutic exercises that can be performed under direct supervision of the therapist in the clinic, but also independently at home (see Fig. 1). Building on prior studies, this pragmatic randomized-controlled-trial (RCT) evaluates Strolll AR integrated into the clinical pathway across 15 physiotherapy centers, focusing on its effectiveness for improving indicators of gait, balance and fall risk and feasibility in terms of safety, adherence, performance and user experience. Additionally, we assess how to best tailor

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AR cues to assist gait during AR exercises.Methods. In this pragmatic RCT, we onboarded 15 centers, trained 31 therapists and included 100 people with Parkinson's disease (Hoehn and Yahr stages 1-3) with gait and/or balance impairments, where all participants followed the same T0-usual-care-control-T1-Strolll-AR-intervention-T2 procedure. The intervention consisted of two weeks in-clinic supervised Strolll AR training followed by 6 weeks independent training with Strolll AR at home (default 5 sessions/week of 30 active minutes). This blinded, two-arm study design pragmatically allows for both between-groups and within-subjects comparisons of intervention effects as well as for evaluating its clinical feasibility. The study protocol is pre-registered: https://zenodo.org/records/13941089.Results. To date (mid December 2024), 27 participants completed the full study while 15 and 43 participants are still in the usual care and intervention periods, respectively. So far we have 15 dropouts, the majority unrelated to the intervention. In ~40.000 minutes independent training logged so far, no serious adverse events, like injurious falls, have occurred. The final T2 assessment is scheduled in February 2025. Preliminary results (n=27) showed a significant within-subjects improvement in our primary outcome Timed-Up-and-Go completion times (main effect of Time ($F(1.45,37.73)=5.097$, $p=0.019$, $\eta p2=0.164$), with a significant 2nd inverse Helmert contrast ($t(26)=-3.490$, $p=0.002$, $\Delta T2\text{-}T0,T1=-0.56\pm0.16s$) without a significant 1st one ($t(26)=-1.687$, $p=0.104$, $\Delta T1\text{-}T0=-0.56\pm0.33s$). Full results are expected in February 2025.Conclusions. Preliminary within-person results confirmed previous waitlist-controlled feasibility study findings (Hardeman et al. 2024), supporting the premise of Strolll AR for facilitating the transition from in-clinic care to independent rehabilitation at home as a scalable solution for long-term self-management in Parkinson's disease.FundingThis project is part of EMIL-XR project financial support to third parties, which is funded by the European Union.References: Hardeman et al. (2024). Front. Neurol. 15:1373740. doi: 10.3389/fneur.2024.1373740

O.05.3 - Longitudinal changes in digital gait and balance markers in early vs. mid-stage Parkinson's disease

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Background & Aim: A critical limitation in development of disease-modifying interventions for Parkinson's disease (PD) is the lack of reliable, objective markers of disease progression. In fact, there is increasing evidence for neuroprotective and neuro-modulatory therapies that may prevent, delay or slow disease progression. Unfortunately, clinical trials and clinical practice that aim to prevent, delay or slow the progression of mobility disability in PD are limited by the low sensitivity of gold-standard outcome measures that depend upon expert opinion. We aimed to investigate the progression of various digital posture and gait markers over one year and hypothesized them to reveal changes that are not captured in clinical expert evaluations. Methods: We

assessed clinical scores (MiniBESTest , MDS-UPDRS II & III) as well as postural sway and gait in 21 untreated, newly diagnosed individuals with PD (earlyPD, 13M/8F; age: [52-78] 70 ± 6; Hoehn & Yahr scale: [1-2] 1.7 ± 0.4; MDS-UPDRS Part III Motor Score: [15-46] 27.5 ± 7.7) and 12 individuals with mid-stage PD (midPD, 7M/5F; age: [61-76] 68 ± 5; H&Y: [2-3] 2.1 ± 0.3; MDS-UPDRS III: [22-49] 35.0 ± 8.1). In each group, two measurements were taken, in the laboratory, 12 months apart. The postural tasks consisted of standing quietly with feet together and eyes open on either firm (EOFirm) or soft (EOfoam) ground for 30 s, while body sway was tracked with an IMU (OPAL, APDM, Clario, Portland, OR) at their Lumbar spine. For the gait assessment, participants performed 2-minute natural walking tasks with and without a cognitive dual-task while equipped with IMUs at their feet, waist, chest, head and wrists. Results: On average, clinical scores were similar after 12 months. MiniBESTest scores worsened slightly in both groups (earlyPD: p=0.39, effect size[e]=0.13; midPD: p=0.22, e=0.25). MDS-UPDRS II (p=0.53, e=0.10) and III (p=0.86, e=0.03) scores deteriorated slightly for the earlyPD group but remained unchanged (UPDRS II: p=0.82, e=0.05) or even slightly improved (UPDRS III: p=0.21, e=0.25) in midPD. In contrast, we found sway parameters in both groups to significantly differ after one year during EOFirm (e.g., earlyPD: mean velocity [p<0.01, e=0.45]; midPD: 50% power frequency [p<0.01, e=0.57]) and EOFoam (e.g., earlyPD: mean frequency [p=0.01, e=0.38]; midPD: mean frequency [p<0.01, e=0.58]). There were no changes in gait markers during walking. However, several gait features revealed significant changes in dual-task cost in both groups (eg., earlyPD: steps per turn [p=0.01, e=0.38]; midPD: mean foot strike angle [p=0.01, e=0.51]). Conclusion: One year of disease progression significantly worsened postural sway while clinical scores remained unchanged, with larger effects for the midPD group. Gait analysis suggested a decrease in dual task-ability rather than motor function. Taken together, our preliminary study yielded promising novel insight into objective tracking of motor progression in PD. Funding: NIH grant # R01 AG077380, OCTRI RedCap Database: UL1TR002369.

O.05.4 - Group exercise incorporating behaviour change increases high intensity physical activity in people with Parkinson’s disease, a randomised controlled trial

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BACKGROUND AND AIM: Exercise-based interventions can lead to short-term improvements in physical activity in people with Parkinson’s disease (PD), however this is difficult to sustain. Approaches that address both physical capacity and self-management to change and maintain exercise behaviours are required. This study aimed to determine if a program of personalized high intensity group exercise incorporated with a self-management approach to behaviour change resulted in a greater and more sustained improvement in physical activity and secondary outcomes than usual care in people with mild-moderate PD.METHODS: A prospective, parallel-group, randomised trial with concealed allocation, blinded assessors and intention-to-treat analysis was

undertaken. A total of 92 people with mild-moderate PD who were not meeting physical activity guidelines were recruited from Queensland Australia and were randomised into two groups. The experimental group undertook twelve, 80-minute sessions of a 4-week physiotherapy-led high intensity group exercise program combined with a self-management approach to change activity behaviours. The control group completed usual care, including physical activity advice and education. Outcome measures were collected at baseline (Wk0), immediately post intervention (Wk5) and at 6 months follow-up (Wk26). The primary outcome was free-living physical activity (average daily step count over 7 days) measured via activPALTM at Wk5. Secondary outcomes included volume and patterns of physical activity, gait, health-related quality of life, self efficacy and outcome expectations for exercise at all timepoints. RESULTS: At Wk0 there were no differences between groups. Loss to follow up was 4% at Wk5 and 14% at Wk26. Participants attended 87% of sessions. A group x time interaction (p=0.012) was found for the primary outcome measure of free-living physical activity. The experimental group had a significantly higher average daily step count post intervention (Wk5-0) than the control group resulting in a between group mean difference of 1704 steps, 95%CI 643 to 2766). This change was not sustained at follow up (Wk26-5, mean diff 206 steps, 95%CI -957 to 1370). The experimental group spent a longer time and took more steps per bout of higher intensity activity (>100steps/min) at Wk5 than the control group, which was sustained at follow up (Wk5-Wk0 p< 0.022). There were no group x time interactions for secondary outcomes.CONCLUSIONS: A high intensity, individualised, small group exercise program incorporating self management can immediately increase free living physical activity in people with PD, but was not sustained. Notably though, participants increased and sustained high intensity physical activity, important as it has been associated with a slower decline in balance and gait (Tsukita, 2022).ACKNOWLEDGEMENTS AND FUNDING: This work is supported by Wesley Medical Research. We would like to thank all participants, and Katrina Kemp.

O.05.5 - Real-world gait training for persons with Parkinson’s disease: A pilot long-term tele-rehabilitation program

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Background and aimPeople with Parkinson’s disease (PD) suffer from gait and balance impairments that significantly affect their functional independence, well-being, and quality of life. The instability caused by gait impairment increases the risk of falling, and more than 60% of people affected by PD report at least one fall per year. Rehabilitation programs that use real-time feedback of spatiotemporal gait parameters have shown promising results in improving gait performance and functional mobility in people with PD, however, retention and long-term effects have not been well-established. We aimed to assess the feasibility and the effectiveness of a long-term gait training program using a digital wearable system (Gait Tutor, GT - mHealth Technologies srl) that provides real-time audio biofeedback to correct or reinforce gait behavior.MethodsTwenty people with PD agreed to perform home-based gait training in their ON medication state for 30 minutes, 3 times/week for 9 months using GT. The GT system is a medical device consisting of three inertial measurement units (IMUs) and an Android-based smartphone with a dedicated app for real-time data processing. The system provides real-time audio feedback on selected gait and posture parameters based on the observed patterns to correct gait behavior (Figure 1A). Clinicians can remotely monitor the results of the gait workouts (Figure 1B). We evaluated adherence, usability, and, preliminarily, efficacy. Adherence was defined as the ratio between the total duration of the training sessions performed and the total duration of the sessions expected to be carried out during the training period. Usability was evaluated after the intervention using a 3-item five-level Likert scale, assessing the ease of use of the assistive device, the perceived effectiveness of the gait training, and the quality of the professional services received. Motor performance was compared before and after the intervention to explore efficacy.ResultsSeventeen participants (85%) completed the study. No adverse events occurred while using the GT system. Adherence to training was higher for persons with an intermediate disease stage (80.5%) compared to those with a more advanced disease stage (46.2%). All participants reported extremely positive scores on the questionnaire about ease of use and effectiveness (4.37 ± 0.42). People with an intermediate disease stage showed an improvement trend in both clinical and digital mobility outcomes, with a significant reduction in dual-task Timed Up and Go time ($p=0.01$). ConclusionsFor the first time, the present study shows the feasibility of long-term, real-world gait training for persons with PD, providing preliminary evidence that personalized, technology-driven rehabilitation strategies can be sustained over extended periods. Furthermore, digitally-assisted rehabilitation sessions can assist clinicians in objectively assessing gait performance in real-life settings.

O.05.6 - Instrumented vision-based pull test assessment for differential diagnosis and fall risk assessment in Parkinsonian syndromes

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Background and Aim: Postural instability and falls are major complications in advanced Parkinson’s disease (PD) and related movement disorders. The Pull Test (PT), which assesses the ability to recover from a backward shoulder pull, remains the standard clinical tool for evaluating postural instability in PD (e.g., MDS-UPDRS). However, its clinical application is limited by inconsistencies in execution, subjective scoring, and

poor intra- and inter-rater reliability. This study introduces vPull, a video-based, markerless pose-tracking approach, to standardize PT execution and objectively quantify postural responses.Methods: Whole-body kinematics were extracted from RGB-D recordings (Microsoft Kinect Azure) using deep-learning-based pose estimation. vPull enabled the objective assessment of PT execution (e.g., pull magnitude) and quantified postural responses via established metrics (e.g., pull-to-step latency, number of steps). A cohort of 70 PD patients, 20 patients with progressive supranuclear palsy (PSP), and 66 healthy controls were examined. A neural network classifier trained on vPull-derived parameters was evaluated for its ability to (1) distinguish PD from PSP and (2) identify individuals at high fall risk (recurrent fallers vs. occasional/no fallers). Performance was compared to clinical expert PT ratings based on MDS-UPDRS categories.Results: vPull achieved high accuracy in differentiating PD from PSP (F1 score: 89%), substantially outperforming classification based on clinical ratings (F1 score: 68%). For fall risk prediction, vPull accurately identified recurrent fallers (F1 score: 89%), performing comparably to clinical expert ratings (F1 score: 86%).Conclusions: vPull offers a robust, objective alternative to conventional Pull Test assessment, enhancing sensitivity and specificity for postural instability evaluation, differential diagnosis, and fall risk prediction in parkinsonian syndromes. Its straightforward implementation supports broader clinical adoption.Acknowledgements and funding: This research was funded by the German Federal Ministry for Education and Science, grant number 01EO1401 and 13GW0490B.

O.06: Gait, falls and cognition

O.06.1 - Exploring the relationship between fatigue severity, prefrontal cortex activation (PFCA), and motor-cognitive performance during repeated dual-task walking bouts in people with Multiple Sclerosis: A cross-sectional and interventional analysis

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BACKGROUND AND AIM: In people with multiple sclerosis (pwMS), alterations in functional connectivity within the sensorimotor and attention networks may lead to an impaired ability to efficiently activate the prefrontal cortex (PFC) during attention-demanding and fatigue-provoking conditions. Here we aimed to examine PFC activation (PFCa) and motor-cognitive performance during repetitive bouts of usual walking (UW) and dual-task walking (DTW), both cross-sectionally and following a treadmill training intervention. We also explored associations with self-reported fatigue.METHODS: We

assessed 30 pwMS (47.911.23 yrs. old, 65% female, EDSS: 2, IQR: 0-5.5) across three bouts of UW and three bouts of DTW. PFCa was measured via fNIRS. Gait was measured using wearables (OPAL) attached to participants' legs and lower backs. Cognitive performance was evaluated through serial subtraction by 3s during standing and walking. Fatigue was assessed using the Modified Fatigue Impact Scale (MFIS). We explored the associations between fatigue, gait, and PFCa using Spearman correlation. The effects of task (UW vs DTW), bout (3 X 30 sec), and time (six weeks of treadmill training) on PFCa and motor cognitive performance were studied via mixed-effects models with restricted maximum likelihood estimation (REML), adjusted for multiple comparisons by the Benjamini, Krieger, and Yekutieli method.RESULTS: At baseline, a significant task and task*bout interaction were observed for PFCa (Figure 1A). Total, physical, and cognitive components of fatigue were negatively associated with the dual-task cost of the third walking bout, while the physical component of fatigue showed the strongest association with PFCa, particularly during the third DTW bout (r=-.481, p=0.001). Compared to the values before the intervention, participants walked faster and more consistently across the walking bouts (mean difference (MD): 0.08-0.06 standard error (SE): 0.02, p=0.002), increased PFCa, especially during DTW (MD: 0.08-0.16 SE: 0.05-0.001, p<0.001), increased cadence (MD: 2.6-3.5 SE: 1.3-1.6, p=0.03), reduced double support (MD: 1.01-1.4 SE: 0.4-0.8, p=0.015), and subtracted more numbers (MD: 3.4-4.3 SE: 0.53-0.60, p<0.001) (Figure 1). Reduction in fatigue symptoms was also reported (total: MD: 5.2 SE: 1.75, p=0.02; physical: MD: 2.9 SE: 0.8, p=0.006). Post-training, PFCa during the third DTW bout (r=0.60, p=0.040) and mean DTW (r=0.71, p=0.009) were strongly positively associated with a reduction in physical fatigue symptoms.CONCLUSIONS: This study provides new evidence both cross-sectional and interventional, linking fatigue with inefficient PFCa in pwMS; intriguingly, this is modifiable. ACKNOWLEDGEMENTS AND FUNDING: This abstract is a side project of the VR4MS RCT study. No specific funding was received for this side project.

O.06.2 - Cognitive-motor dual-task interference during recovery from unexpected balance loss in lower limb prostheses users

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background and aims:Lower-limb amputations pose significant balance challenges, with around 50% of prosthesis users experiencing falls annually, 40% of which result in injury. Data on LLPs' reactive balance strategies and kinematics during balance loss while performing a concurrent cognitive dual-task is limited. Dual-task interference (DTi) occurs when performing two tasks simultaneously, leading to reduced performance in one or both tasks, complicating balance management in LLP users. In the present research, we aimed to examine the reactive balance responses of LLP users under both single-task (ST) and dual-task (DT) conditions, i.e., DTi on both balance and cognitive performancesMethods:Nine traumatic LLPUs (6 transtibial and three transfemoral, average age 49 years) were studied under two conditions: sitting with a cognitive task (counting backward by seven) and standing with a cognitive task. Perturbations were applied in four different directions: forward, backward, towards the prosthetic leg, and towards the intact leg, with six increasing intensity levels. They were instructed to prioritize both tasks, i.e., to avoid falling and to count backward by seven to the best of their ability. The single-step threshold, kinematics of the first reactive step, and cognitive task performance were compared between single- and dual-task conditions to evaluate DTi.Results:The single-step threshold was lower in the DT condition compared to the ST condition during backward perturbation (i.e., loss of balance in the forward direction). At the same time, no differences were observed for anterior and lateral perturbations. LLPs users predominantly performed reactive steps with the affected limb. When the first reactive steps were triggered, the kinematics in the ST condition were like those in the DT condition (Figure 1A-C). An additional observation was that during the DT, LLPs occasionally stopped counting backward following a perturbation, a behavior not observed in the cognitive ST condition. Regarding cognitive performance, there was no significant difference in cognitive task performance, with a comparable success rate in counting backward by seven and the percentage of correct answers between the ST and DT conditions (86.2% vs 84.9%, p=0.564). Conclusions:LLP users prioritize balance, as evidenced by a lower step threshold, and pausing the cognitive task, showing hesitation to step, and supporting the "posture first" strategy. Findings suggest overlapping neural resources for reactive balance and cognitive tasks. A simultaneous motor-cognitive task does not significantly affect the kinematics of the first reactive response following a sudden loss of balance, suggesting that the initial reactive step is likely an automatic reflex-like response.

O.06.3 - Distracted standing: Ambiguous tactile cues trigger startle responses when standing with increased cognitive load

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Background and Aim: Unexpected displacement of a touch reference triggers a short-latency (~100 ms) "false-positive" postural reaction in ~60% of standing participants on the first stimulus that subsequently adapts to tracking the touch reference with a simple arm motion. It is argued that performing cognitive tasks increases dependence on subcortical, automatic postural control mechanisms. Here we asked if increasing cognitive load would result in greater occurrence of "false-positive" postural reactions to ambiguous sensory cues arising from a displaced touch reference. Methods: Twenty adults aged 19-27 were asked to stand on foam atop a force plate under 4 conditions: a) eyes open, b) eyes closed with a cognitive task (CT), c) eyes closed with CT while touching (<1 N) a stable reference, and d) eyes closed with CT while touching a reference that was unexpectedly moved forwards 10 times (1.25 cm, 124 mm/s). The CT consisted of subtraction by 3. The primary outcome of interest was the presence of a presumptive postural reaction (PR) following the touch displacements, defined by forward sway in the center of pressure (COP), preceded by a burst in tibialis anterior (TA) or inhibition in soleus (SOL) with an onset latency of <120 ms, with no evidence of a burst in sternocleidomastoid (SCM) within 200 ms. In contrast, an arm extension response (AR) was defined by the presence of elbow extension with minimal induced motion of the COP. Startle responses (SR) were defined when a burst of activity occurred in SCM within 150 ms, often accompanied by a burst in posterior deltoid (PD) and a complex, multiphasic motion of the COP.Results: The first, unexpected touch displacement while performing the CT evoked PRs in 5/20 participants. Of these, only 1 subsequently engaged an AR, while the other 4 showed habituation of the PR following subsequent displacements. 8/20 participants responded to the first trial with a clear SR. Of these, 3 subsequently engaged an AR, while the other 5 appeared to not respond to subsequent stimuli. The remaining 7/20 participants responded with minimal or inconclusive responses to the first trial. Of these, ARs emerged in 3 on subsequent trials. No participants responded to the first trial with an AR. Conclusions: Increasing cognitive load interacted with the generation of behavioural responses to ambiguous sensory feedback from the fingertip during standing. The effects observed are richer than expected and suggest the ambiguity of the sensory feedback is managed in diverse ways across individuals. The appearance of startle responses in almost half of the participants was unexpected from previous studies, and suggests that ambiguous stimuli may preferentially initiate defensive and potentially destabilizing behaviours, rather than responses to presumed self-motion (i.e. postural responses) or external motion (i.e. arm extension responses). Funding: Natural Sciences and Engineering Research Council, Canada

O.06.4 - A cluster analysis exploring the interplay of gait, balance, and cognition in falls risk assessment and rehabilitation

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Background and Aim Current global guidelines recommend the use of an algorithm to stratify falls risk based on falls status and gait speed. Due to the complex nature of falls, additional intrinsic factors such as cognition, fear of falling, and medication use should also be considered as part of the base screening and stratification of risk. This study explored the relationships among the various factors included in a comprehensive falls risk assessment conducted in a large sample of older adults to identify unique clusters. We hypothesized that a series of clusters would emerge, which will help clinicians identify which assessments afford the best cost-to-benefit ratio to enhance patient care with respect to fall risk and rehabilitation. Methods A secondary analysis was performed on data collected as part of a community fall risk assessment program from 212 participants (70 ± 7 years, 67% female). Participants completed a long form physiological profile assessment (PPA), Montreal Cognitive Assessment (MoCA), Modified Falls Efficacy Scale (MFES), and overground walking trials on a 20-ft pressure-sensitive walkway at their preferred and fast gait speed, collectively leading to 66 intrinsic variables of interest. A hierarchical clustering analysis was performed using: a distance matrix based on the correlation of the measures, and the average agglomerative method for clustering. This analysis yielded a dendrogram from which statistically significant ($p<0.05$) clusters were identified. Results The dendrogram analysis revealed four statistically significant clusters (Figure 1). Each cluster reflects measures that increase and/or decrease together across the participant pool. Conclusion Based on the findings from the dendogram analysis, there are four naturally occurring clusters of falls risk factors which fluctuate together. The four clusters include: (1) a group primarily composed of cognitive factors, (2) a group focused on the spatiotemporal aspects of fast gait, (3) a group centered on physiological performance and fear of falling variables, and (4) a group emphasizing step width and base of support during both fast and preferred gait. This clustering reflects the integration of cognition with movement and aims to better understand how these factors interact and change with age, providing insight into the complex, multifactorial nature of falls risk. We can use these clusters to inform a streamlined approach to comprehensive assessment of falls risk which can inform a tailored approach to intervention selection. The streamlined approach would include a gait assessment at fast and preferred walking speeds, a standardized measure of fear of falling (e.g. MFES or Falls Efficacy Scale – International), and a measure of overall cognition, specifically a MoCA. This battery of measures takes about 30 minutes to administer which makes it feasible for clinicians to perform as part of routine care. Funding source: Project supported by Optima Health.

O.06.5 - Effects of anxiety on reactive balance following trip-like perturbations in older people

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Background and aim: Coordinating an effective balance recovery response following an unexpected perturbation is critical to avoid a fall. Anxiety, which is common in older people, has been shown to negatively influence balance control [1]. However, few studies have examined the effects of anxiety on reactive responses to unexpected balance perturbations while walking. This study examined the effects of generalised anxiety on reactive balance following sudden (trip-like) perturbations in older people.Methods: Nineteen healthy older participants, mean (SD) age 73.2 (4.3) years, walked on an instrumented treadmill at 90% of their usual walking speed while unexpected trip-like belt acceleration perturbations were pseudo-randomly delivered. The Hospital Anxiety

and Depression Scale questionnaire was used to categorise participants into high and low levels of anxiety. 3D motion capture was used to determine margin of stability and gait kinematics following a perturbation, comparing Anxious and Non-anxious groups. Results: No significant between-group differences were observed in walking velocity, step length or cadence (p>0.263) during normal walking across the protocol. Figure 1 shows the margin of stability for Anxious and Non-anxious groups at foot strike prior to the perturbations and the first three recovery steps following the perturbation for four perturbations over four repeated trials. Anxious and Non-anxious groups walked with similar margin of stability prior to the perturbations across all repeated trials (p>0.091). Anxious participants responded to perturbations with a greater margin of stability (were more stable) than Non-anxious participants at recovery step two ($F_{1,19} = 6.362$, p = 0.22) and three ($F_{3,19} = 2.864$, p = 0.046), which was maintained across the four repeated trials (Figure 1). Conclusions: Anxious participants had greater balance control in responding to a perturbation compared to Non-anxious. This may reflect elevated balance concerns leading to a more concerted effort to tighten postural control, which was maintained throughout the repeated trials. This strategy may be beneficial for simple postural tasks, but may have limited efficacy in highly dynamic tasks due to poorer flexibility for adapting to the more complex tasks [2]. Furthermore, the attentional demands of maintaining a tighter control of balance on safety in undertaking more complex activities of daily living should be examined. Acknowledgements and Funding:We acknowledge the assistance of Patrick Song, Michael Davis and Patrick Sengalrayan, as well as all of the participants who volunteered their time. References:Hainaut, J.P., Caillet, G., Lestienne, F.G. & Bolmont, B. The role of trait anxiety on static balance performance in control and anxiogenic situations. Gait Posture 33, 604-608 (2011).Young, W.R. & Mark Williams, A. How fear of falling can increase fall-risk in older adults: Applying psychological theory to practical observations. Gait Posture 41, 7-12 (2015).

O.06.6 - Misjudgment in older adult domestic ladder use

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BACKGROUND & AIMS: Misjudgment between physical ability and perception of ability is associated with increased injury risk (Delbaere et al. 2010). Physical ability is dynamic, increasing or decreasing with age, health and lifestyle changes (Edward et al. 2012). Our perception of ability is affected by performance, but this perception can lag behind physical ability if feedback on performance is not received. Safe feedback in everyday life can help update individual models (e.g. strength limits in carrying groceries, time to body fatigue on long walks). However, feedback in a hazardous everyday task like ladder use can be limited.The majority of older adult's report using a ladder monthly to a few times a year (Hicks et al. 2021), making these events common, but subjected to ability perception errors. Further, feedback through error events in ladder use can be fatal (Auckland et al. 2016). With older adults reporting the highest ladder fall injury rates in the domestic setting (Faergemann and Larsen 2000), there is a need to improve characterization of individuals at increased ladder fall risk. We believe that these high injury rates are partially due to misjudgment. The purpose of this study is to determine the effects of misjudgment on physical attributes and behavior of ladder use. METHODS: 104 older healthy older adults were recruited to participate in a domestic ladder use experiment study. Participants cleared a 5.8 m gutter filled with tennis balls using a straight ladder and were asked to rate their ladder use ability compared to others their age. The time it took to complete the gutter clearing task was captured to quantify ladder use ability, where a shorter task time indicated better ladder use ability. Physical attributes of ladder use were captured through clinical assessments and motion capture of the participant in the gutter clearing task. Behavior of ladder use was captured through questionnaires and scenario-based situations to climb ladders during their visit ranging from 10 cm to 366 cm in height (Figure 1.a). Individuals were grouped into one of four misjudgment groups (Poor Ability/High Perception, Poor Ability/Low Perception, Good Ability/Low Perception, Good Ability/High Perception) based on their time to complete the gutter clearing task and self-rating of their ladder use ability compared to others their age.RESULTS: Individuals with poor ability and high perception took similar risks in reaching during the gutter clearing task and ladder choice selection in the scenario-based situations as individuals with high ability and high perception (Figure 1.b-c.). Only individuals with poor ability and low perception were more cautious in the risks they took for domestic ladder use. CONCLUSIONS: Similar risk-taking behavior between high perception individuals regardless of ability suggest that misjudgment is present in a portion of older ladder users. Individuals with poor ability and high perception may be at increased risk of experiencing a ladder fall. Additional research is needed to assess ladder fall risk in this population.ACKNOWLEDGMENTS: This work was funded by the Whitaker International Fellowship and the NSF Graduate Research Fellowship Program (GRFP 1247842).

O.07: Stroke mechanisms and treatment

O.07.1 - Reduced capacity to modulate sensory information processing during reactive balance control is associated with lower balance and cognitive set shifting ability in aging and after stroke

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Background and Aim: The brain's ability to dynamically process sensory information reflects cortical flexibility important for adaptive behavior in changing environments. With repeated stimuli, evoked cortical responses attenuate through two mechanisms:

sensory gating (attenuation within a pair of consecutive stimuli) and habituation (attenuation across repetitive stimulus presentation). While these processes are well established in simple sensory paradigms, their role in reactive balance is unclear. We hypothesized that older adults (OA) and adults post-stroke have reduced capacity to modulate cortical processing with repeated standing balance perturbations. We predicted that the perturbation-evoked N1 potential, an index of sensory-driven error processing, would be attenuated less within a pair of perturbations and across trials compared to younger adults (YA), and correlate with lower balance and cognitive set-shifting ability. Methods: Electroencephalography was recorded during a whole-body motion perception task in YA (n=28), OA (n=24), and adults post-stroke (>6 months, n=21). Participants experienced 60 pairs of balance perturbations and judged whether they were in the "same" or "different" direction. Balance was assessed with a narrowing-beam walking test and cognitive set-shifting ability with the Trail-Making Test. N1 was extracted from the central midline electrode (Cz). N1 modulation within each pair was quantified by comparing the amplitude on the second perturbation relative to the first. N1 habituation was quantified by comparing amplitude changes across all pairs, separately for the first (unpredictable) versus the second (predictable) perturbation in each pair. Independent correlations were tested between N1 modulation, habituation, and behavior. Results: OA and stroke survivors had smaller and delayed N1s relative to YA. As expected, YA showed N1 attenuation within a perturbation pair and habituation across trials. Despite smaller N1s, OA showed similar N1 attenuation within a pair and across trials, but only on the predictable perturbation. In contrast, N1 modulation and habituation were reduced in stroke survivors. N1 modulation and habituation were not correlated. In OA and stroke survivors, reduced N1 modulation correlated with worse balance and cognitive set-shifting ability. Conclusion: Smaller and delayed N1s in both OA and stroke survivors suggest that age-related neurodegeneration, rather than stroke, affects sensory information processing. However, dynamic information processing was specifically reduced post-stroke, indicating deficits in sensory gating and habituation during reactive balance. Associations between lower set-shifting ability and less N1 modulation suggests a potential shared mechanism of reduced neural flexibility. Interventions aiming to boost the adaptive capacity of the nervous system may be important for reducing falls risk.

O.07.2 - Time course of pro- and reactive balance control changes during quiet standing in relation to leg motor recovery in early subacute stroke - a prospective longitudinal study

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Background and AimBalance control during quiet standing primarily relies on an ankle strategy which acts by shifting the Center of Pressure (CoP) within the base of support to maintain stability [1]. Following a stroke, one-sided sensorimotor deficits impair this strategy, leading to increased reliance on the less-affected side and greater postural sway amplitudes. Therefore, CoP measurements using dual force plates are recommended to inform about changes in inter-limb coordination and contributions poststroke, quantified as between-limb synchronization (BLS) and dynamic control asymmetry (DCA) [2,3], respectively. Decomposing these measures into low-frequency (<0.4 Hz) and high-frequency (>0.4 Hz) may provide further insight into poststroke balance control as they are suggested to represent, respectively, anticipatory control and reactive corrections [4]. Despite recommendations, the test-retest reliability and measurement error of BLS and DCA during the early subacute phase remain unknown to inform stroke recovery studies. Therefore, we aimed to determine (1) the number of test repetitions needed to obtain reliable BLS and DCA scores, and (2) whether test-retest reliability and measurement error vary across fixed timepoints at 3, 5, 8, and 12 weeks poststroke.MethodsThirty poststroke participants (63.7±15.4 years; 12 females; 3weeks FM-LE: 17.27±8.53) were assessed at 3, 5, 8, and 12 weeks poststroke. CoP displacements were measured bilaterally using dual force plates (AMTI OR6-7) at a sampling rate of 1000Hz, while participants stood quietly for 40 seconds with 3 trials per timepoint [5,6]. BLS and DCA were calculated for overall, low-frequency, and high-frequency CoP signals using a 0.4 Hz cutoff via Fast Fourier Transformation (FFT) in Matlab. Test-retest reliability of BLS and DCA was analyzed using a two-way mixed-effects model Intraclass Correlation Coefficients (ICC3,k) for one, two, and three test repetitions. Reliability was considered sufficient at ICC >0.75. ResultsFor aim 1, BLS and DCA yielded consistently ICCs >0.75 across timepoints when three repetitions were performed, whereas high-frequency BLS and DCA demonstrated generally greater reliability. DCA achieved sufficient reliability when reducing to two test repetitions, whereas BLS was insufficiently reliable. For aim 2, at 3 weeks poststroke, reliability was generally poorer, with higher measurement errors, compared to later assessments (Figure 1).ConclusionsOur findings confirm that three test repetitions are needed to provide reliable BLS and DCA outcomes at various fixed timepoint during the early subacute phase poststroke, with DCA showing sufficient reliability with only two repetitions. Test-retest reliability was generally lower at the 3-week assessment, a timepoint that typically coincides with the start of early stroke recovery studies. These findings provide robust guidelines for assessing movement quality during recovery and can inform rehabilitation studies focusing on early poststroke balance control.Acknowledgements and fundingThe authors would like to thank the health care professionals at the cooperating hospitals and the patients for participating in the project, which was supported by the Research Foundation Flanders (FWO, Belgium; application no.1S64819N) and DOCPRO (University of Antwerp, Belgium; application no.44607)

O.07.3 - Altered gaze behavior after a stroke reflects poor balance and gait

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Background: Unstable walkers, and in particular persons with stroke (PwS) tend to gaze down while walking. This statement relies heavily on clinical impressions, but has little, if any quantitative support in the literature. Nonetheless, if downward gazing (DWG) is a true phenomenon among PwS, what underlies this behavior? In this study, we quantify DWG tendency in PwS by comparing their gaze behavior to that of healthy controls. Additionally, we explore the relationship between DWG and various domains related to balance and gait.Methods: PwS (n=45) and healthy controls (n=18) performed the 10-meter walk test twice while wearing a mobile eye-tracker. Preferred walking speed, and gaze behavior data were extracted and used for analysis. In addition, PwS were tested for their lower limb impairment level (Fugl-Mayer-Assessment) and coordination (Lower-Limb-Coordination-Test), their balance (Postural sway) and gait steadiness (spatiotemporal variability). Additionally, PwS completed the Gait-Specific Attentional Profile (G-SAP) questionnaire, assessing several psychological domains implicated in balance and gait control.Results: A total of 126 walks were analyzed. PwS walked slower and gazed downward more frequently than controls. Specifically, they walked with a lower head angle, spent a greater percentage of time looking at the walking surface, and focused on a shorter distance ahead. Notably, they spent a greater percentage of time looking onto the immediate surface (<3m ahead), a range of look-head distances often observed when precise stepping is required. After establishing its existence, we tested the association of this tendency with impairment and activity levels. First, DWG was negatively associated with walking speed and positively associated with the lower limb's impairment and coordination levels. Next, we tested the association between DWG and the steadiness of posture and gait and found negative association with both. Finally, DWG was associated with fear of falling but not with a tendency for conscious movement control, as measured by the G-SAP.Discussion: Our findings confirm that PwS tend to gaze down while walking and provide, for the first time, a quantitative description of this tendency. This tendency was found associated with many quantitative measures of lower limb impairment level, balance and gait. It was also associated with fear of falling (anxiety) but not with a tendency for conscious movement control. We propose that DWG is a behavioral biomarker reflecting reduced ability to control gait and posture after stroke and call for studying the contribution of this behavior to mobility after brain injury.

O.07.4 - An initial exploration of the clinical presentation of people with stroke who respond to a visual feedback training intervention for temporal gait asymmetry

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Background and Aim Temporal gait asymmetry (TGA; unequal swing time between the affected and unaffected legs) affects >55% of people with stroke. TGA is linked with negative outcomes including secondary musculoskeletal issues and resists conventional rehabilitation. Interventions that target TGA are needed. Equally important is understanding the clinical characteristics of people likely to respond so that clinicians can select the ideal TGA intervention for each patient post-stroke.Methods This is a secondary analysis of the intervention group from a randomized feasibility study that examined a visual feedback gait intervention for TGA. Participants <9 months post-stroke attended sessions 3x/week for 4 weeks to complete 30s walking trials over a pressure-sensitive mat that collected spatiotemporal gait parameters. This data was used to create the visual feedback display presented after each walking trial. Clinical characteristics collected at baseline included demographics, time post-stroke, affected side, motor impairment (Fugl-Meyer Assessment; FMA), cognitive impairment (Trial making task A&B), gait speed (cm/s), and TGA (ratio of right and left swing times). TGA, the primary outcome, was collected pre-, post-, and 4-week follow-up to the intervention. TGA change scores were calculated as pre-post, and pre-follow-up for each participant. Responders were defined by a TGA change > minimal detectable change (MDC = 0.26). Individual responders were compared to the remaining group of non-responders on baseline characteristics using one-sample t-tests. Results Eight participants (mean (SD) age 53 (16) years, time post-stroke 6 (2) months) received the feedback intervention and 2 of those 8 were classified as responders. Table 1 summarizes the baseline values for clinical characteristics of the responders and the non-responder group. One responder had a slower gait speed (t_5=4.36, p=0.0073), greater TGA (t_5=9.12, p=0.0003), and lower FMA score (t_5=4.78, p=0.005) at baseline compared to the non-responder group. The other responder was more chronic (t_5=-1.83, p=0.0022), had greater TGA (t_5=-4.63, p=0.0057), and longer Trials A (t_5=-5.25, p=0.0033) and B (t_5=-10.69, p=0.0001) times than the non-responder group. Conclusions These preliminary results indicate that people with stroke who have more severe TGA and more severe motor or cognitive impairment at baseline respond to a visual feedback intervention for TGA. We expected responders to have greater cognitive ability (as measured by the Trial Making task) to interpret and respond to the visual feedback, however, this was not necessarily the case. Interestingly, one responder had worse cognitive impairment compared to the non-responder group. These results will inform a clinical trial that will examine selection of TGA intervention based on severity of baseline TGA, and motor and cognitive impairment.
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O.07.5 - Longitudinal changes in recovery and real-world performance during the first 6 months post-stroke

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Background & Aim: Significant improvements in motor recovery and functional ability characterize the first 6 months post stroke. While clinical measures can capture motor recovery, day to day real-world performance associated with progress is more difficult to quantify. The Stroke Research and Recovery Roundtable recommended use of inertial measurement unit (IMUs) to collect kinematic measures outside of the clinical settings and in free-living environments to provide insights into real-world recovery processes. We aimed to explore longitudinal changes in clinical measures and IMU measures of free-living arm use and walking during the first 6 months post-stroke. Methods: Participants wore bilateral wrist and ankle AX6 Axivity IMUs for 24 hours/day for 1 week at baseline admission to inpatient rehabilitation (<8 weeks post stroke), 4- and 8-weeks post-baseline and 6 months post-stroke. The Fugl Meyer Assessment Upper Extremity (FMA-UE) and Lower Extremity (FMA-LE), and 6-minute walk test (6MWT) were collected at each time point. MU data was analyzed for the impact of wheelchair and aid use, with steps and UE activity measurements calculated after removing sleep and non-wear periods. Intensity (Bilateral Magnitude, BM) and symmetry (Magnitude Ratios, MR) of bilateral arm use characterized free-living UE function. Statistical Analysis: Linear mixed models (LMM) were used to explore changes in clinical measures and IMU measures over time, while accounting for participant differences as a random effect across all models. Results: To date, 9 participants (2 females, mean age 66.6 ± 11.3 years) admitted to inpatient rehabilitation after ischemic stroke (7 cortical) are included in the preliminary analysis. At baseline, 4 participants were walking with assist x1 and 3 were walking independently with a walking aid. At 6 months all participants were walking independently (2 with walking aids). Clinical measures improved across time points compared to baseline in FMA-UE ($p<0.05$), FMA-LE ($p<0.05$), and 6MWT ($p<0.05$). IMU derived average step count significantly increased ($p<0.05$) at all time points compared to baseline. Compared to baseline, BM showed a trend towards improvement ($p<0.1$), and MR significantly decreased ($p< 0.05$) at 4-and 8- weeks post-baseline, but neither showed significant changes at 6 months post-stroke. Conclusions: Motor impairment of the UE and LE, walking endurance and IMU measures of step counts and intensity of bilateral arm use, BR, demonstrated improvement over the first 6 months post-stroke. Declining MR suggests increased asymmetry in arm use during the first 8 weeks in the study, reflecting greater reliance on the non-paretic arm and potential learned non-use of the paretic arm post-stroke. Preliminary results suggest that IMU data may capture free-living functional changes associated with motor recovery post-stroke.Acknowledgements and Funding: This work is supported by Dr. Miriam and Sheldon G. Adelson Medical Research Fund.

O.07.6 - Functional electrical stimulation-aided perturbation-based training can enhance neuromodulation of reactive balance control to reduce fall-risk in people with chronic stroke

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Background: People with stroke (PwS) can improve reactive balance control and acquire fall-resisting skills with perturbation training (PBT). However, our study showed a) slower adaptation and retention on the paretic limb [1] and b) inability to adapt to higher perturbation intensities in PwS with high motor impairment [2]. Thus, PwS might need high training dosage and/or supplemental agents to adapt to high-intensity perturbations. Functional electrical stimulation (FES), applied to the paretic limb muscle(s), is one widely used supplemental agent. Recently, we showed that FES to paretic quadriceps during high-intensity stance-slips [3] and gait-slips [4] improved reactive stability resulting in lower lab falls than slips without FES (neuroprosthetic effect). It remains unknown if the neurofacilitatory effect of FES can be leveraged to enhance motor adaptation during PBT. Here, we examined effects of single-session in PwS low motor impairment (Study 1: SS-low) and multi-session PBT in PwS with high motor impairment (Study 2: MS-high) with and without FES. Methods: 20 PwS with low (Chedoke leg > 4/7, SS-low) and 20 with high motor impairment (Chedoke leg ≤ 4/7, MS-high) were assigned to FES+PBT or PBT groups (n=10 in each group). All participants experienced a pre- and post-testing slip perturbation without FES at a high-intensity (acc: 12 m/s2). PwS in study 1 experienced 11 slips at a lower-intensity (acc: 7.5 m/s2) and those in study 2 underwent 6 weeks of progressive training (distance: 6-24 cm). The FES+PBT groups (Study 1 and 2) received electrical stimulation to paretic quadriceps for 450 ms after slip onset. Outcomes including lab falls and reactive balance measures (post-slip stability and limb support at compensatory step touchdown, compensatory step length, step initiation time) were assessed pre-post training.Results: The 2x2 ANOVA showed group x trial interaction on all outcomes (Study 1 and 2). Post-hoc comparisons showed no group differences in pre-training measures ($p>0.05$). Post-training, the FES+PBT groups showed lower laboratory falls, higher post-slip stability and limb support at compensatory step touchdown, longer compensatory step length and step initiation time than PBT alone groups ($p<0.05$). In study 2, >50% of PwS in FES+PBT group demonstrated progression to highest slip intensity within 4 weeks of training, whereas >50% in PBT group were unable to progress to the highest slip intensity by end of 6 weeks. Conclusions: Addition of FES to PBT can reduce lab fall incidence and enhance reactive balance performance than PBT alone, suggesting that FES might have a short-term neuromodulatory effect possibly due to its peripheral mechanism of action (activation of neuromuscular units), thus enhancing limb support and stability at compensatory limb touchdown. Future studies could also examine the neuroplastic effect of FES to differentiate the peripheral and central neuromodulatory effects on reactive balance control.

O.07.7 - Differences in centre of mass measurements between markerless and marker-based motion capture systems during balance and mobility assessments in individuals with sub-acute stroke

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Background and AimKinematic balance and mobility assessments are typically conducted using marker-based motion capture. Applying reflective markers is time-consuming, and for those with stroke, this process can be burdensome and fatiguing. Markerless motion capture is a recent alternative solution, which reduces the duration of data collection while maintaining the reliability and accuracy of conventional motion capture systems. Prior research has validated markerless motion capture systems compared to marker-based motion capture in balance assessment for young healthy adults, but not post-stroke. People with stroke often develop atypical movement patterns during motor tasks, such as walking. These patterns may not be represented in the algorithm's training data, potentially affecting the ability of a markerless system to predict movement accurately. Therefore, this study compared the centre of mass (COM) measured by a markerless motion capture system to a marker-based motion capture system in individuals with sub-acute stroke. MethodsNine participants (age=50.1 years, 42-128 days post stroke) completed the mini-Balance Evaluation Systems test and gait assessment. Tasks analyzed were: single trials of sit-to-stand, rise on toes, backward reactive step, and quiet standing, and six 4m walking trials. 3-D kinematic data were collected simultaneously using markerless and marker-based motion-capture systems. COM measurements were computed using three biomechanical models (default and matched Theia models and marker-based). We determined the correlation (R2) and root mean square difference (RMSD) between the COM models for all tasks. ResultsR2 for all the tasks was 0.83-0.99 (standard deviation: 0.376-0.001) in each direction: medio-lateral (Y), antero-posterior (X), and vertical (Z). RMSD for all tasks was 0.04-0.01m (standard deviation: 0.03-0.01m) in the X and Y directions, while the Z direction was 0.08-0.04m (standard deviation: 0.018-0.1m). Figure 1 shows results from a sample participant. Results were similar for both markerless biomechanical models. ConclusionsOur findings suggest that both motion capture systems agree on the COM position for various movements. Thus, markerless motion capture may be reliable for mobility assessment post-stroke. Consistent with previous studies, there was a significant bias in the vertical direction; markerless motion capture predicted the COM to be lower. Future studies should account for this bias when using markerless motion capture for COM measurements; however, we are unable to determine which method of motion capture more accurately represents the true COM location. Acknowledgements and FundingFunding for this project is provided by the Heart and Stroke Foundation of Canada, the Canada Brain Research Fund (CBRF), an innovative arrangement between the government of Canada (through Health Canada) and Brain Canada Foundation, and the Heart and Stroke Foundation Canadian Partnership for Stroke Recovery.

O.07.8 - Effect of surgical correction of pes equinovarus in people with upper motor neuron syndrome

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BACKGROUND AND AIMPes equinovarus is a disabling ankle-foot deformity frequently seen in people with upper motor neuron syndrome (UMNS), like stroke or traumatic brain injury. It often affects gait and balance, causing a wide range of symptoms such as difficulty with walking barefoot, pain during standing and walking, and reduced walking endurance. Tarsal arthrodesis – when necessary combined with Achilles tendon lengthening – is a surgical intervention that has demonstrated promising clinical outcomes in correcting pes equinovarus. However, evidence on its effectiveness remains limited. Therefore, this study aimed to evaluate the effect of corrective surgery for pes equinovarus on personalized goal attainment, gait and balance capacity in people with UMNS.METHODSIn this repeated measures study, 45 adults with chronic UMNS and pes equinovarus who underwent corrective tarsal arthrodesis were included. Personalized goal attainment was assessed before and 12 months post-surgery using the Canadian Occupational Performance Measure (COPM), which has a score ranging from 0 to 10. Furthermore, balance capacity was evaluated with the Mini Balance Evaluation Systems Test (Mini-BESTest), and gait capacity was assessed by three-dimensional instrumented gait analysis. Paired samples t-tests were conducted to compare pre- and post-surgery outcomes.RESULTSPerformance of and satisfaction with personalized goals improved significantly following surgery (change performance: +3.4±1.8, $p<0.001$; change satisfaction: +3.9±1.8, $p<0.001$). Similarly, mini-BESTest scores demonstrated a significant increase of +5.0±5.1 ($p<0.001$). Eighteen of the 22 participants who were unable to walk barefoot prior to the surgical intervention were able to walk barefoot afterward. Post-surgery barefoot gait speed improvements correlated with pre-surgery gait speed, with slower participants demonstrating greater improvement. Gait analysis revealed a significant increase in step length (change: +0.05±0.08 m, $p<0.04$) and increased ankle dorsiflexion during the loading response and swing phase on the paretic side ($p<0.05$). Finally, peak ankle power increased on the non-paretic side (change: 0.46±0.61 W/kg, $p<0.02$).DISCUSSIONClinically meaningful improvements in personalized goal attainment, balance capacity, and gait capacity were observed after corrective surgery for pes equinovarus. The increased step length and ankle dorsiflexion on the paretic side and increased peak ankle power on the non-paretic side suggest improved prepositioning and subsequent loading of the paretic foot after surgery. Therefore, tarsal arthrodesis – when necessary combined with Achilles tendon lengthening – should be regarded as an effective intervention in people with UMNS and pes equinovarus.

O.08: PD and the brain

O.08.1 - Preserved neuroplasticity in patients affected by Parkinson's disease responders to compensatory external auditory cueing strategies for gait impairments

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Background and Aim: Neural plasticity in the primary motor cortex (M1) is impaired in Parkinson's disease (PD), with a noted lack of long-term potentiation LTP-like plasticity in this region. Additionally, PD patients exhibit abnormal beta-band activity in sensorimotor areas, characterized by decreased desynchronization during movement initiation, leading to more pronounced motor symptoms. Notably, the use of external cues, such as rhythmic auditory cueing (RAC) during gait, has been shown to normalize beta-band activity in sensorimotor areas in PD patients. Recent studies suggest that LTP-like plasticity in M1 may contribute to more effective beta-band desynchronization in sensorimotor areas during movement execution. Based on these observations, we hypothesize that PD patients who respond positively to RAC (i.e., showing significantly lower gait variability during cued versus uncued gait) may retain LTP-like plasticity in M1. This plasticity appears to be closely associated with beta activity in the sensorimotor cortex, distinguishing responders from non-responders. Methods: We recruited 11 responders (Age: 67,6 ± 7,7 y.o.; H&Y: 2,1 ± 0,31) and 10 non-responders (Age: 67,6 ± 7,8 y.o.; H&Y: 2,1 ± 0,40), all affected by PD, that were tested for corticospinal excitability (CSE) of the tibialis anterior via an I/O curve at 80%, 100%, 120%, 140% and 160% of the individual resting motor threshold (RMT), before and after an intermittent theta burst (iTBS) TMS protocol, used to induce LTP-like plasticity mechanisms in M1. The area under the I/O curve (AUC) was also computed to characterize the state of corticospinal projections. PD patients were considered responders to RAC when showing an absolute reduction of stride time variability of 0.5 points compared to uncued gait. Results: Our results showed that responders to RAC exhibited an increased corticospinal excitability post-iTBS in terms of increased MEPs post-iTBS protocol at 100% ($p=0.008$), 120% ($p=0.022$), 140% ($p=0.003$), and 160% ($p=0.001$) of RMT and AUC ($p=0.001$). No significant differences were found for non-responders. Moreover, a significantly higher AUC ($p=0.021$) was found in the post-iTBS protocol for responders compared to non-responders, while no differences were found between the two groups at baseline. Conclusions: These preliminary results suggest that PD responders to RAC might have intact neuroplastic mechanisms in M1, possibly related to less abnormal synchronized beta-band activity in sensorimotor areas or to a more efficient mechanism of beta

desynchronization during externally cued movement execution, compared to non-responders. Importantly, this study is part of an international project called UNITE-PD whose aim is to disentangle the neural underpinnings of cueing strategies in PD through non-invasive brain stimulation techniques and neurophysiological methods. Acknowledgements and funding: This study is part of the UNITE-PD project, funded by the EU-JPND program.

O.08.2 - Higher cortical sensorimotor beta oscillations prior to balance perturbations are associated with balance impairments in older adults with–but not without–Parkinson's disease

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Background and Aim: Cortical sensorimotor beta oscillations (13–30 Hz) are elevated in aging and Parkinson's Disease (PD) and are linked to impaired motor control due to abnormal basal ganglia-thalamocortical circuit function. In PD, excessive beta power disrupts sensorimotor integration and balance responses, while in older adults, increased beta may reflect compensatory mechanisms. The supplementary motor area (SMA), a key region for integrating sensory input and motor planning during balance recovery, shows beta activity modulations that could influence balance performance. This study investigates whether sensorimotor beta oscillations during standing before balance perturbations predict clinical balance ability, as measured by the Mini-BESTest, in older adults with and without PD. Methods: Sensorimotor beta power was analyzed from EEG recordings of 17 individuals with PD (median Hoehn & Yahr: 2) and 18 older adults during standing balance perturbations. Beta oscillations were measured in the dipole locations contributing to the perturbation-evoked N1 event-related potential localized to the supplementary motor area (SMA). EEG data were preprocessed, and spectral parameters of the pre-stimulus beta power (−1000 ms to −2 ms) were analyzed using the FOOOF algorithm (outputs peak beta power, bandwidth, center frequency, aperiodic offset, and aperiodic exponent). Clinical balance ability was assessed using the Mini-BESTest. Results: Average beta power (PD: M = 0.352, SD = 0.181 μV^2; OA: M = 0.397, SD = 0.172 μV^2; p = 0.380) and peak beta power (PD: M = 0.372, SD = 0.178 μV^2; OA: M = 0.462, SD = 0.159 μV^2; p = 0.126) were similar across groups, although a trend toward higher peak beta center frequencies was observed in older adults without PD (p = 0.050). All other beta characteristics were similar across groups (p>0.70). Within the PD group, higher pre-stimulus beta power was associated with lower clinical balance ability (average beta power: r = -0.67, p = 0.003; peak beta power: r = -0.64, p = 0.006), but no such relationship was observed in older adults (average beta power: r = -0.16, p = 0.52; peak beta power: r = -0.12, p = 0.64). Regression analyses revealed significant interactions between group and beta power, with higher beta power predicting worse

balance in PD participants (average beta power: β = -1.37, 95% CI [-2.25, -0.49], p = 0.003, η^{2p} = 0.25; peak beta power: β = -1.34, 95% CI [-2.30, -0.38], p = 0.008, η^{2p} = 0.21). Conclusions: These findings suggest a distinct relationship between sensorimotor beta power and clinical balance impairments in PD, that is not observed in older adults. These results suggest that elevated beta power is related to balance impairments in PD, highlighting sensorimotor beta oscillations as potential biomarkers for balance dysfunction in this population. Acknowledgements and Funding: This work was supported by the National Institutes of Health (Eunice Kennedy Shriver National Institute of Child Health & Human Development grant number R01 HD46922).

O.08.3 - Cholinergic system changes associated with freezing of gait in Parkinson's Disease have right hemispheric lateralisation

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Background and aim:Freezing of gait (FoG) is one of the most debilitating symptoms of advanced stage Parkinson's. Previous research indicates that FoG and falls may be linked to the degeneration of predominantly right-sided cholinergic projections between the pedunculopontine nucleus (PPN) and thalamus. Furthermore, gait rehabilitation may be associated with improved connectivity between the left and right PPN. The current study aimed to assess whether similar right-lateralised changes are witnessed in the cholinergic basal forebrain (cBF) in FoG and/or falls.Methods:136 people with Parkinson's underwent 18F-fluroethoxybenzovesamicol ([18F]FEOBV) PET and anatomical MRI. The sample included 87 people without falls (M age = 66.83 yrs, M UPDRS III = 33.90), 31 fallers without FoG (M age = 65.52 yrs, M UPDRS III = 36.31) and 18 people with FoG (M age = 72.94 yrs, M UPDRS III = 49.92). FoG was classified via clinical examination of item 3.11 "Freezing of Gait" on the MDS-UPDRS Part III. Fallers were classified according to any history of falls in the previous 12 months. Volumetric analyses normalised by total intracranial volume (TIV) were calculated for each subregion of the cBF (Ch4, Ch4p and Ch1-2) both unilaterally and bilaterally. Volume-of-interest based correlation analysis was used to assess the relationships between regional [18F]-FEOBV binding and cBF integrity in each subregion.Results: Participants with FoG showed significant atrophy in the right (but not left) Ch4p, compared to non-FoG fallers (Bonferroni post-hoc, P= .006) and non-fallers (Bonferroni post-hoc, P= .002). This effect survived controlling for disease duration, levodopa-equivalent dose, sex and most affected side. Similar group differences between FoG and non-FoG fallers and non-fallers were witnessed bilaterally for Ch4. Weak-to-moderate correlations between unilateral cBF volumes and [18F]-FEOBV binding were shown broadly in both hemispheres in people without FoG, including both non-fallers and fallers. On the other hand, moderate-to-strong correlations were almost exclusively observed in the right hemisphere among individuals with FoG. The strongest correlations in FoG were found between right cBF regions and [18F]-FEOBV binding in orbitofrontal and temporal regions, hippocampus and amygdala. Conclusions:Our results support emerging evidence that dysfunctional neocortical and limbic cholinergic transmission in the right hemisphere may be a feature of FoG in Parkinson's disease. Replication of these lateralised effects could help inform more targeted neurosurgical approaches treatment.

O.08.4 - Resting-state functional near-infrared spectroscopy in people with Parkinson's disease

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BackgroundMagnetic resonance imaging (MRI) has been used to describe resting-state brain connectivity differences in people with Parkinson's disease (PwPD) compared with healthy controls (HC). MRI is considered the gold standard, but many PwPD do not meet the inclusion criteria to undergo this costly imaging technique. Thus, functional near-infrared spectroscopy (fNIRS) is a promising tool that can include a broader spectrum and is less costly. We Aim to describe differences we obtain in the functional connectivity and replicate resting-state functional connectivity differences between PwPD and HC found in resting-state MRI. We hypothesized that there is a lower eigenvector centrality in PwPD than in HC in the channels corresponding to the superior temporal gyrus (STG), the supramarginal gyrus (SMG), and the inferior parietal lobe (IPL) (Ballarini et al. 2018, Tahmasian et al. 2017). MethodsData of twenty-seven PwPD (69.3±6.7) and 30 HC (69.3±7.4) were collected during a single experimental session at the uMOVE core facility, Karolinska University Hospital, Solna, Sweden, as part of the "Park-MOVE" trial (doi.org/10.48723/vscr-eq07). A NIRSport2 (NIRx) system with 16 sources, 16 detectors, and eight short-separation detectors transmitted light at 760 and 850 nm. Two measurements of 10 min were used to cover the left and right brain hemispheres (Fig.1). Clinical tests of balance (Mini-BESTest), global cognition (MoCA), and self-report questionnaires related to health status were collected (gait ability: Walk12G, anxiety and depression: HADS, Edinburgh Handedness Inventory, and for the PD group MDS-UPDRS parts Ib & II). FNIRS were processed using Brain AnalyzIR and BRAPH. The results were false discovery rate (FDR) corrected. The study and hypotheses were preregistered (osf.io/wtsy7). Results show that we could include 42 channels with good signal quality. Significantly lower eigenvector centrality was found in PD than in HC in the left inferior parietal lobe (Channels: SRC10-DET9, MNI coordinates: -39,-54,46) with a difference of -0.0032, FDRp=0.036. Significantly higher eigenvector centrality was found in PD than in HC in the right superior frontal lobe (Channels: SRC7-DET6, MNI: 15,-17, 69) with a difference of 0.034, FDR-p=0.0029 (Fig.2). In conclusion, we partially replicated resting-state MRI eigenvector centrality obtained networks in PwPD compared with HC, but also found unexpected increased resting-state activity. Reasons for this can also be a slight difference in how eigenvector centrality is calculated as well as many other factors such as disease stage or medication status. Acknowledgments/Funding We thank all participants and assessors. This study is supported by the Swedish Research Council

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O.08.5 - Neural activity underpinning real-time gait and postural control in Parkinson's disease using a novel fdg-pet/mr imaging methodology: The dynamo-pd study

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Background and aim: Gait impairments and postural instability are hallmark symptoms of Parkinson’s disease (PD), often leading to recurrent falls and reduced independence. People with Parkinson’s (PwP) consistently identify gait impairments as a top research priority. However, the neural mechanisms underpinning these impairments remain poorly understood, as conventional neuroimaging techniques are incompatible with real-time walking tasks. This impedes the development of effective treatments. We recently developed a novel protocol using [18F]fluorodeoxyglucose (FDG)-Positron Emission Tomography (PET) to study neural activity related to real-time walking and postural control. In older adults, we observed increased glucose metabolism during walking in regions important for locomotion, spatial navigation, and sensorimotor integration1. Here, we apply this methodology to PwP. Methods: Thirteen PwP (68.6±4.2 years, 10 males) were recruited. Fifteen older adult controls (65.7±3.9 years, 5 males) were available for comparison1. Participants underwent FDG-PET/MR brain imaging following two distinct tasks: a 15-minute standing task and a 15-minute walking task, each preceded by an intravenous injection of FDG (Fig 1-A). To eliminate signal from the first injection (PETSTAND) in the second scan (PETWALK), we applied a novel ‘dose-correction’. We then subtracted the corrected PETWALK from the PETSTAND images to generate per-participant contrast images. Whole brain statistical analyses were conducted to compare glucose consumption between groups during standing and walking—standing (contrast), correcting for multiple comparisons (pFWE<0.05). Results: During standing, PwP showed hypometabolism in areas linked to executive control and cognitive processing, including the orbital frontal cortices and cerebellar Crus 1. Conversely, PwP demonstrated hypermetabolism in motor and sensory processing regions including the cingulate cortex, cerebellum, and the basal ganglia, compared to controls (Fig 1-B). When comparing walking—standing contrast images, PwP exhibited hypometabolism (Fig 1-C) relative to controls in areas important for visuospatial processing (precuneus, occipital cortex), motor planning (thalamus, cerebellum) and

executive control (frontal pole). Conclusions: In this study we used advanced neuroimaging techniques to study whole-brain activations related to gait impairments and postural control in PwP. Using our novel methodology, we identified PD-specific alterations in neural activity during both static postural control and gait. Our preliminary findings suggest that gait impairments in PwP are underpinned by deficits in sensory, motor and cognitive control brain networks. These insights offer a foundation for developing targeted interventions to improve gait and postural control, with the aim of empowering PwP to maintain independence for longer. FUNDING: This work is funded by Parkinson's UK.[1] Sigurdsson, et al., 2024 PMID:38331333.

O.08.6 - Resting-state EEG alpha reactivity is reduced in Parkinson's disease and associated with gait variability and cognition

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Background and aimThe extent to which the cholinergic system contributes to gait impairments in Parkinson's disease (PD) remains unclear. Electroencephalography (EEG) alpha reactivity, which refers to change in alpha power over occipital electrodes upon opening the eyes, has been suggested as a marker of cholinergic function. This study aimed to compare alpha reactivity between people with PD and healthy individuals and explore its potential association with gait and cognition.Methods Participants included 20 people with mild to moderate PD and 19 age- and sex-matched healthy individuals; people with PD were tested in their ON state of medication. Resting-state EEG data (eyes-closed and eyes-open) were recorded with a 64-channel EEG system. Alpha reactivity was calculated as the relative change in alpha power (8-13 Hz) over occipital electrodes (O1, Oz and O2) from eyes-closed to eyes-open. After EEG recordings, participants walked, at their preferred pace, for one minute around a 25.8 m oval circuit; 4 repetitions were performed. Gait spatiotemporal measures were obtained with the GAITRite electronic walkway. We recorded an average of 107.3 [range: 97 – 127] steps (per participant) for people with PD and 103.4 [range: 86 – 119] steps for healthy individuals. Global cognition was assessed with the Mini Mental State Examination.Results Alpha reactivity was reduced in people with PD compared to healthy individuals ($U = 105$, $p = 0.017$, Figure 1); the rank-biserial correlation of 0.447 indicated a moderate effect size. Across the entire sample, alpha reactivity associated with measures of gait variability only (Figure 1), namely: stance time variability (rho = -0.532), step velocity variability (rho = -0.515), step time variability (rho = -0.463), step length variability (rho = -0.449) and swing time variability (rho = -0.437). When only people with PD were considered for correlations, alpha reactivity also associated with measures of gait variability only, namely: stance time variability (rho = -0.638) and swing time variability (rho = -0.544). Additionally, alpha reactivity associated with Mini Mental (rhosample = 0.346, rhoPD =

0.536).ConclusionsReduced alpha reactivity in mild to moderate PD suggests impaired cholinergic function as an early pathophysiological characteristic of PD. Reduced alpha reactivity was associated with greater gait variability and poorer cognition, indicating a role of the cholinergic system in the mechanisms underlying gait variability and cognition. Therefore, the cholinergic system may represent a target for treatments aiming to reduce gait variability and improve cognition. Alpha reactivity should be further explored as an endpoint for clinical trials. Alpha reactivity may be a useful biomarker for identifying patients with cholinergic deficits, enabling tailored interventions.Acknowledgements and fundingSao Paulo Research Foundation (FAPESP) [2014/22308-0; 2017/19845-1].

O.08.7 - Neural activity during turning in Parkinson's disease: A mobile EEG study

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BackgroundTurning is impaired in Parkinson's disease (PD) and has been linked to increased falls risk. The risk of hip fracture is eight-times greater when a fall occurs during a turn. Turning is impacted by age and neurological disease, with slow turns that can elicit freezing of gait (FOG) episodes in PD seen in clinical and real-world settings. Turning performance is further impaired when distracted by a secondary task (e.g., dual-tasking). Intervention for turning deficits is challenging due to the lack of understanding of the underlying neural mechanisms involved. Assessment of the neural activity involved during turning in PD, older adults (OA) and young adults (YA) may allow greater understanding of the age- and PD-related mechanisms involved in turning deficits, which could inform development of targeted and effective therapeutics. Mobile electroencephalogram (EEG) is a neuroimaging technique that can measure neural activity during turning. This study aimed to compare neural activity during turning across PD, OA, and YA groups. Methods92 PD, 38 with FOG (PD+FOG) and 54 without FOG (PD-FOG)), 21 OA and 17 YA participants turned-in-place 360 degrees under single and dual-task conditions (forward digit span) for two minutes, while a 32-channel mobile EEG system (TMSi, Netherlands) recorded neural activity and synchronized inertial sensors measured turning performance. EEGLAB software was used to process EEG signals to derive neural activity, specifically source localized independent component (IC) clusters and their power spectral densities (PSD). PSD bands included: Delta (d:1-3Hz), Theta (t:4-7Hz), Alpha (a:8-13Hz), Beta (b:14-29Hz) and Gamma (g:30-50Hz) band. We identified 485 ICs in total and formed 10 clusters with source locations in the pre-frontal, somatosensory, parietal, temporal and motor cortices.ResultsTurning velocity and duration were impaired in PD compared to control groups (OA, YA) (all $p<0.05$), and further impaired in PD+FOG and when performing a dual-task. EEG analysis showed that there were significant differences across groups for selective PSDs within specific brain regions during turning. Specifically, PD had significantly greater a-band, b-band and g-

band PSD across pre-frontal, parietal, somatosensory and motor regions compared to controls when turning under single or dual-task (all p<0.05). This may indicate increased cognitive, sensory and motor processing in PD compared to OA or YA controls. Additionally, PD+FOG had greater activation of b-band and g-band PSDs in the right temporal and parietal regions, and a-band in the right temporal region under both single and dual-task, compared to all other groups (all p<0.05). This may indicate increased cognitive (attentional) processing and sensorimotor processing in the parietal and temporal regions for PD+FOG.ConclusionOur initial findings demonstrate that turning influences neural activity in specific regions across PD, OA and YA, with different regional activity in those with PD compared to OA or YA across single and dual-task conditions. Furthermore, PD+FOG have differences in neural activity in selective brain regions compared to PD-FOG. Funding: PF-PDF-1898, PF-CRA-2073 (PI; Stuart)

O.9: Vestibular function and disorders

O.09.1 - A modeling approach to identifying causes and potential treatments for poor walking stability in people with vestibular hypofunction

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BACKGROUND AND AIM: People with vestibular hypofunction (PwVH) have poor walking stability and increased fall risk. The poor stability may arise directly from the vestibular loss or rather may result from PwVH adopting altered walking mechanics characteristic of “cautious” walking (i.e. slow speed, wide steps, short steps). Identifying the cause of poor stability is critical for developing interventions, but doing so is difficult experimentally. We use a modeling approach to identify the cause of poor stability in PwVH and suggest potential training mechanisms to improve stability. METHODS: We added a vestibular system to a simple bipedal walking model, which we previously developed based on linear inverted pendulum dynamics with an extended mass. We employed an optimization approach to develop five model variants: a variant representative of a healthy adult, a variant with reduced vestibular sensitivity representative of mild bilateral loss, and variants with a healthy vestibular system that walked with a slow speed, wide steps, or short steps. We compared walking behavior in the model variants with vestibular loss or altered walking mechanics to the healthy model variant, looking for differences consistent with what is seen when comparing PwVH to healthy adults. We evaluated walking behavior using a measure of stability (minimum margin of stability or MoSmin) and outcomes related to the stabilizing control strategies used during walking (trunk sway, foot placement, center of pressure shift, push-off force). For model variants showing behavior consistent with PwVH, we performed additional

optimization of control parameters to restore normal walking behavior to gain insight for training mechanisms. RESULTS: The model with reduced vestibular sensitivity displayed increased peak-to-peak lateral trunk sway commonly seen in PwVH (healthy: 4.5±1.8° vs. vestibular loss: 11.0±4.3°; $p < 0.001$), but no differences in other stabilizing control strategies. Reduced vestibular sensitivity did not decrease walking stability; rather, poor walking stability (MoSmin) only occurred in the model variant with slow speed (healthy: 8.6±0.4 cm vs. slow speed: 7.5±0.4 cm; $p = 0.003$). Lateral trunk sway was restored in the model with vestibular loss when decreased reliance was placed on controllers using vestibular input and increased reliance was placed on controllers using proprioceptive input, reminiscent of sensory reweighting used in vestibular rehabilitation therapy. Stability was restored in the model with slow speed when step width increased. CONCLUSIONS: This study shows that abnormal walking characteristics and poor stability seen in PwVH can be attributed to vestibular loss and slow walking speed, respectively. The results suggest that sensory reweighting exercises may reduce increased trunk sway while gait interventions to increase speed and step width may be most effective in restoring stability in PwVH. ACKNOWLEDGEMENTS AND FUNDING: F31DC020110

O.09.2 - Acute imbalance syndrome (AIS) versus acute vestibular syndrome (AVS): Differentiation matters

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Background and aim: Stroke is a major differential diagnosis in patients with acute vertigo/dizziness/imbalance. Diagnostic tests like HINTS are optimized for presentations with spontaneous nystagmus (SPN), called acute vestibular syndrome (AVS). However, in recent studies a relevant proportion of patients with stroke-related vertigo/dizziness had no SPN, but postural imbalance. For this phenotype, the term acute imbalance syndrome (AIS) was coined. We outlined the pathoanatomical differences of AIS/AVS and its clinical implications.Methods: Seventy-five patients (66.7±12.6y) with acute vertigo/dizziness/imbalance due to MRI-proven stroke were included and classified as AIS/AVS documenting vestibular/ocular motor/postural signs. Stroke lesion distribution was depicted in MNI space and supplemented by structural disconnectome mapping. Multivariate lesion symptom mapping based on support-vector regression and disconnectome mapping were applied. Results: AIS was diagnosed in 58%, AVS in 39%, central positional vertigo in 3% of patients. In AIS, lesions were located in the anterior cerebellar lobe/deep cerebellar nuclei (SCA/PICA territory) connecting to the bilateral pontomesencephalic tegmentum. AVS stroke lesions were mostly located in the posterior cerebellar/flocculonodular lobe (PICA/AICA territory) and connected to the ipsilesional vestibular nucleus (VN)/bilateral medial longitudinal fascicle (MLF). SPN

intensity correlated with voxels in the cerebellar lobules VI-IX connecting to VN/MLF.Conclusion: AIS accounts for more than half of patients with stroke-related vertigo/dizziness/imbalance. AIS lesions were located in the anterior cerebellar lobe, disturbing cerebellar-pontomesencephalic networks for posture/gait control. AVS lesions affected the posterior cerebellar/flocculonodular lobe and associated vestibulo-ocular reflex networks. Recognition of both clinical phenotypes is essential to identify all strokes among patients with vertigo/dizziness in the ER.Acknowledgements and funding: The study was funded by the German Federal Ministry of Education and Research (BMBF).

O.09.3 - The geneva balance test as a useful tool to monitor pediatric patients with bilateral vestibulopathy after vestibular rehabilitation

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Background and Aim Vestibular deficits are considered rare in children, but the scarcity of systematic screening and the lack of representative outcome measures leads to underdiagnosis and suboptimal clinical management. For this purpose, our research group has developed the Geneva Balance Test (GBT), aiming to objectively quantify balance abilities of children with bilateral vestibulopathy (BV) over a broad age range. In a first study we demonstrated that the GBT allowed quantifying balance deficits in children with BV. In the present study, we aimed to evaluate the capacity of the GBT to quantify potential improvements in balance abilities after vestibular rehabilitation. Methods A group of 5 children with BV (according to the criteria established by the Bárány Society) from various etiologies underwent a first evaluation with the GBT (T0), with scores in the pathological range according to their age. A second evaluation with the same test was performed after a period between eight months and one year and a half (T1), during which patients followed vestibular physiotherapy. The scoring in bright light and dim light at T0 and T1 were compared with Student's t-test.The scores of the GBT is expected to decrease with age as children develop their balance capacity. To exclude the impact of the normal development of balance capacity with age, we performed an ANOVA between the scores of the GBT of children with BV of different age group (3-5, 6-9, >10) at T0. We included retrospective data of 6 patients aged 3-5 years old, 4 patients aged 6-9 and 4 patients aged >10 years old. Results We observed significant improvements in GBT scores in bright light after vestibular rehabilitation at T1 (p=0,002) as well as in dim light (p=0,02). No significant results were found between different age categories of children with BV at T0 (In bright light: p = 0,1) (In dim light p= 0,1) ConclusionPatients who benefitted from vestibular physiotherapy showed significant amelioration after a period of 8 months to 1,5 years. This amelioration cannot be explained only by the normal development with age, as comparison of GBT scores of patients with BV of different groups of age shows a non-significant amelioration. Despite the very small sample size in the present study, the GBT allowed quantifying

improvements in balance abilities in children with BV after vestibular rehabilitation. Acknowledgements and FundingNo funding were necessary for this research. The GBT is used as a usual test in the ORL Departement at the University Hospital of Geneva.

O.09.4 - Visual-vestibular integration during walking after concussion

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Background and aim: Individuals with concussion have been shown to over rely on visual and vestibular information when performing standing balance tasks (Slobounov et al. 2006, Caccese et al. 2021). The integration of visual and vestibular information is crucial for heading trajectory and safely navigating throughout the environment. The present study aims to examine how concussion impacts visual-vestibular integration during gait. This will be investigated using virtual reality and galvanic vestibular stimulation to induce controlled perturbations while walking.Methods: 25 total participants took part in the present study, of which 10 were concussed (CO; 28.4 +/- 7.3 years of age) and 15 were healthy controls (HA; 29.5 +/-4.5 years of age). Participants completed three blocks of walking trials while wearing a VR headset and electrodes that elicited Galvanic Vestibular Stimulation (GVS). The first block (VIS) consisted of participants being presented a 'lab room' in the VR headset and a visual surround shift occurring as a function of the forward displacement of the participant. Visual perturbations were applied at -20° resulting in leftward deviation (L-VIS), +20° resulting in rightward deviation (R-VIS), or with no visual perturbation (N-VIS). 12 total trials were completed in this block (4 of each).The second block (VES) consisted of the participants being presented with a dark room in the VR headset to mimic an eye's closed situation, with vestibular stimulation (right, left, or no stimulation). Thresholds were determined at the start of testing and GVS was elicited at 2x threshold. 12 total trials were completed in this block (4 of each).Finally, the last block (INT) consisted of an integration perturbation where participants walked in the 'lab room' with vestibular stimulation. GVS was applied with no visual stimulation (R-GVS+N-VIS or L-GVS+N-VIS) or conflicting visual stimulation (R-GVS+L-VIS or L-GVS+R-VIS). This block included 16 randomized trials with four of each condition. Primary outcome measures included absolute endpoint deviations.Results: An effect of group ($p<0.001$) was observed where CO (0.23 +/- 0.02m) had increased deviations compared to HA (0.12 +/- 0.02m) while walking in the dark environment. CO (0.24 +/- 0.02m) had increased deviations ($p<0.001$) in response to GVS perturbations compared to HA (0.15 +/- 0.02m). HA (0.44 +/-0.02) had increased deviations ($p<0.05$) in response to visual perturbations compared to CO (0.34 +/- 0.03m). CO (0.20 +/- 0.02m) had increased deviations during the GVS+N-VIS trials ($p<0.05$) compared to HA (0.10 +/- 0.02m). CO (0.34 +/- 0.02m) had increased deviations during the GVS+VIS trials ($p<0.05$) compared to HA(0.26+/-0.02m).Conclusion: Increased deviations were observed in response to vestibular stimulation after concussion, however, no increased responses were seen in response to the visual stimulation. Individuals with concussion may demonstrate a conservative

response when completing a gait task thus resulting in the deceased response to visual stimuli.

O.09.5 - Unperturbed and perturbed gait variability in bilateral vestibulopathy vs. age-matched heathy controls

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Background and aim: Gait and balance deficits in bilateral vestibulopathy (BVP) are common and include increased gait variability, instability and falls. Until now, there are no large studies of people with BVP and age and gender matched healthy control participants, which is needed to better disentangle the effects of age and vestibulopathy on gait variability. In this study, we tested the hypotheses that people with BVP would demonstrate increased gait variability compared to matched control participants (a significant group effect) and that these differences would increase with the introduction of mediolateral perturbations (a significant group*perturbation condition interaction). If confirmed, this could indicate a benefit of adding such perturbations for future assessment purposes.Methods: Fifty-two people with BVP and 52 healthy age- and sex-matched adults walked at 0.6 m/s, 0.8 m/s, and 1.0 m/s without and with two levels of mediolateral platform pseudorandom sway perturbation (Computer Assisted Rehabilitation Environment; Motek). The maximum platform displacements caused by the perturbations were approximately 2cm and 3cm and were not intended to cause large balance disturbances but rather introduce a proprioceptive challenge. Using 3D motion capture of the foot markers (Vicon), the means and coefficients of variation (CoV) for step time, step length, double support time and step width were calculated. The data were analysed using marginal linear regression with an unstructured covariance matrix.Results: Significant group*speed effects were found for the CoV of all parameters ($p<0.01$). Significant perturbation condition effects were found for the CoV of step time, double support time and step width ($p<0.05$) and a significant speed*perturbation condition effect was found for step length CoV ($p=0.042$). Generally, the perturbations led to increased CoV for step time, double support time and step width and increasing speed led to decreases in CoV for all parameters. Conclusions: Our findings confirm that gait variability is increased in people with BVP, independent of age. The introduction of mediolateral sway perturbations increased gait variability, but the sway perturbations did not increase this to a greater extent in the people with BVP, so our hypothesis of a group*perturbation condition interaction was not supported. Larger perturbations that more overtly cause balance disturbance may lead to the hypothesized interaction but this will not then be feasible for all people with BVP to complete, reducing feasibility of such an assessment approach.

O.09.6 - Lifetime noise exposure is associated with greater postural sway during quiet stance

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Background & Aim: Noise exposure (NE), while long implicated in loss of hearing, has only recently gained recognition as a cause of vestibular loss and imbalance. Depending on the type of NE, damage may be acute or cumulative, uni- or bilateral. In the case of incomplete, bilateral damage, sensory reweighting adaptations may effectively conceal noise-induced vestibular damage. In this study we examined the effect of lifetime NE on postural sway under different sensory conditions (vestibular, visual, and proprioceptive). Methods: We assessed lifetime noise exposure in 19 participants (8F, age = 45.9±16.8 years) using the Noise Exposure Structured Interview (NESI), which is designed to quantify lifetime NE due to recreational, occupational, and firearm noise. Pure tone audiometry was used to assess auditory function, and we determined the presence of a "noise notch" (a marker of noise exposure) by combining the NESI score and hearing thresholds around in the 3-6 KHz sound frequency range. Postural stability was assessed standing on a force plate, under four conditions: eyes open, firm surface (EOFL); eyes closed, firm surface (ECFL); eyes open, foam (EOFO); and eyes closed, foam (ECFO). Statistical analysis: Mann-Whitney tests with Holm-Šídák adjustment for multiple comparisons. Normality was tested with the Kolmogorov-Smirnov test.Results: We found that the presence of the audiometric notch was associated with greater sway area in the EOFL (adjusted $p = 0.01$), ECFL (adjusted $p = 0.01$), and EOFO (adjusted $p = 0.01$) conditions. While there is a trend towards higher sway areas for noise exposed individuals in the ECFO condition, the difference was not significant (adjusted $p = 0.3$), reflecting an overall instability increase for all individuals in this condition. Noise exposure was also associated with lower movement complexity (entropy AP) in the ECFL condition and lower entropy (ML) in the EOFL and ECFO conditions, though these relationships did not survive the multiple comparison adjustment. Conclusions: These data suggest that noise exposure leads to significant vestibular changes that are only partially compensated for by visual and proprioceptive feedback. Acknowledgements & Funding: This work was supported by NIH grant R01-AG073157 & the Smith-Kettlewell Eye Research Institute. We thank Al Lotze for administering the hearing tests.

O.09.7 - The acute influence of cannabis ingestion on whole-body vestibular-evoked balance responses

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Background and Aim: Cannabis, a substance used globally by ~220 million people each year, contains two primary cannabinoids, Δ9-tetrahydrocannabinol (THC) and

cannabidiol (CBD). THC, the main psychoactive component of cannabis, is believed to cause the hallmark signs of acute cannabis intoxication, such as altered cognition and perception. CBD is purported to be not psychoactive, but, instead, may attenuate THC-related impairment. These cannabinoids interact with the endocannabinoid system and, ultimately, reduce neurotransmission. Though evidence indicates cannabinoid receptors are present within the vestibular system, it is currently unknown if acute cannabis use alters vestibular-evoked balance responses. Thus, the aim of this study was to characterize the acute effects of ingesting cannabis products with varying levels of THC and CBD on whole-body vestibular-evoked balance responses. It was hypothesized that THC would reduce vestibular-evoked balance responses compared to a placebo, and that co-administration of CBD would attenuate the THC-induced reduction. Additionally, CBD alone was hypothesized to not alter vestibular function compared to placebo. Methods: Seven healthy, infrequent cannabis users (32±9y; 2 females) participated in four double-blinded experimental sessions: THC (10mg THC:0mg CBD); CBD (0mg THC:10mg CBD); Hybrid (10mg THC:10mg CBD); and Placebo (0mg THC:0mg CBD). Throughout each session, participants completed the Drug Effect Questionnaire to quantify subjective ratings of intoxication. Participants completed two testing blocks, each consisting of two 90-s trials of stochastic electrical vestibular stimulation (EVS; 0-25Hz, root-mean-square=1.1mA). The two blocks took place before (PRE) and 2h after (POST) ingestion of the intervention. Ground reaction forces were collected and used to determine whole-body vestibular-evoked balance responses. These responses were analyzed via cumulant density functions and quantified using peak-to-peak amplitude and time to the medium-latency peak. Results: Out of 100, participants rated their perceived drug effects as 46±23 (THC), 53±25 (Hybrid), 15±13 (CBD), and 1±3 (Placebo) immediately prior to receiving EVS. The whole-body vestibular-evoked balance response peak-to-peak amplitude was reduced at POST compared to PRE for the THC condition ($p=0.048$). No differences between evoked-response amplitudes were observed during the other experimental sessions ($p \geq 0.134$). Further, there were no effects of block or intervention on vestibular-evoked balance response latency. Conclusions: Despite similar significant ratings of perceived intoxication for the THC and Hybrid intervention days, ingestion of 10mg of THC decreased the amplitude of whole-body vestibular-evoked balance responses compared to placebo, but co-administration of CBD with THC attenuated this reduction. Funding: Natural Sciences and Engineering Research Council of Canada and The Stober Foundation Health Fund

O.09.8 - Despite an impaired postural control after repositioning maneuvers, fear of falling normalized in older adults with Benign Paroxysmal Positioning Vertigo

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Background and aim: Benign Paroxysmal Positioning Vertigo (BPPV), a common vestibular disorder in older adults, causes movement-related vertigo(Von Brevern et al.2006). Treatment with repositioning maneuvers can resolve symptoms, but its effect on fear of falling, falls and postural control has rarely been studied in older adults(Bhattacharyya et al.2017). This study aimed to investigate the effect of repositioning maneuvers on postural control, fear of falling and falls in older adults with BPPV (oaBPPV), and compare them to controls. Methods: Twenty-five community-dwelling older adults (≥ 65 years old) diagnosed with BPPV (mean age 73.2(4.9)) were recruited and compared to twenty-two matched controls (mean age 73.5(4.5)). OaBPPV were treated with repositioning maneuvers until nystagmus disappeared. The Clinical Test of Sensory Interaction on Balance (CTSIB) and the mini Balance Evaluation System Test (mini-BESTest) were used to assess postural control (Cohen et al.1993, Horak et al.2009). Falls Efficacy Scale – international (FES-I) inquired fear of falling(Yardley et al.2005b). Assessments were repeated pre-, 1 month, 3 months and 6 months post-treatment. Fall history of the 12 months pre-treatment was inquired and fall incidence post-treatment was inquired via 2-weekly phone interview during follow-up. Controls completed the same protocol, without the treatment for BPPV. Significance level was set at $\alpha=0.05$ and p-values were adjusted for multiple testing. Results: Pre-treatment, oaBPPV experienced significantly more fear of falling according to the FES-I($p<0.001$), and a significantly increased odds of falling(odds ratio (OR) 4.2, 95%confidence interval (CI)[0.98,18.12], $p=0.05$) and fall incidence($p=0.04$) compared to controls. After treatment, the FES-I score was significantly decreased and equal to controls. During the 6 months follow-up, the odds of falling(OR 1.07, 95%CI[0.28,4.16], $p=0.9$) and fall incidence ($p=0.6$) was no longer significantly increased in oaBPPV. Pre-treatment, there was a trend towards a decreased total score of the miniBEST-test($p=0.004$) and sub-score of dynamic gait($p=0.02$). There was no significant effect of repositioning maneuvers on these scores, and both remained lower compared to controls. OaBPPV had a significantly decreased sub-score of sensory orientation($p=0.003$) compared to controls. There was a significant improvement of the sub-score of sensory orientation after treatment. Only 1 month post-treatment the sub-score of sensory orientation was equal to those of controls, whilst 3 and 6 months after treatment it was significantly worse again. There was no significant difference between oaBPPV and controls, nor an effect of repositioning maneuvers at any time in any of the six conditions of CTSIB. Conclusion: Despite the lack of improvements in dynamic gait and sensory orientation after treatment in oaBPPV, fear of falling normalized. Additional rehabilitation after repositioning maneuvers might be needed to address persistent deficits in oaBPPV. Acknowledgement: We thank all participants and staff at hospital for their collaboration in this study. Funding: This study was supported by the Special Research Fund of the Hasselt University and Maastricht University (BOF20OWB12) and ZOL Genk.

O.10: Sensorimotor control: methods and findings

O.10.1 - The postural control system responds to three-dimensional pseudorandom perturbations

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Postural sway evoked by pseudo-random perturbations has a high potential to predict fall risk (Maki, 1994). To help better understand the multidimensional postural control system, a novel two-dimensional perturbation assessment (Wagner 2024) was recently developed. However, it is still unknown how the human postural control system responds to three-dimensional pseudorandom perturbations. This study aimed to find how the postural control system responds to each of three pseudorandom perturbations provided simultaneously in earth-vertical (EV) translations and vestibular coordinate (RALP and LARP) tilts. We hypothesized increasing the peak velocity of the platform motion stimulus would lead to smaller postural sway relative to the stimulus as a larger vestibular signal leads to a stronger postural response. (Peterka 2002). We generated sum of sinusoids (SoS) trajectories by summing signals at each of five frequencies (0.06-1.55 Hz) (Panel. A). This enabled us to deliver spectrally separated platform perturbations in the three directions simultaneously. Center of pressure (CoP) data were collected from 24 healthy adults (40.7±13.6 years, 12 females) on a motion platform (Virtualis, Motion VR) that has two embedded force plates. Each trial lasted three minutes, and each participant completed four different trials with arms crossed and eyes closed. The peak-to-peak amplitudes were: (i) 3 cm for EV translation and 1 degree for tilts, (ii) 6 cm for EV translation and 1 degree for tilts, (iii) 3 cm for EV translation and 2 degrees for tilts, and (iv) 6 cm for EV translation and 2 degrees for tilts. The trial order was randomized to mitigate order effects. CoP spectral data showed postural responses at the stimulated frequencies that were clearly distinguishable and independent from one another (Panel. B). Three-way repeated measures MANOVA found a significant effect: (i) of tilt on gain ($p<0.001$) and phase ($p<0.001$) at tilt perturbation frequencies and (ii) of EV translation on gain ($p<0.001$) at EV perturbation frequencies. Further pairwise comparisons confirmed the hypothesis that 2-degree tilts evoked significantly smaller postural responses than 1-degree tilts ($p<0.001$) when normalized by the stimulus amplitude, and 6 cm translation evoked significantly smaller normalized postural responses than 3 cm translation ($p=0.002$). We also found that EV perturbations evoked Anterior-Posterior (AP) sway more than Medial-Lateral (ML) sway (AP 95% CI: 0.471-0.608 mm/deg and ML 95% CI: 0.213-0.260 mm/deg). These findings highlight that we were able to quantify specific postural responses to each dimension of a three-dimensional platform perturbation. This preliminary study showed the feasibility of our approach, which we propose to expand

upon to study postural responses 12-dimensional perturbations (6D platform motion + 6D visual motion), that better match naturalistic perturbations that trigger fall events.

O.10.2 - Presbyopia onset affects Dynamic Visual Acuity via motor adaptation in naturalistic viewing conditions

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Background: Smartphones have become an essential tool in daily life with 7 billion users by the end of 2024 (SupplyGem survey – 39 mobile phone usage statistics). The increased use of smartphones during locomotion creates common situations where dynamic visual acuity (DVA), known to decline with age, plays a crucial role. Despite the widespread use of smartphones across age, sensorimotor contingencies underlying DVA decrease remain poorly understood. Presbyopia is an age-related progressive decline in lens accommodation. Virtually all previous studies characterized DVA changes in young (non-presbyope) and aged (presbyope) populations, with the largely unexplored transition point between the two. Moreover, standard DVA tests use optotypes fixed to the wall or to the head, suffering from poor ecological validity. The aim of the present study is to test the hypothesis that presbyopia plays a critical role in the DVA changes in an ecologically valid experimental paradigm. The second objective is to characterize visual and motor variables underlying the presbyopia-induced DVA changes. Methods: 63 participants divided into young (YNP; μ=21.5y) and adult non-presbyopes (ANP; μ=31.5y), pre-presbyopes (PP; μ=43y) and presbyopes (P; μ=58y) carried out Landolt C visual acuity task implemented on a smartphone application while sitting, standing, and walking. In addition to DVA performance, we recorded eye-to-smartphone distance, smartphone declination and its amount of movement in the head reference frame, reflecting motor adaptions to stimulus changes. To characterize visual variables potentially underlying DVA changes, we measured several convergence-accommodation factors including the shear ratio, accommodative rock, and gradient. Results: A significant decrease in DVA was observed between ANP and PP groups (σ = -0.08 logMAR). The difference between YNP and ANP as well as between PP and P were not significant, suggesting that presbyopia onset is indeed the critical period for DVA decrease. Moreover, while PP exhibit a decrease in DVA similar to that of P, they continue to hold their smartphones at distances comparable to ANP suggesting motor adaptation deficits in this group. Indeed, motor adaptation variables (smartphone distance and declination) accounted for within-participant DVA differences between static and walking conditions better than visual variables. Conclusions: While presbyopia is a purely visual deficit, its onset leads to a distinct sensorimotor adaptation profile underlying age-related DVA changes in ecological conditions. This result suggests that focusing on motor adaptation variables may be more efficient in counteracting DVA deficits on the onset of presbyopia and highlights the necessity for further investigation

of sensorimotor coordination in this phase. More generally, our study paves the way for the development of tailored visual that aligns with individuals' behaviors and needs.
Keywords: Dynamic Visual Acuity, Ageing, Smartphone, Behavior, Binocular, Stabilization
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O.10.3 - Re-learning to stand with novel sensorimotor delays in balance control

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Background: To accurately control movement, the brain must build associations between self-generated motor commands and delayed sensory feedback. These delays are particularly critical for maintaining upright posture, where precise timing of sensory and motor signals is essential for stability. As sensorimotor delays increase – whether due to aging or neurological disease – they disrupt this timing, heightening the risk of losing balance and falling. Here, we investigated how sensorimotor delays added into the control loop of human standing balance destabilize posture, and explored the mechanisms underlying any subsequent adaptation, learning and generalization.Methods: We performed several experiments in which adults stood upright in a robotic balance simulator that recreates the physical sensations and sensorimotor signals of standing balance by placing the participant in-the-loop of the robotic control. Using this robotic system, we imposed various delays between balancing motor commands (ankle torques) and resulting sensory feedback (whole-body motion), and evaluated how individuals initially respond, adapt their behaviour, and generalize any learning. Experiments were performed with healthy young adults (<30 years, n=132) and older adults (>65 years, n=20).Results: We found that lengthening the sensorimotor delay >300 ms destabilized upright equilibrium, aligning with predictions from feedback models of upright balance. However, contrary to these model predictions, participants in our experiments were able to reduce their postural oscillations through training and successfully regained their ability to balance with delays as long as 560 ms. These compensations were retained three months later, demonstrating long-term retention of learning. Furthermore, learning to balance with novel delays was generalized: participants transferred their balance improvements when standing with imposed delays across spatial directions, biomechanically independent muscle effectors and visual feedback conditions. Additionally, we showed that older adults can learn to balance with delays >300 ms, but learn at slower rates and exhibit greater postural oscillations than their young counterparts. Conclusions: Collectively, these experiments show that the human brain can adapt the control of balance to accommodate for unexpected sensorimotor delays across diverse contexts. While long delays are initially destabilizing,

humans learn to overcome them by re-associating delayed whole-body motion with self-generated balancing motor commands. Moreover, humans generalize these learned policies, suggesting that the brain estimates the source of unexpected balance motion (i.e., the new motor command-to-body movement relationship) and broadly updates its control of balance to account for imposed delays, even in substantially different contexts.

O.10.4 - Proprioceptive training improves postural control in people with low back pain: A proof-of-concept study

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BACKGROUND AND AIMLow back pain (LBP) is the leading cause of disability worldwide. Previous studies suggested that people with LBP showed impaired proprioceptive postural control, which could be related to both the onset and maintenance of LBP. However, the reversibility of disturbed proprioceptive postural control in people with LBP remains unclear. Therefore, this study investigated the effect of proprioceptive training on (1) proprioceptive postural control and (2) pain and disability in people with LBP.METHODSTwenty-five people with recurrent LBP (14 men, 11 women; Age= 47 ± 10 years; BMI= 24.1 ± 2.3) participated in an 8-week proprioceptive training. Exercises aimed to promote variability in sensing, discriminating and localizing lumbar postures, movements and muscle activation. Participants were instructed to implement these exercises in their daily lives.Postural control was evaluated during standing on stable and unstable ground, with vision occluded. Muscle vibration, a strong stimulus to muscle spindles, was applied to the ankle and back muscles. Center of pressure (COP) displacements indicated the magnitude of proprioceptive reliance on the vibrated muscle, and were measured on a force plate (Kistler). A ratio of COP displacement to ankle versus back muscle vibration was calculated. Additionally, self-reported percentages of change in pain and disability (scale from 0 to 100% improvement), and the Modified Low Back Pain Disability Questionnaire (MDQ) evaluated the clinical effect of training. Non-parametric statistics were used, since data was non-normally distributed.RESULTSAfter training, patients showed increased COP displacement in response to back muscle vibration on both stable ($p= 0.036$) and unstable ground ($p= 0.043$). Moreover, after training, the ratio of ankle versus back muscle vibration indicated a more dominant reliance on lumbar proprioceptive use, on unstable ground ($p= 0.034$). In addition, clinical outcomes significantly improved after training for the MDQ (pre training: 27 ± 10; post training 14 ± 10, $p< 0.001$), with high self-reported change in disability (51%) and pain (49%). CONCLUSIONSProprioceptive training increased lumbar proprioceptive reliance during standing on both stable and unstable ground. This could potentially be explained by increased lumbar muscle spindle sensitivity, resulting in

enhanced lumbar segmental control. Patients also showed a more dominant reliance on lumbar proprioceptive use on unstable ground, instead of a typical rigid ankle control strategy. This suggested improved adaptability of postural control to the environment. Since both pain and disability improved after training, proprioceptive training could be considered in the treatment for people with recurrent LBP. Future studies should explore long term effects of training and whether distinct patient characteristics may improve responsiveness to training. ACKNOWLEDGEMENTS AND FUNDING: FWO (grant 11B6522N, grant G072122N)

O.10.5 - Do children with CP have a greater dependency on visual information to maintain standing balance than typically developing children? A systematic review with meta-analysis

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In children with cerebral palsy (CP), deficits in controlling balance during basic body postures manifest early and hinder the acquisition of walking abilities (Woollacott & Shumway-Cook, 2005). Therefore, understanding the factors contributing to CP-related balance deficits could help inform physical therapies to lower disabilities. Next to motor impairments, which are recognized as a hallmark contributor to balance deficits, lower limb somatosensory impairments may play a role as they appear highly prevalent in CP (unpublished data from our group, Wingert et al., 2009). These somatosensory impairments may cause children with CP to rely more on visual information for balance control.

The present systematic review had two aims: first, to investigate whether children with CP demonstrate poorer balance when standing with eyes open (EO) - the baseline condition - compared to typically developing (TD) children; and second, to examine whether the effects of visual deprivation on balance through an eyes closed (EC) condition are more pronounced in children with CP compared to TD children.

Methods:

The current abstract focuses on a subset of standing balance data from a larger systematic review on the role of sensation in CP-related balance deficits. Seventeen observational studies were included that assessed center-of-pressure (COP) or center-of-mass sway in CP and TD children of the same age (<18 years) during various postures and under conditions that manipulated visual and/or somatosensory input.

Two reviewers independently extracted study and population characteristics, assessed risk of bias using a SIGN checklist for cross-sectional designs, and collected COP outcomes. The latter were categorized as positional (i.e., displacement-based) or dynamic (i.e., velocity-based) variables (Quijoux et al., 2021).

Standardized mean differences (Hedges' g) were calculated using random-effects meta-analyses, reflecting a between-group (CP vs. TD) difference in COP sway during EO standing (Aim 1) and between-condition (EO vs EC) sway differences (Aim 2). For Aim 2, a subgroup analysis was added: visual deprivation effects are estimated separately for CP and TD groups, including a probability statistic for their differences. Hedges' g = 0.15, 0.40, and 0.75 cutoffs were used to interpret small, medium, and large effect. Heterogeneity was determined with I^2.

Results:

The included studies had limited sample sizes (N=10-41) and were of low-to-acceptable quality. The participating children with CP had GMFCS levels I-III and a mean age of 10 (range 5-18) years.

For Aim 1, children with CP exhibit significantly greater positional COP sway in AP and ML directions (N=10 studies, Hedge's g=1.04(0.12), p<0.01, I^2=60%) and dynamic COP sway in AP and ML directions (N=6, Hedge's g=0.71(0.13), p<0.01, I^2=28%) than TD children.

For Aim 2, when introducing the EC condition, we found that all children increase their positional (N=6, Hedge's g=0.50(0.08), p<0.01, I^2=29%) and dynamic (N=4, Hedge's g=0.85(0.14), p<0.01, I^2=10%) sway, regardless of their group (positional: p=0.25, dynamic: p=0.81).

Conclusion:

While children with CP show worse standing balance when standing with EO, we found no evidence for a greater effect of visual deprivation on balance when compared to TD controls. However, the included studies examined COP variables that reflect general postural stability and do not inform on underlying compensatory strategies, nor did they select children based on severity of somatosensory impairment. This warrants further high-quality research in larger samples.

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O.10.6 - A protocol and software to assess coil-head stability during TMS gait studies

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Background and aim: Transcranial magnetic stimulation (TMS) is a non-invasive method to investigate connections between the cortex and muscles. Despite its potential, TMS is primarily used in static positions due to the precision required for cortical targeting. Current studies using TMS during walking primarily rely on visual assessment or assume coil stability. In these studies, the coil is often kept in place by a harnesses, helmet, or cap. To advance research on gait control, coil stability needs to be validated and standardised. This study aims to standardise coil stability assessment and demonstrate how stability can be maintained during normal and perturbed gait. We performed one experiment using a helmet mounted coil (in Cardiff) and will perform another experiment using a coil connected to the head using a water polo cap and Velcro (in Amsterdam). In both experiments, the helmet weight was offset by a spring. Methods: For the experiment in Cardiff, fifteen participants completed ~20 minutes of normal and perturbed treadmill gait while receiving random TMS pulses. The TMS coil was helmet-mounted and unweighted using spring coil balancers suspended from the ceiling to allow natural movement. Before the trials, a static recording of the coil centre's position and four helmet markers was made. During the trials, three markers were placed on the participant's head (nasal bridge, left tragus, right tragus). The positions of the markers on the helmet and head were recorded throughout the trials at 100 Hz using an optoelectronic motion capture system (Vicon Nexus). An open source software package was developed which used these recordings to calculate coil stability. The software includes a graphical user interface as well as the ability to use the code within a script, without the necessity for user interaction. In Amsterdam, experiments are being planned to use the same software with a different coil stability design and motion capture system (Qualisys). Results: The results of the Cardiff experiment showed an average displacement of the helmet on the head of 0.54 - 1.09 mm across movement directions during normal gait, and 0.71 -1.59 mm during perturbed gait. Peak-to-peak displacements were maximum 10.7 mm during normal gait, 15.9 mm during perturbed gait. However, most stimulations happened within a 3 mm displacement threshold (normal: 91.5% ± 7.7%, perturbed: 80.8% ± 18.9%). The results of the Amsterdam experiment will be ready for the ISPGR meeting. Conclusion: Our software enables standardised coil stability assessment across different experimental setups. This will allow comparison of results across laboratories. Using this software, we demonstrate that with a suitable setup, TMS coil stability can be sufficiently maintained during normal and even perturbed gait, paving the way for more precise coil positioning (and assessment thereof), hopefully furthering the research on corticospinal excitability during gait.

O.10.7 - On the origin of sensory reweighting in human standing balance

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BACKGROUND AND AIMS: Humans rely on multisensory integration (MSI) to estimate body orientation and maintain balance. A well-known property in this MSI process is the change in sensory contributions depending on context and availability. Typically, these changes are attributed to sensory reweighting: a change of the gain-scaling of individual sensory contributions. Here we propose a different mechanism underlying the change in sensory contributions: a nonlinear reconstruction of sensory reference frame motion in space. For example, we use vision for balance by default, but have a mechanism estimating the movement of the visual scene. If the estimate exceeds a certain velocity threshold, the signal is automatically subtracted from our internal estimate of body orientation. In this study we formulated a minimal balance control model implementing this mechanism for visual scene movements and tested its explanatory and predictive capacity for stimuli across different amplitudes and spectral characteristics. METHODS: Twenty-four healthy young subjects (23.3 ± 3.4 years) viewed a patterned screen following seven different tilt sequences in a virtual reality head-mounted display. Body sway was recorded from motion trackers on the hip and shoulders. We fit model parameters to three pseudorandom sequences and then predicted responses to two new pseudorandom sequences with amplitudes outside the fit range, as well as to sinusoidal sequences. We further compared model performance to earlier studies related to Bayesian MSI concepts.RESULTS: The Reference-Frame-Motion (RFM) model successfully described the nonlinear amplitude-dependent changes in sway responses to the three pseudorandom stimuli with changing amplitudes used for the fit. This without requiring explicit sensory reweighting and without any changes in model parameters. Further, the model predicted sway responses for two pseudorandom stimuli not used for the fits with high precision (VAF of 91% and 81%). For sinusoidal stimuli, the RFM model predicted a specific pattern of distortions of sway responses. When two sines with adjacent frequencies were combined, the waxing and waning stimulus pattern evoked sway at multiple frequencies other than those contained in the stimulus. This predicted pattern provided a specific nonintuitive fingerprint of the RFM mechanism. Experimental data confirmed the pattern in human sway responses with a VAF of 81% and 86% for the single sine. Furthermore, the RFM model reproduced a power-law relationship between stimulus and response previously linked to Bayesian sensory integration principles.CONCLUSIONS: In summary, we propose a MSI mechanism for human balance control which is based on a nonlinear estimation of reference frame motions. We provide considerable evidence indicating that the central nervous system uses RFM estimation rather than explicit reweighting to change sensory contributions in MSI for human standing balance.

O.10.8 - The influence of hindlimb afferent inputs on lumbar spinal interneurons in the cat

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Background and aim: The majority of input to alpha-motoneurons is provided by spinal interneurons. These typically receive convergent input from multiple sensory channels and descending centers, and therefore represent a common path integrating information from a wide range of sources essential for coordinating motor output during the control of balance and locomotion. It is not well understood how input from specific afferent pathways influence the discharge behaviour of spinal interneurons across multiple segments of the spinal cord. The purpose of this study was to determine how input from soleus muscle afferents, which are generally provide focal reflex drive to the homonymous muscle, influence the activity of spinal interneurons spanning multiple lumbar spinal segments. Methods: In three male cats, two 64-channel microelectrode arrays were placed into lamina VII of the spinal cord (right hemisection) at multiple segments spanning L3-L7. From these extracellular recordings, the spike trains of multiple, concurrently active interneurons were decomposed. The right soleus was exposed and separated from the gastrocnemii, and its tendon was coupled to a linear motor. A series of bipolar fine wire electrodes were inserted into the soleus and a 64-channel high-density surface electrode array was secured over the muscle in order to record soleus motor units. Sinusoidal (50 and 100 Hz) and aperiodic (10-100 Hz) vibratory stimuli at different amplitudes (80-1600 μm) were applied to the soleus tendon. Linear systems analyses (coherence and cumulant density) were used to examine how soleus motor units and interneurons from different spinal cord segments responded to tendon vibration.Results: Consistent with previous work, clear responses to tendon vibration were seen in soleus EMG after ~10-15 ms. A modest proportion of interneurons demonstrated a significant response to tendon vibration at variable latencies (5-50 ms). In general, the proportion of interneurons that significantly modulated their firing rates in response to tendon vibration were greater at more caudal recording sites (L6-7), where afferent input from the soleus enters the spinal cord. Remarkably, a considerable proportion of interneurons as high as the L3 spinal cord segment also demonstrated significant responses to tendon vibration. Conclusions: These data demonstrate that input from hindlimb muscle afferents have wide-reaching influences throughout the spinal cord. Given the wide range of response latencies, muscle afferent input influences the activity of spinal interneurons through both mono- and polysynaptic pathways which potentially allow hindlimb proprioceptive signals to sculpt coordinated motor output across multiple muscles.

O.11: Digital real world mobility outcomes

O.11.1 - Walking in older adults: Comparing lab-based and real-world assessments using digital mobility outcomes

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Background and Aim: Walking is a critical indicator of mobility and health in older adults. However, the extent to which laboratory gait assessments reflect real-world walking behaviors remains unclear. This study compared walking digital mobility outcomes (DMOs) derived from laboratory tests with those captured during real-world monitoring.Methods: Data were collected from 200 participants from the InChianti dataset who completed standardized lab-based walking tests, including the 4m Walk Test (4mWT) and 400m Walk Test (400mWT). They wore an inertial sensor at the lower back for a week during real-world activities. The Mobilise-D computational pipeline was applied to extract DMOs, such as walking speed, stride length, stride duration, and cadence. In real-world, DMOs were grouped in shorter (10-30s) and longer (>30s) WBs. Differences between lab and real-world walking behaviors were analyzed using paired statistical tests, and correlations were assessed.Results: Real-world walking speed was slower than lab-based walking speed (mean difference: 0.5 m/s, $p < 0.001$). While in the laboratory, walking speed was 1.1 ± 0.2 m/s, in real-world, walking speed in shorter and longer WBs was 0.64 ± 0.07 m/s and 0.79 ± 0.11 m/s, respectively, stride length was 87.8 ± 8.6 cm and 103.3 ± 11.8 cm, and cadence was 84.8 ± 4.7 steps/min and 91.4 ± 6.5 steps/min, respectively. Furthermore, real-world walking speed and cadence exhibited age-related declines, with older adults (85-94 years) demonstrating significantly slower speeds (0.60 ± 0.08 m/s) and reduced stride length (83.4 ±9.7 cm) compared to younger older adults (65-74 years) (0.68 ± 0.04 m/s, 91.7 ±7.0 cm). Finally, moderate-to-strong correlations (r = 0.45–0.78) between lab and real-world DMOs suggest these measures capture complementary aspects of mobility, with real-world DMOs reflecting functional adaptation to diverse environments.Conclusions: This study demonstrates the differences between lab-based and real-world walking in older adults, emphasizing the importance of real-world DMOs for a comprehensive understanding of mobility. These findings can inform more effective assessments and interventions to address gait impairments in older adults.Acknowledgements and Funding: The study has been funded by the Mobilise-D project that has received funding from the Innovative Medicines Initiative 2 Joint Undertaking (JU) under grant agreement No. 820820. This JU receives support from the European Union's Horizon 2020 research and innovation program and the European Federation of Pharmaceutical Industries and Associations (EFPIA). The InCHIANTI study was supported by the Agency for Regional Health Care of Tuscany.

O.11.2 - A novel cardiovascular adaptation response based on 24-hr time-locked heart rate and daily activities in community-dwelling older adults

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AbstractBackground and Aim: Cardiovascular dysfunction is a common co-morbidity of impaired gait in older adults [1]. Few studies have collected simultaneous 24-hr heart rate (HR) and daily living activities. We employed a novel sensor system to obtain time-locked daily-living measurements of HR and physical activity in community-dwelling older adults.Methods: The study involved 105 older adults (mean age 83.5±6.8 years; 74 females) using the novel ANNE wearable sensor system (Fig. 1A), which provides time-locked recordings of ECG and physical activity (Fig. 1B, C). Gait quality measures—including step regularity, symmetry, and variability—were extracted from each subject's many bouts of walking to identify their best and worst walking performances (90th and 10th percentiles). A Heart Rate Response Score (HRRS) was developed using root Jensen-Shannon divergence to quantify cardiovascular adaptation. HRRS reflects differences in HR distributions across consecutive activity states, with higher scores indicating more distinct and adaptive responses to activity demands.Results: Substantial individual variability was observed in HR responses during walking (mean HRRS: 0.38±0.14; range: -0.11 to 0.74, see Fig. 1d). Higher HRRS values, indicative of better cardiovascular adaptation, correlated significantly with superior gait quality during best walking performances (90th percentile). Notable correlations included positive associations with step and stride regularity (vertical and anterior-posterior directions) and negative associations with step time variability. Similar but weaker associations were found for poor walking performances (10th percentile). Conventional, single time cuff-based blood pressure (BP) measurements, including sitting and standing BP pressures and their postural change differences, were not correlated with any of the daily living gait measures ($p>0.15$).Conclusions: Our findings suggest that impaired cardiovascular adaptation, as measured by the novel HRRS metric, is associated with poorer gait quality in older adults. The combination of time-locked HR and gait monitoring of daily living may lead to the earlier identification of older adults with impaired cardiovascular adaptation and mobility disability and lead to earlier targeted interventions that improve cardiovascular adaptation and independent ambulation in older adults. 1. [1] Bourke, R., Doody, P., Pérez, S., Moloney, D., Lipsitz, L.A., & Kenny, R.A. Cardiovascular disorders and falls among older adults: a systematic review and meta-analysis. J. Gerontol. A Biol. Sci. Med. Sci. 79, glad221 (2024).

O.11.3 - Integrating IMU and narrative reports for comprehensive understanding of real-world fall dynamics

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Introduction: Understanding how and why falls occur in the real-world is essential for developing effective fall prevention strategies for older adults. However, our knowledge remains limited due to a lack of objective data on fall dynamics and environmental context. This study integrates wearable IMU data with narrative reports from the FARSEEING real-world fall dataset to analyse common scenarios leading to falls and examine the fall trajectories and biomechanics. We aim to identify agreement and disagreement between IMU and narrative reports and provide a comprehensive understanding of circumstances surrounding real-world falls.Methods: Data from 117 real-world falls, captured using a mid-back IMU sensor, were analysed with a validated sensor fusion algorithm to identify common pre-fall activities and fall trajectories. Participants (mean age: 67.43 years, 58/59 female) had moderate to high fall risk. Narrative reports provided additional context, enabling the reconstruction of pre-fall scenarios and dynamics.Results and Discussion:The common pre-fall activities were stand-to-turn (27.18%), walking (18.45%), walk-turn (15.53%), and standing-up (13.59%). Moderate agreement (65%, Cohen's κ = 0.59) was found between reported and recorded pre-fall activities. Narrative reports identified walking as the most frequent pre-fall activity (35.9%), but IMU data revealed that 49% of these cases involved turning or reaching. Similarly, standing was reported in 16.5% of cases, but IMU data showed 41% included turning and 29% involved transitions such as standing up or sitting down. Overall, narrative reports often simplified pre-fall activities, such as reporting walking for navigation around furniture, or focused on intended actions, such as reporting standing as pre-fall activity instead of falling during a sit-to-stand transition. IMU data clarified these gaps by capturing implicit transitions, e.g. turning, in the reports and whether intended actions were completed before the fall.Most falls involved rotation during descent which highlights the biomechanical complexity of falls. Falls were predominantly initiated in backwards (BW) and sideways (SW) directions, with 74% of BW-initiated falls and 77% of SW-initiated falls resulting in BW impacts, suggesting a potential preference or perceived safety in landing backwards. Agreement between reported and recorded fall directions was observed in 44% of cases for both initial and impact directions. Initial-only and impact-only agreements were 24% and 16%, respectively, while 16% of cases showed no agreement. Despite these discrepancies, 84% of falls showed at least partial agreement.Conclusion:The integration of IMU data and narrative reports bridges the gap between objective motion analysis and subjective contextual insights. Identifying areas of agreement and disagreement between objective and subjective data, such as distinguishing between intended and actual activities and recognizing implicit transitions in reports, can provide a comprehensive understanding of fall circumstances and ultimately contribute to the development of more effective fall prevention strategies.

O.11.4 - Measuring head movements during free-living daily life

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Background and aim: Head movements are crucial for daily functioning, reflecting various aspects of neurological health including mobility, vestibular function, and oculomotor control. Laboratory-based studies have shown that head movements can be impaired in people with mTBI, with slower and smaller head turns after injury. However, traditional clinic and lab-based assessments may not reflect head-movements in real-world settings, highlighting the need for more ecologically valid measurement approaches. The aim of this study was to explore differences in head turn frequency and kinematics between individuals with persisting symptoms after mTBI and healthy controls (HC) during free-living daily life. Methods: Ten participants with persisting symptoms after mTBI (6F, mean (SD) = 29 (6.9); symptom score (SD) = 28.5 (17.9)) and 21 HC participants (14F, mean (SD) = 30.1 (7.6) years) provided informed written consent for this IRB-approved study. Participants wore three inertial measurement units (IMUs) on their head, neck, and lumbar regions continuously for seven days. The IMUs (Axivity Ax6) sampled acceleration and angular velocity data at 100 Hz. Head turns were identified as events where the peak yaw angular rate of the head IMU exceeded 15°/s. Kinematic measures included head turn amplitude (integrated angular rate over each turn), speed (maximum angular rate per turn), and frequency (the quantity of head turns performed). Generalized linear models were used to compare groups, accounting for the effects of age, sex, and the age*group interaction.Results: On average, individuals with mTBI demonstrated similar head turn amplitudes (mTBI mean (SD): 58.5° (1.58°); HC mean (SD): 63.5° (9.63°)) and head turn speeds (mTBI mean (SD): 99.6°/s (10.3°/s); HC mean (SD): 104.8°/s (9.12°/s)) compared to HCs. However, young individuals with mTBI (< 30 years old) exhibited slower median head turn speeds than similarly aged controls, as indicated by an age*group interaction (β=0.969, p = 0.011). No significant differences were observed in median head turn amplitudes between individuals with mTBI and HC (β=0.032, p=0.77), but individuals with mTBI performed fewer head turns, with a significant concussion status by age*group interaction (β=150.78, p=0.007).Conclusions: Head movements captured during daily living may reveal differences between mTBI and similarly aged controls. While head turn amplitudes and speeds were similar overall, younger individuals with mTBI showed lower head turn speeds, suggesting subtle motor impairments. These findings demonstrate the feasibility of continuously tracking head movement patterns in real-world environments and encourage larger studies to confirm their potential for understanding neurological function and monitoring post-mTBI recovery. Acknowledgement and Funding: NSF GRFP - 2139322, University of Utah Digital Health Initiative Seed Grant

O.11.5 - A sensor fusion method to reconstruct CoM vertical displacement during daily-activities based on barometric and inertial data

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BACKGROUND AND AIM: The description of the body center of mass (CoM) movement during daily life activities reflect neuro-muscular attributes such as lower-limb strength, postural control, and dynamic stability [1]. Some researchers have proposed to use a wearable inertial unit (IMU) attached to the lower back to track the trajectory of a point approximating the CoM during the execution of specific motor tasks of short duration. However, as accelerometer-based displacements are strongly affected by drift errors, this approach is unsuitable for long-term monitoring [2]. To reduce drift effects, miniaturized high-resolution barometers can be used to obtain a direct height measurement which is stable over time but sensitive to environmental noise. The objective of this study was to develop and test a "Transition-Based Complementary Filter" method that, by fusing inertial and barometric data, could provide an accurate estimation of the CoM vertical displacements during daily life activities. METHODS: 20 healthy subjects wore an IMU and a barometer on their lower back (sample frequency= 100Hz). The barometer was integrated into the IMU system at firmware, software and hardware levels. A twelve-camera marker-based stereophotogrammetry system was used as reference. Subjects performed several motor tasks replicating typical home-based activities (standing, sitting, laying, squatting, stair climbing, etc) for a total duration of the trial of about 7 minutes. To limit the drift in trajectory estimation associated with inertial signal integration, a two-step method was implemented. First, a "transition detection step" identified intervals of vertical CoM displacement. Then, a "complementary filter step" combined barometric and accelerometric data to reconstruct the vertical CoM displacement within the transition intervals. Performances were quantified by positive predicted value (PPV) for transitions detection, and root-mean-square error (RMSE) and Concordance Correlation Coefficient (CCC) for vertical CoM displacement reconstruction. RESULTS: Transitions were correctly detected with a median PPV of 97%. Across subjects and motor tasks, the CoM vertical displacement reconstruction exhibited a mean RMSE of 0.03 m and a CCC of 96%. CONCLUSIONS: The proposed method showed great accuracy in detecting transitions and reconstructing the vertical displacement of the CoM during simulated daily activities, improving the CoM trajectory reconstruction by about ten times compared to previous methods. Integrating a high-resolution barometer and IMU proved to be an effective solution for accurately measuring height changes, offering important perspectives for biomechanical analysis and energy consumption assessment during daily activities. ACKNOWLEDGEMENTS AND FUNDING: This publication is part of the project PNRR-NGEU which has received funding from the MUR- DM 630/2024.

O.11.6 - Feasibility of estimating digital mobility outcomes from smartphones in real-world conditions with mobgap, the open-source package for mobility assessment by mobilise-D

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Wearable sensors enable mobility assessment, providing insights into functional health. MobGap, an open-source Python library from the Mobilise-D consortium, is a robust tool for extracting digital mobility outcomes (DMOs) in real-world conditions. Implementing the Mobilise-D computational pipeline, MobGap applies state-of-the-art algorithms to compute DMOs from a single wearable sensor. Initially validated for lower back-worn research grade inertial measurement units (IMUs), MobGap offers a scalable, cost-effective solution. While smartphones with integrated IMUs provide an even more accessible alternative, their noisier data introduce algorithmic challenges. This study aimed to validate MobGap's ability to compute DMOs from smartphone sensors, addressing these challenges and expanding its applicability.Thirty healthy participants performed two structured walking tasks: (1) straight walking at three self-selected speeds and (2) circular walking at a comfortable pace. Fifteen participants also engaged in a 2.5-hour unsupervised real-world walking task. An Android smartphone (Samsung Galaxy A53 5G) was belt-mounted horizontally at the lower back, alongside a reference multi-sensor system (INDIP) comprising force sensitive resistor pressure insoles and high-grade magneto-IMUs. Both systems sampled data at 100 Hz. MobGap (v0.10.0) computed DMOs, including gait sequences, initial contacts, cadence, and stride length, which were compared against INDIP-derived reference values. To reduce error propagation, block-by-block validation was used, with prior outputs (e.g., cadence and stride length) fed reference initial contacts measured by INDIP.Structured tests resulted in around 3 hours of walking data, while real-world tests captured an additional 7 hours of walking data. For structured tests, MobGap achieved high sensitivity (99.8%) and specificity (79.8%) for gait sequence detection, with 86.6% accuracy. Initial contact detection showed 88.4% recall, 95.1% precision, and a 58 ms mean absolute error. Cadence estimation had a 1.87 steps/min absolute error (0.3% relative error), and stride length showed a 14.5 cm mean absolute error (-10.1% relative error). Real-world data analysis revealed slight performance declines in initial contacts detection (precision: 81.7%, recall: 81.9%), and cadence estimation (absolute error: 5.66 steps/min). Interestingly, gait sequences and stride length showed improved estimation with higher accuracy of 96.8% and lower mean absolute error of 10.4 cm, respectively.These results align with prior validation using dedicated IMU, confirming MobGap's robustness with smartphone-derived data even in real-world conditions. This study highlights MobGap's potential as a scalable, affordable mobility assessment tool. Despite limitations such as modest sample size (n = 30) and reliance on a single smartphone model, these findings support the feasibility of app-based mobility monitoring for clinical and real-world applications.

O.12: Rehabilitation: mechanism, assessments and interventions

O.12.1 - From hip to ankle: Evidence for generalized proprioceptive deficits in children with Cerebral Palsy through 3D motion analysis

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BACKGROUND AND AIM: Motor deficits are accompanied by proprioceptive impairments in 42% to 82% of children with cerebral palsy (CPc)[1,2]. Despite their prevalence and impact on daily activities[3], these proprioceptive impairments often remain overlooked, particularly in the lower limbs. Current assessment methods are limited in scope, as they rely on clinical (dichotomous) evaluations[4] or active movement protocols targeting one joint[2,5]. These joint-specific assessments are not generalizable to other joints[6] and fail to capture the severity of proprioceptive deficits, while also overlooking age-related changes and the confounding effects of motor deficits. This gap in comprehensive evaluation limits our understanding of lower limb proprioception in CPc, highlighting the need for a new, passive, kinematic-based approach across multiple joints, with comparison to typically developing children (TDc) while controlling for age. METHODS: Spastic CPc and TDc aged 5 to 12 years were included. Hip, knee and ankle Joint Position Sense(JPS) was assessed as a child's ability to re-identify a passively placed target position of the ipsilateral hip, knee and ankle joint. Three trials were assessed per joint, and the Joint Reproduction Error (JRE,°) between reproduction and target position was calculated from 3D kinematics [Vicon, ISB lower-limb model[8]] for the dominant/less-affected(JREd) and nondominant/most-affected(JREnd) side. Group differences in the best JRE (across three trials)[9] were analysed for each joint using a general linear model(GLM) with response variables: JREd and JREnd(°) and predictors: group (fixed factor) and age (co-variate).RESULTS: 28 TDc (8.4±1.5years; boys/girls=15/13) and 28 CPc (8.8±1.6years; boys/girls=15/13; GMFCS-I/II=18/10; uni/bilateral=16/12) were included. CPc showed poorer ankle and hip JPS bilaterally, with significant main effects of group (Figure1;JREdankle:$F=6.7$,$\eta p2=0.08$; JREndankle:$F=13.6$,$\eta p2=0.21$; JREdhip:$F=5.0$,$\eta p2=0.09$; JREndhip:$F=16.5$,$\eta p2=0.25$, $p<0.05$), reflecting a 30-100% increment in JRE compared to TDc. Unlike in TDc, JREd values in CPc did not improve with increasing age, as shown by significant group*age interaction effects (ankle:$F=7.1$,$\eta p2=0.12$; hip:$F=6.8$,$\eta p2=0.12$, $p=0.01$). For knee JPS, significant group differences were observed only for JREnd (main group effect: $F=8.6$,$\eta p2=0.15$,$p=0.005$), while both groups showed similar age-related improvements in JRE (main age effect:

F=5.1,ηp2=0.09, p=0.03).CONCLUSIONS: CPc show generalized proprioceptive impairments affecting multiple lower limb joints bilaterally, including the motorically non- or less-affected side. These findings highlight the need for joint-specific assessments across multiple joints in CPc, using a passive, kinematic-based approach. Ongoing research, will further clarify whether the observed limb- and age-related differences are related to variations in CP topography and functional abilities, rather than a potential developmental deviation.References: [1] Goble D., et al. (2009);[2] Wingert J., et al. (2011);[3] Ipek Erdem F., et al. (2007);[4] Mclaughlin et al. (2005);[5] Damiano, et al. (2020);[6] Horvath A., et al. (2023);[7] Wu, et al. (2002);[8] Jacobs N., et al. (2024) [preprint: https://doi.org/10.1101/2024.06.19.24308933]

O.12.2 - Frontoparietal brain activity during an anticipatory postural control task in children with developmental coordination disorder, Cerebral Palsy and those with typical development: An fNIRS study

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Background and aim: Difficulties with anticipatory postural adjustments (APA) are prevalent (87%) but heterogeneous in children with Developmental Coordination Disorder (DCD). Modeling the underlying neural mechanisms may explain this heterogeneity [1]. Children with DCD show intermediate postural control performance, including APA, between those with mild Cerebral Palsy (CP) and typical development (TD), but can overlap with either group, indicating a continuum [2]. Frontoparietal brain regions are involved in APA in adults [3], but their role in DCD, CP, and TD remains unclear. Functional Near-Infrared Spectroscopy (fNIRS) offers insights into real-time brain control during movement [4]. This study aimed to examine frontoparietal activity in DCD, CP, and TD groups during an APA task and its relationship to performance. Methods: 73 children (DCD:31, CP:13, TD:29; 6-10y) performed an alternate stair touching task, i.e. tapping 8 times as fast as possible with their feet on a stool while standing (APA task; 5 repetitions). Longer task duration indicated poorer performance. Concurrently, fNIRS (NIRSport 2, NIRx, GE) recorded activity in two regions of interest: supplementary motor area/premotor cortex (SMA/PMC) and inferior/superior parietal lobule (IPL/SPL). Raw data from all trials were filtered for motion and physiological artifacts, and time normalized. Oxyhemoglobin changes (ΔHbO) during the task were then calculated. ANCOVA (covariate: age) with the Tukey HSD post-hoc test examined between-group differences in durations and mean ΔHbO during task ($p<.05$). Pearson correlations assessed the relationship between ΔHbO and task duration. Results: At behavioral level, TD children outperformed those with DCD and CP ($p<.001$) with no significant difference between DCD and CP ($p=.266$). Mean ΔHbO did not differ significantly between groups

(SMA/PMC: p=.481; IPL/SPL: p=.147). However, visually, IPL/SPL activity was lower in DCD and CP compared to TD, while SMA/PMC activity overlapped across groups (Figure 1). DCD showed greater variability in both ROIs (larger SD). Correlations between mean ΔHbO and task duration varied per group: in CP, SMA/PMC activity correlated positively with task duration (r=.59), while in TD it correlated negatively (r=-.33); no relationship was found in DCD (r=.08). No relationship was found in IPL/SPL for CP (r=.10) and DCD (r=-.04). A negative correlation was present in TD (r=-.24).Conclusions: Both children with DCD and CP showed reduced parietal activity compared to TD children visually (Figure 1), suggesting similar sensory processing deficits in both DCD and CP. Despite no differences in SMA/PMC activity, distinct strategies were observed based on their relationship with APA task duration: CP children had greater activation linked to poorer performance, while TD children showed the opposite trend. In DCD, no such relationship was found, indicating diverse strategies to achieve similar performance, reflecting DCD's heterogeneity. This variability highlights the need for further investigation into movement strategies and their neural underpinnings to identify potential subgroups.Ref (DOI): [1] Blank et al 2019 (10.1111/dmcn.14132) [2] Johnson et al 2024 (10.23736/S1973-9087.24.08472-7)[3] Dijkstra et al 2020 (10.1016/j.neubiorev.2020.04.028)[4] Menant et al 2020 (10.1016/j.gaitpost.2020.09.012)Acknowledgements/funding: This research was funded by the Research Foundation – Flanders (FWO), grant: 43498, 2020.

O.12.3 - Movements that matter to people with Multiple Sclerosis: A photovoice exploration into the walking experience

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Background and AimsWalking is important for the quality of life of people with multiple sclerosis (MS). Real-world walking outcomes provide objective measures of how people with MS walk in their daily lives. It is crucial that the lived experience of people with MS is incorporated into the development of real-world walking outcomes to ensure clinical management and interventions lead to meaningful change in real-world walking. The primary aim of this study was to describe the walking experience in the home and community of people with MS to help develop an initial program theory as to how the walking experience aligns with validated real-world walking outcomes. MethodsWe employed the Photovoice methodology to better understand the walking experience of people with MS in their home and community. Photovoice is a novel methodology used to explore experiences from an emic perspective using photo-elicitation and participatory analysis methods. Participants were asked to take photos of situations where their walking was impacted by MS within their homes and communities over two weeks, and then participate in a one-to-one interview, where participants explained why they took the photo, described what symptoms of MS they associated with the situation presented in the photo and discussed what this meant for their everyday lives. Then, a subgroup of interviewees were invited to contribute to a participatory analysis during a focus group in which we co-designed key themes that participants felt represented their collective walking experience.ResultsTwenty-two people with MS who were at least partially ambulant (mean age: 58.8 ± 13.9, sex: female (n=18, 81.8%), PDDS range: 0 (normal) – 6 (walking assistance is required)) participated, seven of whom attended the focus group. During one-on-one interviews, walking-related activities that were frequently reported as important included the (1) use of stairs, (2) use of poor-quality pavements and other uneven surfaces, and (3) navigating unplanned obstacles. MS symptoms such as fatigue, foot drag, heavy legs, and challenges with dual tasking were often identified as a hinderance to participation in walking-related activities. Four main themes were developed during participatory focus group analysis: (1) the person; (2) facilitators; and (3) hazards in the physical environment. ConclusionThemes of 'hazards in the physical environment' and 'facilitators', developed by people with MS, align with the theory that physical domains should be considered when conceptualising accessibility and the walking experience. 'The person' highlights the importance of acknowledging the individual within their own unique social, psychological and physical context. Interestingly, when prompted to identify walking related MS symptoms that hold importance, the experiences of people with MS do not necessarily overlap with the real-world walking outcomes used in cohort studies and clinical trials. These findings inform initial program theory to help ensure future development and selection of real-world walking outcomes for people with MS are informed by their walking experience. This will allow walking outcomes to be reflective and impactful to people living with the MS. Acknowledgements:PhD supervisors Associate Prof. Yvonne Learmonth and Dr. Brook Galna. Funding: MS Australia.

O.12.4 - Understanding trip mechanisms in children with Cerebral Palsy on uneven pavements: Insights for fall prevention

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Background and AimChildren with cerebral palsy (CwCP) show reduced stability compared to typically developing (TD) children, walking over uneven ground (Malone et al. 2015), which may contribute to the large number of falls they experience (Boyer et al. 2018). Our recent work capturing lived experiences of CwCP revealed that tripping over uneven pavements is one of the most common causes of falls in real-world environments, especially with distractions present (Walker et al. 2023), but we knew little about mechanisms responsible for the fall occurrences. This study investigated CwCP navigating replica real-world uneven pavements.MethodsA bespoke walkway was created to replicate real-world environments CwCP told us were challenging (Walker et al. 2023), including uneven artificial pavement. Ten ambulatory CwCP (3 hemiplegia, 7 diplegia, 10.9±1.3 years) and 9 TD children (10.9±2.4 years) completed 6 walks over

uneven pavement. Three trials included an audiovisual distraction on a TV screen (e.g. dog barking). Reflective markers placed on the full body were captured with a 10-camera Qualisys Arqus system. Participants wore eye tracking glasses to capture gaze position while walking. Trip occurrence, margin of stability (MOS) and gaze fixations were analysed.ResultsTwo CwCP (diplegia) experienced a total of 6 trips. Two trip mechanisms were identified; (1) contact of the trail foot (3 right, 1 left) with a leading pavement edge during initial swing, (2) contact of the lead (right) foot with a leading pavement edge during mid-swing (figure 1). All trips occurred within the first 4 pavement trials and one child repeatedly tripped on the first pavement edge. Trip occurrences decreased anterior MOS, indicating instability. Gaze data were unavailable for both CwCP as they wore glasses, which offset pupil tracking. Two out of 6 trips occurred with a distraction. CwCP who experienced trips identified 'not looking' as a cause for previous falls. TD children did not experience any trips.ConclusionsThis is the first study to investigate mechanisms of trips over uneven pavement that replicate real-world fall risk for CwCP. Two CwCP showed repeated individualised mechanisms of trips. One explanation may be varied movement restrictions associated with CP (e.g. reduced range of motion preventing adequate foot clearance), as most trips occurred on the same limb for each child. Another reason may be a lack of adequate preplanning due to not looking at challenging features of an unfamiliar environment. This aligns with previously reported fall experiences of CwCP (Walker et al. 2023) and is shown here as CwCP tripped in early trials. Findings support taking a holistic approach to investigating mechanisms of falls by considering individualised physical, behavioural and environmental factors contributing to falls on a broader scale. This information is vital for informing applicable fall prevention and identifying individual CwCP most at risk of falls in everyday life.

O.12.5 - Machine learning models for predicting treatment outcomes in chronic non-specific back pain undergoing lumbar extension traction

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BACKGROUND AND AIMAn emerging manual treatment for chronic non-specific lumbar pain (CNSLP) is lumbar extension traction (LET) to re-align the biomechanical lordosis. This study explores the use of machine learning (ML) models to predict post-treatment outcomes in patients with CNSLP undergoing LET therapy. The objective was to identify key factors that influence clinical outcomes, such as lumbar lordotic angle, pain scores, and the Oswestry Disability Index (ODI), with the aim of improving personalized treatment approaches and optimizing patient-specific interventions. METHODSWe utilized a retrospectively collected database from consecutive patients between 2010 to 2023. Three outcome variables were predicted including post-outcome lumbar lordosis, post-treatment pain score and post-treatment ODI. Input model variables included pre-treatment lumbar lordosis, sacral base angle, fit type, pre-treatment pain, ODI,

frequency, duration and compliancy of LET as well as demographic variables of age and BMI; each were analyzed to predict the three post-treatment clinical outcomes. Three machine learning models—Random Forest (RF), XGBoost, and Multilayer Perceptron (MLP), were employed due to their capability to handle both continuous and categorical variables effectively. Model performance was evaluated in terms of predictive accuracy, and the most influential factors affecting treatment outcomes were identified using Shapley Additive Explanations (SHAP). Treatment was a multimodal spine rehabilitation program featuring LET given for 3-6 times per week for 4-10 weeks and for a duration of 15-20 minutes per session. Follow-up assessments were performed at 3 and 6-months. Inclusion criteria included patients with CNSLP, lumbar hypolordosis and without complicating factors such disc herniation or surgery. RESULTSRecords from 431 patients met the inclusion criteria. Pre-to-post measures (improvements) in lumbar lordosis, pain intensity and ODI were -11.5° to -23.6°, 7.3/10 to 3.3/10, and 33.2% to 10.4%, respectively. The XGBoost model outperformed the other algorithms in terms of predictive accuracy, particularly for the prediction of lumbar lordotic angle and pain reduction. Feature importance analysis revealed that the pre-treatment lumbar curve (lumbar lordosis angle) and traction duration were the most significant predictors of post-treatment outcomes; specifically, the largest variance explained was 73% of the lumbar lordosis angle outcome was explained by the XGBoost model. CONCLUSIONSThis study demonstrates the potential of machine learning to enhance personalized management strategies for CNSLP patients undergoing LET. By accurately predicting post-treatment outcomes, machine learning can support tailored interventions, optimizing patient care. The findings suggest that incorporating ML models into clinical practice could significantly improve treatment planning and decision-making in lumbar pain management. ACKNOWLEDGEMENTS AND FUNDINGP.A.O. is a paid consultant for CBP NonProfit, Inc. D.E.H. teaches continuing education conferences to health care providers, is the CEO of Chiropractic BioPhysics, teaches rehabilitation methods, and distributes products for patient rehabilitation to physicians in the USA.

O.12.6 - Effect of an anti-gravity exosuit on kinematics in individuals with incomplete spinal cord injury

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Background and aim: Recently, soft anti-gravity exosuits have emerged as a new device for overground training, supporting knee and hip extension for people with impaired gait. Unlike body-weight support (BWS) systems, which are restricted to (specialized) rehabilitation centers, these systems can be used in home environments, offering greater accessibility. Anti-gravity exosuits and BWS systems are both viable options for gait training, but their mechanisms of providing support differ. The aim of this study was to investigate the effect of an anti-gravity exosuit on kinematics in individuals with incomplete spinal cord injury (iSCI) compared to regular walking without support and to an overground BWS system.Methods: Fourteen individuals with iSCI (10 males, 4 females, age: 61 years (SD=13), time since injury: 10 years (SD=9)), classified as limited community ambulators, were tested during overground walking in three conditions: 'regular', 'exosuit', and 'BWS'. For the exosuit condition the Myosuit (MyoSwiss AG) and for the BWS condition the ZeroG (Aretech LLC; Ashburn, Virginia) was used. Participants self-selected their preferred assistance level of the exosuit support (1 to 4) and BWS (5 to 20% BWS in 5% increments). Each condition consisted of six walking trials at a comfortable walking speed, covering a distance of 12.5m each. Kinematics were assessed using the Xsens MVN motion capture system. Primary outcome measures were maximum knee and hip extension during stance (initial contact – toe-off) of the most affected leg. For the primary outcome measures, paired t-tests were conducted to compare the exosuit condition with the regular walking and with the BWS condition. A significance level of 0.025 was applied to account for the two primary outcomes. Secondary outcome measures were spatiotemporal parameters and medio-lateral center of mass (ML COM) excursion. Results: Hip extension showed only a significant increase (4.7° (95% CI [1.4,8.0], p=0.008, d=0.8)) with the exosuit compared to regular walking, but not compared to BWS. Knee extension was significantly larger in the exosuit condition compared to both regular and BWS, 2.0° (95% CI [0.5,3.4], p=0.01, d=0.3) and 3.4° (95% CI [0.8,6.0], p=0.01, d=0.7), respectively. The effect on spatiotemporal parameters was limited, only step width was smaller in the exosuit condition compared to BWS, -4.4cm (95% CI [-8.7,-0.05]). ML COM excursion was larger in the exosuit condition compared to both regular and BWS, 0.5cm (95% CI [0.01,1.1]) and 0.7cm (95% CI [0.1,1.2]), respectively. Conclusions: Walking with an anti-gravity exosuit resulted in a significant increase in knee and hip extension compared to regular walking. The increase in hip extension of 4.7 degrees was close to the clinically significant differences of five degrees and may contribute to improved stance stability and enhanced propulsion. In contrast, the modest increase in knee extension had a limited impact on the gait pattern.

Poster session 1

P01-A-01 - Fear of falling affects quality of gait and turning in daily life in people with Parkinson's disease

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Background and Aims: Fear of Falling (FoF) in people with Parkinson's disease (PwPD) is complex and involves multiple factors linked to falls such as past falls, gait and turning impairments, freezing of gait (FOG) and cognitive status. It is known that FoF changes mobility (balance, turning, and gait) when tested in the laboratory, under prescribed tasks. However, it is unknown if FoF impacts daily life mobility, particularly gait and turning quality, under natural daily life living. We hypothesize that PwPD who have FoF will present with worse quality of gait and turning at home compared to those without FoF. Methods: One hundred and thirteen PwPD were assessed for FoF using the Falls Efficacy Scale (FES) and International (FES-I) scores. People were separated into two groups based on their scores: FoF was defined as scoring either >10 points on FES or >16 points on FES-I (n=73, age= 69.7 years, MDS-UPDRS-III= 33.1 score) and non-FoF group was defined as scoring the lowest score on either assessment: 10 points on FES or 16 points on FES-I (n=40, age= 66.4 years, MDS-UPDRS-III= 33.5 score). Quality of gait and turning at home was measured over a 7-day period using two instrumented socks with inertial sensors embedded, on each foot, and a sensor on the waist (Opals, APDM Wearable Technologies) for a week of continuous monitoring. The number of falls in the last 12 months, age, FOG score, cognition (Montreal Cognitive Assessment score), and disease severity were used as covariates in ANCOVA analyses. Benjamini-Hochberg False Discovery Rate correction was used. Results: PwPD with FoF had worse quality of gait and turning such as longer double-support proportion (25.1[4.8] versus 22.9[2.7]), lower pitch angle of foot at toe-off (24.8[4.7] versus 27.6[4.3]), smaller turning angle per step (25.5[3.9] versus 27.4[3.6]), and slower turn rate maximum (85.7[11.6] versus 91.7[13.9]) at home than PwPD without FoF (p-corrected <0.05). Conclusions: PwPD with FoF show worse quality of gait and turning at home, regardless of disease duration, FOG severity, or the number of previous falls than those without FoF. However, it is not clear whether the altered gait and turning performance at home were beneficial compensations to avoid falls or actually reflected reasons for falls. Future studies should investigate if FoF can predict falls at home based on the quality of gait and turning and whether rehabilitation can reduce FoF and improve daily life gait and turning quality. Acknowledgments and Funding: This study is funded by the NIH (R01 HD100383 and R01HD107074; REDCap database supported by funding to Oregon Clinical & Translational Research Institute (OCTRI), and grant number UL1TR002369 and UL1TR002369.

P01-A-02 - Altered rest-activity rhythm in Parkinson's disease: Associations with motor severity and orthostatic hypotension

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BACKGROUND AND AIM: The rest-activity rhythm (RAR) captures the distribution of rest and activity periods between and within days. Previous studies have shown that RAR is dysregulated in Parkinson's disease, but the contributions of various motor and non-motor symptoms to RAR dysregulation remains unclear. The aim of this study is to evaluate the extent to which motor and non-motor symptoms account for variations in PwPD. METHODS: 471 PwPD and 105 age-matched controls underwent clinical assessment, including the assessment of motor, cognitive, psychiatric, sleep, and autonomic function. Participants wore a motion sensor on the wrist for one week to measure RAR, i.e. relative amplitude, interdaily stability, and intradaily variability. Backward stepwise regression models were used to examine associations between clinical and demographical variables, and RAR. RESULTS: After adjustment for age and gender, PwPD had lower relative amplitude ($p<0.001$), lower interdaily stability ($p<0.001$), and higher intradaily variability ($p<0.001$), than healthy controls. Motor impairment (β=-0.262, 95% CI=[-0.487,-0.125], R^2=6.8%) and the presence of orthostatic hypotension (OH) (β=-0.142, 95% CI=[-0.276,-0.026], R^2=1.9%) were associated with decreased relative amplitude. The presence of OH (β=0.182, 95% CI=[0.079,0.307], R^2=3.6%), motor impairment (β=0.129, 95% CI=[0.005,0.238], R^2=2.5%), increasing age (β=0.158, 95% CI=[0.039,0.277], R^2=4.0%), and male gender (β=-0.196, 95% CI=[-0.318,-0.088], R^2=4.7%) were associated with increased intradaily variability. Male gender was linked to lower interdaily stability (β=0.205, 95% CI=[0.071,0.321], R^2=4.2%).CONCLUSION: PwPD have less distinct rest and activity periods, greater variability in activity between days, and a more fragmented rhythm throughout the day, in comparison to healthy controls. More severe motor impairment and the presence of OH are associated with RAR dysregulation in PwPD. Future studies are needed to understand the relation between RAR and quality of life in PwPD, and whether RAR can be improved by treating motor symptoms and OH. ACKNOWLEDGEMENTS: The authors would to thank the participants of the ProPark study for their invaluable participation. We also wish to express our gratitude to the research associates and patient researchers for their contributions to the ProPark study. FUNDING: No specific funding source for this research.

P01-A-03 - Methods for IMU based daily life gait classification

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Background and aimMonitoring daily life gait with inertial measurement units (IMU) helps following disease course and identifying rehabilitation goals in people with gait impairments. A crucial first step in deriving relevant gait characteristics from all-day recordings is accurately identifying gait bouts. This has been done with signal-processing and machine learning approaches, using one or more sensors on the back and/or feet. These resulted in varying outcomes depending for example on the amount of sensors, sensor locations and study population. We contrasted the validity of a new algorithm using sensors on both feet and a machine learning method, with two other signal-processing methods for classifying gait in people with and without gait impairments.MethodsThirty-two participants (healthy [n=12], stroke [n=8], incomplete spinal cord injury [n=6] and hereditary motor and sensory neuropathy [n=6]) performed 20-30 minutes of daily life activities while wearing IMUs on both feet and the sacrum. Four gait classification methods were compared against video reference: 1) 'Both feet': An algorithm using IMU data from both feet, consisted of three stages: a) selecting potential gait based on alternating foot motions; b) excluding time frames based on the angular velocity auto-correlation pattern; c) applying minimal spatiotemporal criteria for gait bouts. 2) 'Sacrum': Based on sacrum accelerometer data [1]. 3) 'Single foot': Based on gyroscopic data of one foot [2]. 4) 'SVM': A support vector machine (SVM) trained on all data of the feet and sacrum sensors, evaluated with leave-one-out cross-validation. The outcomes of these methods were compared with the video reference for each 0.5 s window. Median [IQR] values of the accuracy, sensitivity and specificity were calculated for each method. Wilcoxon signed rank tests with Bonferroni corrections were used to compare the performance of 'Both feet' and 'SVM' with the others.ResultsBased on accuracy, the 'Both feet' (92.8% [3.36]) and 'SVM' (92.5% [2.6]) methods performed significantly better compared to the others (figure 1, p<0.001, Z=4.6-4.5.0). 'Sacrum' had excellent sensitivity (99.5% [0.8]), but at the expense of moderate specificity (72.1% [15.1]). Sensitivity of 'SVM' (92.9% [6.1]) was significantly higher (p<0.01, Z=3.0-3.2) compared to 'Both feet' (87.8% [5.5]) and 'Single foot' (86.6% [10.7]). Regarding specificity, the 'Both feet' algorithm was significantly higher than all other algorithms (96.6% [4.1], p<0.001, Z=4.1-4.9).ConclusionsEven though the 'SVM' method made use of all three sensors, it did not outperform the 'Both feet' algorithm on specificity. When spatiotemporal outcomes are of interest, the priority should be on specificity rather than on sensitivity, making the 'Both feet' algorithm the best choice for this purpose.ReferencesIluz, T. et al. JNER, 2014Ullrich, M. et al. IEEE JBHI, 2020

P01-A-04 - Identifying sleep parameters most strongly associated with balance in young people in Saudi Arabia

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BACKGROUND AND AIM: Previous research has primarily focused on the relationship between sleep duration and various health outcomes. Recently, there has been a growing

interest in studying the connection between bedtime and different health outcomes, such as balance. However, the available information on this specific topic is limited, especially for college students who often suffer from anxiety, sleep disturbances, and consume high-caffeine coffee. This study aims to examine the relationship between sleep parameters (sleep duration and bedtime) and balance, to determine which sleep parameter is more associated with quantitative measures of balance.METHODS: Healthy male young adults between the age of 18 and 25 years old participated in this cross-sectional study. Participants underwent static and dynamic balance tests designed to assess various aspects of balance. Dynamic balance tests included Gait Speed Test and Functional Reach Test. Static balance was assessed by performing the Romberg test, both with eyes open and closed, and measuring the root mean square (RMS) of trunk angular displacement in the pitch and roll planes. Trunk sway was measured with an inertial sensor placed on the subject's lower back at the level of the iliac crest (L4). To evaluate sleep parameters (sleep duration and bedtime), participants completed the Pittsburgh Sleep Quality Index (PSQI). Pearson correlation test was used to analyze the relationship between sleep duration and balance data (gait speed, functional reach, and sway data), while Spearman correlation test was used to analyze the relationship between bedtime and balance data.RESULTS: Twenty-five male young adults (mean age 21.0 ± 1.8 years old), participated in this study. Delayed bedtime was significantly associated with increased RMS of trunk angular displacement in the pitch plane during eyes open ($r = 0.482$, $p = 0.017$) and closed ($r = 0.452$, $p = 0.027$), while there were no other significant relationships with other balance measures. Conversely, sleep duration was not significantly associated with any of the balance measures. In further analysis, bedtime was significantly associated with the overall Pittsburgh Sleep Quality Index (PSQI) score ($r = 0.676$, $p \leq 0.001$), while there was no significant association between the PSQI score and sleep duration.CONCLUSIONS: The time of going to sleep was significantly associated with some balance measures and the Pittsburgh Sleep Quality Index. In contrast, there was no association between sleep duration and any of the balance measures or the Pittsburgh Sleep Quality Index. The results of this study support considering the bedtime when developing balance rehabilitation guidelines and clinical practice recommendations as a potential risk factor for balance impairment.

P01-B-05 - Sensorimotor adaptation, visual feedback and step length asymmetry in stroke survivors

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BACKGROUND AND AIM: Locomotor adaptation is the process of modifying a learned gait pattern during a period of trial-and-error practice as the performer is exposed to a perturbation, and it is considered part of a learning process. Stroke survivors can adapt to a similar magnitude as non-disabled individuals, although they present a slower rate of adaptation. In this study, we investigated the time course of combining visual feedback (VFB) and sensorimotor adaptation to modify step length asymmetry (SLA) in stroke survivors compared to non-disabled controls.METHODS: Sixty-five stroke survivors (> 6 months) and 18 individuals with no gait impairment, age- and sex-matched control, participated in the study. Participants walked on a split-belt treadmill during 4 phases: both belts tied and VFB off (baseline, 1min); belts tied and VFB on (practice, 3min); split-belt at 2:1 speed ratio (adaptation, 8min), with VFB on only during the first 40 strides; and with both belts tied and VFB off (de-adaptation, 8min). During adaptation, the fast belt speed moved at the participant's fastest overground speed, and the slow belt moved at half of that. The split-belt condition perturbed each leg's step length away from their baseline step length. The leg with shorter baseline step length was placed on the slower belt. The real-time VFB was displayed in front of the participant and consisted of a grid with a target row indicating the step length of each leg during baseline (highlighted box on the grid). Participants were instructed to step to the highlighted row when VFB was available. We calculated the SLA and employed statistic parametric mapping to compare the entire time course of change between groups and between phases (baseline and adaptation with VFB on and VFB off, baseline and de-adaptation, and adaptation with VFB on and VFB off).RESULTS: In the beginning of adaptation, participants from both groups experienced a pronounced perturbation and improved SLA in the remaining period with VFB on. However, they experienced a pronounced perturbation again when VFB was removed, and finally improved SLA again. During de-adaptation, participants presented another pronounced perturbation in the contrary direction from the adaptation phase, but this aftereffect decayed, and participants returned walking to their baseline pattern.CONCLUSIONS: Both groups showed a similar time course of adaptation of the SLA in both the combined split-belt and VFB or split-belt alone portions of the study. This contrasts with previous evidence of slowed adaptation in stroke survivors. It is possible that these differences are related to the use of the statistic parametric mapping approach in this study, which allows comparison of the entire time course of adaptation between groups. Interestingly, the time course of changes in SLA was not different between the two groups with the VFB on, despite previous evidence that stroke survivors are not as effective at using VFB to modify SLA in response to a split-belt perturbation.ACKNOWLEDGEMENTS AND FUNDING: This work was supported by the National Institutes of Health to Darcy S. Reisman (NIH 2 R01HD078330) and the São Paulo Research Foundation (FAPESP) to Ana MF Barela (BPE 2024/02287-0).

P01-B-06 - Adaptation of motor control strategies and neurophysiological anxious arousal during repeated blocks of split-belt walking

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Introduction: Anxious arousal mediated by autonomic nervous system modulates alongside motor control strategy of the ankle in response to repeated standing perturbations. Co-modulation between anxious arousal and motor control strategies has not been explored in complex walking challenges. The aim of this study is to explore the co-modulation between anxious arousal measured by electrodermal activation (EDA) and motor control strategies used during adaptation of step length symmetry (SLS) to split-belt walking.Methods: Twenty unimpaired young adults (26.8 ± 3.3 years, 10 F) participated in a single session of repeated blocks of split-belt walking and self-rated the challenge level of each block. Fast and slow belt speeds were individualized to a 2:1 ratio. Participants were exposed to 3 blocks x 3.5min of split-belt walking (2:1 speed ratio) alternated with tied-belt walking. EDA was measured from the palmer surface of the hand. Motor control strategy about the ankle was assessed by bilateral tibialis anterior (TA) and gastrocnemius medialis (GM) activation recorded by electromyography (EMG), and propulsive force at toe-off. SLS and propulsive force were measured with embedded force plates. Linear mixed models (LMM) tested changes in EDA, SLS and propulsive forces during early (first 15 strides) and late (last 15 strides) phases within each block of split-belt walking. Statistical parametric mapping (SPM) paired t-tests analyzed EMG during stance of early and late phases within split blocks.Results: Split block 1 (S1) was reported as significantly more challenging than S2 and S3 ($p<0.05$). During S1 only, SLS was increased while EDA was decreased in the late phase compared to the early phase ($p<0.01$). Adaptation savings were evident in both SLS and EDA in S2 and S3 when compared to the late phase of S1. There were no significant differences between the early and late phases of SLS and EDA in S2 and S3. Propulsive forces showed significant adaptation between early and late phases of each block ($p<0.05$). Similarly, the results of SPM demonstrated significant change of motor patterns comparing the early and late phases in bilateral TA and GM muscle activations across all split blocks. However, magnitude of change of bilateral muscle activation from early to late phases was notably less in S2 and S3 compared to S1.Conclusions: Our findings demonstrate that anxious arousal and SLS show significant adaptation only during the initial exposure to split-belt walking. While the motor control strategy and propulsive forces also show the greatest magnitude of adaptation in the first exposure to split-belt walking, they continue to show adaptation across subsequent blocks. Our findings are suggestive of early adaptation to split-belt walking during the initial block, that is also rated as the most challenging block, followed by further refinement of motor control strategy despite no further significant change in symmetry.Funding: NSERC & MSHSBC

P01-B-07 - Learning to suppress a balance recovery step: Implications for improving behavioral flexibility in reactive balance control

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Background and Aim: Research shows compensatory balance responses can be improved with training. The present study represents a chance finding from a separate registered report where our research team investigated neural markers underlying response inhibition in a balance recovery task1. For methodological reasons, we needed to split the balance assessment over two days in the original study, allowing us to explore the trainability of response inhibition in a reactive balance context. Here, we address the following research question: Can suppression of a rapid balance recovery step be improved with training? Methods: Young, healthy participants (N = 20) were released from a supported, forward lean to prompt a rapid balance recovery step. On most trials, participants were instructed to recover balance by quickly stepping forward (i.e., GO trials). However, on 20% of the trials, a high-pitch tone was randomly played immediately after postural perturbation, signaling participants to suppress a step and relax into a catch harness (i.e., STOP). Our balance task was based upon the Stop Signal Task (SST), a classic test of response inhibition in cognitive neuroscience. The SST is designed to measure a covert stopping process represented as the Stop Signal Reaction Time (SSRT) where a lower SSRT indicates quicker inhibition of a prepotent response. Force plates measured GO reaction time post-perturbation and stepping errors on STOP trials. Testing was repeated on two separate days. Results: Task performance improved on the second day of testing for both step response speed and accuracy. Specifically, participants were more accurate at suppressing a step on day two (46 ± 19 %) compared to day one (36 ± 19 %); $t_{19} = -3.172$, $p = 0.005$. They were also faster at generating the GO response measured by lift-off (321 ± 37 ms vs. 348 ± 40 ms); $t_{19} = 6.439$, $p < 0.001$, and touchdown (453 ± 51 ms vs. 484 ± 55 ms); $t_{19} = 6.301$, $p < 0.001$. Finally, participants had a significantly faster SSRT on day two compared to day one (308 ± 46 ms vs. 286 ± 41 ms); $t_{19} = 2.187$, $p = 0.041$. Conclusions: Our results build from past work in which balance reactions improve with practice and we now show that response inhibition within a reactive balance context can be trained. A decrease in stopping capacity, as estimated by the SSRT, offers support that the cognitive ability to suppress a highly prepotent action was directly influenced. Critically, participants became faster in generating a step while also becoming more successful at inhibiting an unwanted step, thus arguing against a strategic slowdown aimed at reducing errors. Trainability of response inhibition suggests behavioral flexibility can be improved in this task, and this adaptation does not necessarily compromise response speed. 1Bolton et al., Registered report, stage-1 acceptance Psychophysiology. DOI:10.17605/OSF.IO/XB8ZQ

P01-B-08 - Comparing the impact of massed versus distributed perturbation-based balance training on 6-month fall rates and dynamic balance in older adult fallers: A single-blind randomized trial

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Background and Aim: The ability to maintain balance and respond to unexpected perturbations is a key component of effective postural control, relying on reactive mechanisms to move the base of support. Traditional balance training focuses on anticipatory control through static and planned movements. In contrast, perturbation-based balance training (PBT) provides controlled, repeated exposure to unpredictable disturbances, enhancing reactive responses. While PBT's benefits are well-supported, its long-term effects in specific clinical populations remain underexplored. Optimizing delivery—such as session scheduling—may enhance its effectiveness. This study examined whether practice distribution (massed vs. distributed) influences fall reduction in older adults with a recent fall history, assessed at a 6-month follow-up after four PBT sessions.Methods: A randomized clinical trial included 30 community-dwelling adults aged ≥65 who had fallen within the past six months. Participants were assigned to either a massed (2 sessions/day in 1 week) or distributed (2 sessions/week over 2 weeks) practice group. They completed four sessions on a custom treadmill with a safety harness. Each session involved 24 perturbations (12 accelerations and 12 decelerations of the treadmill belt), totaling 96 over 80–100 minutes (20–25 min/session). Assessments included fall incidence, Mini-BESTest section scores, and the Falls Efficacy Scale–International (FES-I) at baseline, post-training, and 6-month follow-up.Results: No significant differences emerged between groups or in group × time interactions. However, both groups experienced a significant fall reduction after the intervention ($p<0.001$, Cohen's $d=1.2$), averaging 2.2 fewer falls—a 74.1% decrease. Survival analysis over the 6-month follow-up indicated fewer fall events (5 vs. 11) and a longer restricted mean survival time in the distributed group, though the difference was not statistically significant ($p=0.130$). The analysis of the Mini-BESTest sections showed that reactive control improved from baseline to follow-up ($p<0.001$, Cohen's $d=0.9$, 1.3 points) and from baseline to follow-up ($p<0.001$, Cohen's $d=1.6$, 2.4 points). Dynamic gait section scores increased from baseline to retention ($p=0.001$, Cohen's $d=0.8$, 1.0 point) and were maintained at follow-up. FES-I showed a time points effect ($p=0.010$), with a near-significant reduction between baseline and follow-up ($p=0.051$, Cohen's $d=0.4$), suggesting a trend toward decreased fear of falling over time.Conclusion: Four sessions of PBT effectively reduced falls and enhanced dynamic balance in older adults with a history of falls, regardless of how the sessions were scheduled. These results support PBT as a practical, short-term intervention with benefits lasting up to six months. They also highlight its potential for integration into flexible fall prevention programs adapted to various settings and patient schedules.

P01-B-09 - The characterization of multiscale dynamics of resting-state supraspinal activity and its association to balance control in chronic ankle instability

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Background and aim: Chronic ankle instability (CAI) is a consequence of lateral ankle sprains, one of the most common lower-extremity musculoskeletal injuries, and is closely associated with diminished standing and walking performance and poor quality of life. Balance control depends not only upon the peripheral neuromuscular function, but also the cortical neural control with the brain, consisting of numerous underlying components that interact and interconnect with each other over multiple temporal scales. Therefore, within a given brain cortical network, the multiscale dynamics of the spontaneous (i.e., resting-state) fluctuations of neuronal activity are “complex,” meaning they contain meaningful information over multiple scales of time. Still, such complexity of the resting-state fluctuations within the brain in CAI has not been characterized, and its associations to balance performance in this cohort is unclear.Methods: Twenty-nine younger participants with CAI (age:20.6 ± 1.6 years; 14 women) and 35 age-matched healthy controls (HC) (age: 21.3 ± 2.3 years; 21 women) completed the one-leg standing balance in eyes-open (EO) and eyes-closed (EC) condition and Y-balance test (YBT). The postural sway outcomes (e.g., sway speed) and YBT score was measured. They also completed one resting-state functional MRI scan of blood oxygen level-dependent (BOLD) signal. We used multiscale entropy to quantify the complexity of BOLD signals and the BOLD complexity of each of seven functional cortical networks (i.e., visual, sensorimotor (SMN), ventral (VAN) and dorsal attention, frontoparietal, limbic, default mode network) was then obtained.Results:Compared to HC, participants in CAI presented lower BOLD complexity in SMN ($F = 14.83$, $p < 0.001$), visual network ($F = 6.39$, $p = 0.014$), and VAN ($F = 4.55$, $p = 0.037$) (Figure 1A). Within CAI group, lower BOLD complexity in SMN was significantly associated with higher sway speed (i.e., greater sway) in EO ($\beta = -0.38$, $p = 0.04$) and EC ($\beta = -0.42$, $p = 0.02$) condition, and lower YBT score ($\beta = 0.54$, $p = 0.003$) (Figure 1B~D); and lowerBOLD complexity of visual ($\beta = -0.47$, $p = 0.01$) and limbic network ($\beta = -0.44$, $p = 0.02$) was associated with higher sway speed in EO condition (Figure 1E&F). No such associations were observed in HC group.Conclusions: To our knowledge, this is the first work to characterize the multiscale dynamics in supraspinal regulation pertaining to balance control in CAI by measuring the resting-state BOLD complexity. Diminished BOLD complexity related to CAI were identified in networks related to the sensorimotor, visual and attention control, all are important contributors to balance control. More importantly, lower BOLD complexity is associated with poorer performance of balance control within CAI only, highlighting that the regulation of standing balance in CAI may be particularly dependent upon the supraspinal control, which can be captured by this resting-state BOLD complexity metric.

P01-B-10 - Neural variability may be reflective of motor refinement beyond initial adaptation of cortical activity in split-belt walking

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Background and AimFunctional near-infrared spectroscopy (fNIRS) allows the measurement of cortical activity during dynamic tasks, such as walking, through hemodynamic changes. Typically, mean oxyhemoglobin (HbO) is analyzed to infer cortical involvement in various tasks. However, some research suggests that measures of variability in hemodynamic activity may provide information beyond measures of mean activation (1). Changes in hemodynamic activity measured through fNIRS during locomotor adaptation tasks have yet to be explored. This work aims to explore the cortical hemodynamic response of both mean and variability during repeated blocks of split-belt treadmill walking.MethodsTwenty (10F) unimpaired young adults (23-34yrs) completed a single-session, repeated block design on a split-belt treadmill, with 3x3.5-minute split-belt walking blocks (2:1 speed ratio) interspersed with tied-belt blocks. Step length symmetry (SLS) was calculated from embedded force plates to measure locomotor adaptation. Prefrontal (PFC), premotor (PMC), posterior parietal (PPC), and sensorimotor (SMC) cortices were included as regions of interest (ROIs). Dependent variables included SLS, mean and variability in HbO for each ROI. Measures of variability included standard deviation (SD), and root mean square successive difference (RMSSD). The first 30 strides were defined as early adaptation, and the last 30 strides as late adaptation during each split block. Linear-mixed-effects models explored changes in SLS and HbO mean and variability in each split block (S1/S2/S3) and phase (early/late). Estimated marginal means (EMMs) were calculated to examine the split-phase interaction in each model. Pairwise comparisons were performed with an alpha of 0.05.Results A significant decrease in mean HbO between the early and late phases of S1 occurred alongside a significant change in motor adaptation (SLS). EMMs revealed differences by phase for mean SLS, increasing from early to late for S1 only. Mean HbO significantly decreased by phase from early to late for S1 only in the PFC and PMC ROIs. In contrast, measures of variability were lower across all ROIs in the early phase and higher in the late phase. SD and RMSSD significantly increased by phase in S1 and S2 for the PFC. While PMC, SMC and PPC ROIs showed increases in neural variability by phase in blocks S2 and S3.ConclusionsPreviously, measures of variability have been shown to be opposite and larger in magnitude than mean changes and increase as motor task difficulty decreases (1). Our findings in locomotor adaptation are in agreement; as individuals adapted, neural variability increased, and mean activity decreased. Although mean changes in SLS and HbO appear to plateau after block 1, neural variability continues to change in later blocks, potentially indicative of refinement of locomotor adaptation. Acknowledgements and fundingKJY is supported by a CIHR doctoral award. CLP is supported by MSFHR scholar award. References1. Reddy P, Shewokis PA, Izzetoglu K. Can variability of brain activity serve as a metric for assessing human performance during UAS dual-task training. In: 2022 IEEE 3rd International Conference on Human-Machine Systems (ICHMS) [Internet]. Orlando, FL, USA: IEEE; 2022. p. 1–5. Available from: https://ieeexplore.ieee.org/document/9980752/

P01-B-11 - Micro- but not macro-offline gains in gait sequence learning

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Background and aim: Motor memory consolidation is crucial for motor learning. In motor memory, consolidation is defined as improvements in, or stabilization of, performance in absence of physical practice (i.e., offline). Motor memory consolidation is historically studied in fine motor sequence learning exploiting a sequential finger tapping paradigm, but is largely underexplored in the context of gait. Insights into how gait sequences are acquired and retained provide a behavioral basis for training and rehabilitation interventions. Psychophysical and neuroimaging studies exploiting the fine motor sequence learning paradigm suggest the existence of a “goal representation” and “movement representation” built under spatial and motor coordinates, respectively. Spatial and motoric representations of sequential skills are consolidated during post-learning sleep or wakeful rest. Recent data indirectly suggest that 1) brain networks supporting consolidation of fine motor sequence memories may also support the consolidation of gait sequence memories and 2) consolidation also occurs in rest periods as short as 15 seconds. Based hereon, this study tested the hypothesis that micro- and macro offline gains contribute to total improvements in performance on a novel gait sequence learning task, where macro- and micro offline gains are defined as offline improvements between sessions (e.g., subsequent days) and in short rest periods between blocks of practice within sessions, respectively. Methods: Eighteen healthy young individuals visited the lab on two consecutive days. On Day 1 (training session), they were trained on a sequential gait task with the instruction to walk, at comfortable walking speed, on lanes that were projected on the surface of an instrumented C-Mill treadmill and to change as quickly as possible to the next lane upon appearance. The order of lane locations followed a sequential pattern (Fig.1A). After 24 hours, they were retested on the same sequence (retest). The training and retest sessions consisted of 12 training blocks, each containing three repetitions of a 12-element sequence, interspersed by 15-s-long blocks without lane projections. Force-plate data were used to evaluate response time, quantified as the delay between the time of lane projection and the first step within that lane. Results: In accordance with the hypothesis, micro-offline gains within the first session were larger than the micro-online gains ($F(1,14) = 11.877$, $p = 0.004$, $\eta p2 = 0.459$; Fig.1B). However, there were no macro-offline gains between the training and retest session ($F(1,13) = 3.008$, $p = 0.106$, $\eta p2 = 0.188$; Fig.1C-D). Conclusions: The current data show micro-offline gains during gait sequence skill acquisition consistent with fine motor sequence data, but no micro-offline gains. These data provide initial insights into gait sequence learning, but future research is needed for translation to clinical settings.

P01-B-12 - Differential neural activations between mental imagery and action observation of slipping among older adults

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BACKGROUND AND AIM: Mental imagery and action observation are often incorporated into volitional and reactive balance (e.g., recovery from a slip) training among older adults, and have shown greater improvements in balance and falls self-efficacy than exercise training alone. Understanding the neural correlates underlying mental imagery and action observation could assist in tailorizing balance interventions for targeting specific age-related CNS impairments. Our previous study showed greater activations in cortical and subcortical structures during imagined versus observed slipping among young adults. Here, we examined differences in neural activations between these two conditions in older adults. METHODS: Forty older adults (72±7 years) underwent a single session of functional magnetic resonance imaging. Participants received instructions to imagine slipping (IS), observe slipping (OS), and rest in a randomized order. Data preprocessing including realignment and slicing, normalization and smoothing were conducted using SPM12. First level models were built using x, y, z translation realignment movement regressors and subtraction method was used to create contrast images. Planned contrasts were performed between IS and rest, OS and rest and IS and OS (p uncorrected=0.05 and K=80) and xjview10 was used to extract the anatomical activation areas. Generalized linear models were used to analyze the main effect of condition on anatomical activations. RESULTS: Neural activations were greater in both active conditions (IS and OS) than rest. IS-Rest showed greater activations in bilateral frontal lobes, supplementary motor area, inferior frontal gyrus, right occipital lobe, and left cerebellum. OS showed greater activations in bilateral occipital lobes, left frontal lobe, left cerebellum, corpus callosum, precentral gyrus and middle temporal gyrus than rest. IS minus OS revealed no suprathreshold activation clusters. However, OS showed greater activations in the left occipital and frontal lobe, corpus callosum, precentral gyrus and middle temporal gyrus than IS. CONCLUSIONS: Older adults activated many similar areas as young during IS and OS than rest. Unlike young, older adults demonstrate higher activations in cortico-subcortical structures during OS than IS, which suggest greater neural engagement for visual information processing and interpretation of perturbation, and possibly greater demand/allocation of resources for planning, initiation, and execution of coordinated movements to recover from unexpected balance loss. Alternatively, lesser activation during IS could suggest age-induced deficits in processing speed, working memory, which are known to affect the ability to perform mental rehearsing tasks. Older adults might potentially benefit more from training components of action observation than mental imagery specifically pertaining to reactive balance tasks (e.g., slipping). FUNDING: This work is funded by R01AG073152 awarded to PI Tanvi Bhatt

P01-B-13 - Neuromuscular adaptations to perturbation-based balance training using obstacle trips in older people: the SafeTrip randomised controlled trial

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Background and Aim: Trips are the most common fall circumstance in older people. Conventional exercise programs can prevent falls by over 20%, however, these programs may lack the task-specificity required to prevent trip falls. Perturbation-based balance training (PBT), aims to improve reactive balance to perturbations such as trips in a safe manner and may transfer to preventing falls with few training sessions due to the retention of training-induced adaptations. This study investigated the adaptation and retention of muscle activity responses to a low dose trip PBT intervention over 12-months. Methods: A randomised controlled trial was conducted with 111 community-dwelling older people randomised into intervention (n=54) and control (n=57) groups. The intervention group undertook an initial three-week PBT program followed by three-monthly ‘booster’ sessions over one year (six training sessions in total). The control group received a fall prevention educational booklet and continued usual activities. Muscle responses in the rectus femoris (RF) and gastrocnemius medialis (GM) were assessed on the ipsilateral (left) and contralateral (right) limbs using surface electromyography. Time to clear the trip obstacle and peak harness loading at the 12-month re-assessment were also assessed. Between-group (intervention vs control) and within-group (across training sessions) comparisons were performed.Results: At the 12-month re-assessment, the intervention group had shorter onset latencies in the ipsilateral GM, lower co-contraction in the ipsilateral ankle muscles, shorter obstacle clearance time and reduced peak harness loading compared to control ($P<0.01$). For within-group comparisons, short-term (single session) adaptations were evident via lower peak magnitudes in the ipsilateral GM and lower peak harness loading ($P<0.01$). Medium-term (three sessions over three-weeks of training) adaptations included reduced co-contraction around the ipsilateral and contralateral ankle muscles and lower peak harness loading ($P<0.01$).Conclusions: Neuromuscular adaptations following a low dose 12-month PBT intervention occurred within ankle musculature, evidenced by shorter onset latency in the ipsilateral plantar flexors and reduced co-contraction of ankle muscles. This may have contributed to improved balance recovery (reduced peak harness loading) which was maintained at 12 months. These findings provide a mechanistic understanding of how PBT programs may improve reactive balance over an extended period in older people.Acknowledgements and Funding: Martin Heroux for expertise in analysing EMG data collected. Funding: National Health and Medical Research Council (NHMRC).

P01-B-14 - Effects of sensory constraint on sensorimotor function in individuals with chronic ankle instability: A systematic review and meta-analysis

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Background and Aim: Chronic ankle instability (CAI) is a high prevalent and recurrent sports-related injury that usually presents sensorimotor dysfunction. Previous studies have investigated sensorimotor function of CAI in different postural tasks, but little

attention has been paid to the effects of sensory constraint, which is crucial for modulating posture. Hence, this study aimed to assess the impact of sensory constraint on sensorimotor function and to evaluate sensory reweighting ability in those with CAI.Methods: This study followed PRISMA guideline and was conducted literature search on PubMed, Web of Science, EMBASE, Cochrane, SPORTDiscus (EBSCO) and Medline (EBSCO). Case control, cross-sectional design, and baseline data from intervention studies with somatosensory, visual or vestibular constraints were extracted. The outcomes included centre-of-pressure based parameters, muscle activition amplitude, and onset time. The epidemiological appraisal instrument, Cochrane standardized bias tool, and International Ankle Consortium recommendation were used to evaluate the quality, risk of bias, and CAI's variability of included studies, respectively. Stata version 18 with random effect model was applied to conduct meta-analysis. Mean and 95% confidence interval (CI) of hedges's g were calculated.Results: 1504 studies were identified, and 43 articles were finally included in meta-analysis. When constraining visual information in unilateral stance, the CAI group presented higher anteroposterior (Effect size (ES) = 0.29, 95% CI: 0.13 to 0.44), mediolateral (ES = 0.30, 95% CI: 0.11 to 0.49) velocity of centre of pressure, as well as increased medial gastrocnemius activity (ES = 1.02, 95% CI: 0.35 to 1.68). Increased postural sway in mediolateral direction (ES = 1.05, 95% CI: 0.41 to 1.69) and delayed activation of gluteus medius (ES = 2.73, 95% CI: 0.32 to 5.13), vastus medialis (ES = 0.57, 95% CI: 0.12 to 1.06), peroneus longus (ES = 1.71, 95% CI: 1.10 to 2.31) and tibialis anterior (ES = 2.04, 95% CI: 1.26 to 2.83) were observed in CAI group during dynamic control with visual constraint. CAI group showed decreased sensory reweighting in mediolateral direction during unilateral stance with visual constraint (ES = 0.26, 95% CI: 0.06 to 0.46) and during double stance with visual and somatosensory constraints (ES = 0.45, 95% CI: 0.15 to 0.75).Conclusions: Visual constraint could influence postural stability by delaying muscle activation and inhibiting sensory reweighting. Sensory reweighting ability in CAI may fluctuate based on task and sensory constraints. Individuals with CAI may present increased visual-dominant strategy during postural control. Moreover, increased visual and vestibular reliance during complex tasks may hinder visual-vestibular interaction in those with CAI. Further research should consider clarifying visual-vestibular interactions and visual perturbation interventions in individuals with CAI.

P01-C-15 - Age-related changes in cognitive control during step initiation

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Background and Aim:Older adults often have impaired neuromuscular function, which increases their risk of falling. While fall risk arises from multiple contributing factors, recent evidence highlights the critical role of age-related deficits in cognitive control. In particular, impairments in cognitive control may influence anticipatory postural adjustments (APAs) observed during step initiation. In this study, we employed a choice

stepping task, in which we manipulated the probability of step initiation to examine age-related differences in movement anticipation and planning. We hypothesized that in addition to general age-related slowing, older adults would be less sensitive to variations in the likelihood of step initiation.Methods:Twenty-four young (age 23 ± 3) and twenty-five older (age 72 ± 3.5) healthy participants performed a choice stepping task using a Go/No-Go paradigm. In this task, a priming cue indicated the side of step initiation and after a variable interval the imperative cue indicated whether it was a go or no-go trial. Response likelihood was manipulated by changing the ratio between go and no-go trials: 3:1 in the mostly-go and 1:3 in the mostly-no-go condition. Each condition consisted of 120 trials (240 trials in total). A stepping mat recorded foot liftoff and touchdown times and differences in lift-off and movement time (time from liftoff to touchdown) were assessed using a linear mixed model.Results:While older participants showed longer lift-off times ($p < 0.001$, Fig. 1), no group effect for movement time was found ($p = 0.09$). In addition, we found an interaction between group and condition in lift-off time ($p = 0.019$). Post-hoc test showed that age-related differences in lift-off time were larger in the mostly-go (-102 ± 20 ms, $p < 0.001$) than in the mostly-no-go condition (-59 ± 22 ms, $p = 0.008$). Discussion and Conclusion:Longer lift-off times show that cognitive control processes were affected in older participants, in contrast to motor control processes that remained unchanged as reflected by similar movement times. Younger participants were more senstive to variations in the likelihood of step initiation showing shorter lift-off times in the mostly-go condition. Older participants did not show a similar improvement in reaction time, suggesting that they maintained similar levels of response inhibition in the mostly-go-condition. This may suggest that older participants were more focused on maintaining postural control whereas younger participants prioritized faster response times.

P01-C-16 - Clinical utility of turning in Parkinson’s disease: Initial findings from a systematic review

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Background and aim: Difficulty turning is an early symptom of Parkinson’s disease (PD) and is noticeable prior to straight line gait impairments [1]. Cardinal motor symptoms (i.e. bradykinesia, rigidity, postural instability etc.) make turning a complex task for people with PD. Turning may be a sensitive marker of PD severity and mobility impairment as it reflects the complex neural control of dynamic balance. To understand the importance of turning as a marker of PD, a systematic review was undertaken. Methods: Seven databases (PubMed, IEEE, CINAHL, PsychInfo, Web of Science, Scopus, Embase) were searched to identify studies assessing turning in people with PD. Two independent reviewers screened abstracts and titles. Before full text review, preliminary information from eligible studies was extracted, including publication date, study aim, and technology. Results: The search yielded 7411 results, 2802 duplicates were removed

(n=4606 remaining) and 267 studies eligible for full-text review. Turning has been used as an outcome measure since 2000, most commonly evaluated using 3D motion capture (n=52, 18%). The use of inertial measurement units (IMUs) for instrumenting turning assessments increased from 2015 onwards (n=118, 41%). 160 papers (60%) evaluated turning as part of a battery of outcomes to understand PD and symptom presentation. The remaining 40% focused solely on turning performance/ impairment. Investigating the effect of turning on specific symptoms (n=103, 33%) was most common, with half assessing gait and freezing (Figure 1). Turning was used as an outcome to evaluate intervention efficacy (94 papers, 30%) such as rehabilitation therapies, the use of brain stimulation and response to medication. A smaller proportion of studies focused on developing turning protocols and outcomes (n=69, 22 %), using turning outcomes to support PD diagnosis (n=28, 9%), and quantifying disease severity and/or progression of the disorder (n=19, 6%). Two studies explored validation and reliability of turning outcomes and 46 papers addressed multiple aims. Conclusion: Turning is an important outcome measure for informing the evaluation, progression and treatment of PD. The shift from using 3D motion capture to using body worn IMUs coincides with the publication of validated algorithms [2,3] and permits turning to be evaluated in real-world environments. A significant volume of research investigating turning as a measure for understanding PD symptoms and the effect of intervention is available to enable a full synthesis and meta-analysis availability of findings. Limited research has been conducted to understand how useful turning outcomes are for supporting PD diagnosis and quantifying PD severity/ progression and should be the focus of future research. Refs: [1] Hulbert 2015 PMID: 25255298 [2] El-Gohary 2014 PMID: 24379043 [3] Pham 2017 PMID: 28443059.

P01-C-17 - The effect of pain on everyday walking in older people

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Background and Aims: Pain is common in older people, affecting more than 50% of those aged 65+. It can significantly impact mobility, physical function and quality of life. Chronic musculoskeletal pain also increases falls risk, with those affected almost twice as likely to experience falls. However, the extent to which pain severity and location influence everyday walking in older adults remains poorly understood. This study examines the impact of pain on walking speed, gait quality and overall walking activity. A secondary aim is to explore whether pain in specific pain locations has distinct effect on gait parameters.Methods: This study analysed baseline data from two randomised control studies conducted at Neuroscience Research Australia. Participants were 758 community-living people (mean age = 74.2, SD = 5.7, with 525 women), who could walk

household distances without assistance. Exclusion criteria were progressive neurological conditions, cognitive impairments (SPMSQ score < 8), or participation in fall prevention programs. Pain severity was assessed using the EQ-5D questionnaire, categorising participants into three groups: no, slight or moderate-to-severe pain. Pain location was determined using the Charlson Comorbidity Index. Gait characteristics, including speed, variability and quality, were objectively assessed using accelerometers worn on the trunk for one week. Laboratory gait speed was measured using a 10-meter walk test. Descriptive statistics summarised participant characteristics and multiple linear regressions examined associations between pain severity, location and gait, adjusted for gender, BMI, age and fall history. Results: Among the 758 participants, 30.6% reported no pain, 54.1% slight pain and 15.3% moderate-to-severe pain. The moderate-to-severe pain group had a higher BMI (29.2 vs. 26.3, p < 0.001), more falls in the past year (1.3 vs. 0.6, p < 0.001) and greater concerns about falling (62.9 vs. 49.3, p < 0.001) compared to the no-pain group. Moderate to severe pain was significantly associated with slower walking speeds in daily life (β= -0.043, p= 0.035) and the laboratory (β= -0.072, p= 0.009) and reduced gait quality (β= -0.239, p= 0.008), but not total walking time. Back pain was associated with poorer gait quality (β= -0.132, p= 0.029) and shorter walking bouts (β= -35.064, p=0.038). Upper extremity pain was linked to faster walking speed in the laboratory (β= 0.046, p=0.019), but not daily life walking outcomes, compared to those without pain.Conclusions: Chronic pain was associated with reduced walking speed and impaired gait quality in older people. These findings underscore the need to address pain as part of fall prevention strategies to improve mobility and potentially reduce fall risk in this population. Back pain in particular, may require targeted interventions due to its strong link with poorer gait quality and shorter walking bouts, which reduce independence and daily life mobility.

P01-C-18 - Dynamic balance training in young and older adults: Does resting state EEG predict effects of TDCS?

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Age significantly affects postural control, resulting in a higher risk of falls (Roman-Liu, 2018), mobility limitations (Kanekar & Aruin, 2014), and reduced quality of life (Hartholt et al., 2011). Balance training has been shown to improve strength, postural stability, and physical functioning, thereby reducing fall risk in older adults (Granacher et al., 2011). Despite evidence supporting a facilitative role of transcranial direct current stimulation (tDCS) targeting the primary motor cortex (M1) or the dorsolateral prefrontal cortex (DLPFC) in motor learning in young adults (YA), the effects of tDCS on balance control in older adults (OA) remain inconclusive. Studies using tools like functional brain imaging and electroencephalography (EEG) will help to elucidate the underlying neural mechanisms and to establish standardized stimulation and training protocols in YA and OA (Edwards et al., 2017; Guo et al., 2020). To this aim, we investigated the effects of tDCS on dynamic balance task (DBT) learning and resting-state EEG measures in both healthy YA and OA. In two separate studies, forty-three healthy YA (18-30 years) and eighteen healthy OA 60-80 years) performed DBT training under three conditions: anodal tDCS over M1 (Cz) or DLPFC (F3), and sham stimulation. While in the first study, YA were split into three experimental groups, OA did all three conditions in a randomized, crossover design In YA, compared to sham stimulation, a-tDCS over both M1 and DLPFC significantly improved balance performance. Retention effects were observed on the second day for the M1 and sham groups but not for the DLPFC group. No transfer effects to untrained static balance tasks were observed. EEG analysis showed an increase in relative alpha power post-training, regardless of stimulation group, suggesting neural adaptations induced by training. Baseline theta and beta power at pre-test were associated with practice effects, highlighting their predictive value for motor learning outcomes in YA. OA demonstrated superior performance in the DLPFC condition compared to M1 and sham stimulation conditions, emphasizing the role of cognitive control in facilitating balance training in OA. Baseline EEG analysis indicated that lower alpha power significantly predicted stronger practice effects in the DLPFC stimulation condition, suggesting the influence of mental states on motor training outcomes in OA. Collectively, these findings reveal that the effectiveness of a-tDCS on balance learning depends on the stimulation target and baseline mental states. In YA, both M1 and DLPFC stimulation enhanced motor performance, with differences in retention outcomes. In OA, DLPFC stimulation proved particularly beneficial, likely due to its role in compensating for age-related cognitive decline. Importantly, resting-state EEG measures, such as alpha, theta, and beta oscillations, offer promising predictive biomarkers for motor learning outcomes. Roman-Liu, D. (2018). Age-related changes in the range and velocity of postural sway. Archives of Gerontology and Geriatrics, 77, 68–80. https://doi.org/10.1016/j.archger.2018.04.007Kanekar, N., & Aruin, A. S. (2014). The effect of aging on anticipatory postural control. Experimental Brain Research, 232(4), 1127–1136. https://doi.org/10.1007/s00221-014-3822-3Hartholt, K. A., van Beeck, E. F., Polinder, S., van der Velde, N., van Lieshout, E. M. M., Panneman, M. J. M., van der Cammen, T. J. M., & Patka, P. (2011). Societal Consequences of Falls in the Older Population: Injuries, Healthcare Costs, and Long-Term Reduced Quality of Life. Journal of Trauma: Injury, Infection & Critical Care, 71(3), 748–753. https://doi.org/10.1097/TA.0b013e3181f6f5e5Granacher, U., Muehlbauer, T., Zahner, L., Gollhofer, A., & Kressig, R. W. (2011). Comparison of traditional and recent approaches in the promotion of balance and strength in older adults. Sports Medicine, 41(5), 377–400. https://doi.org/10.2165/11539920-000000000-00000Edwards, D. J., Cortes, M., Wortman-Jutt, S., Putrino, D., Bikson, M., Thickbroom, G., & Pascual-Leone, A. (2017). Transcranial Direct Current Stimulation and Sports Performance. Frontiers in Human Neuroscience, 11. https://doi.org/10.3389/fnhum.2017.00243Guo, Z., Bao, D., Manor, B., & Zhou, J. (2020). The Effects of Transcranial Direct Current Stimulation (tDCS) on

Balance Control in Older Adults: A Systematic Review and Meta-Analysis. Frontiers in Aging Neuroscience, 12. https://doi.org/10.3389/fnagi.2020.00275

P01-C-19 - Characteristics of Falls in Older Adults in Europe: The SCOPE Study

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Background: Falls among older adults are frequent and will remain a health concern. While considerable attention has been directed towards identifying underlying risk factors and mechanisms for falls, less research has investigated the specific locations and activities engaged in by community-dwelling older adults at the time of a fall and their relation to injurious falls. Notably, there is a need for more data concerning the contextual differences in the consequences of falls between community-dwelling older adults who fell inside their homes vs. outside their homes. In addition, exploring the activities performed during a fall, and causes of injurious falls and non-injurious falls is needed. In this analysis, we describe fall events over a 3-year period in older adults who live in the community.Methods: As part of the SCOPE study, fall occurrence, location, causes, circumstances, and consequences were reported by 1,754 community-dwelling older adults across Europe at baseline (F0), 12-month follow-up (FU12), and 24-month follow-up (FU24). A geriatric assessment that included demographics, clinical and medication assessment, depression, Cumulative Illness Rating Scale, blood and urine examination, hand grip strength, and fear of falling was performed. Falls characteristics were described, and a multivariate logistic regression analysis was performed to examine the probability of being severely injured because of a fall, inside or outdoors. Results: Data on falls revealed 938 falls at baseline, 773 falls at FU12, and 797 falls at FU24, which are presented in Figure 1A-D. Falls were more likely to occur outdoors rather than at home (54.8% and 37.7%, respectively). Figure 1B shows that Ambulation, specifically walking, was ranked as the most frequent activity (64.6%), and transferring was the 2nd most common activity that accounted for a fall (15.2%). The most frequently cited reasons (50%) for falls were accidental falls, such as trips, slips, or bumping into objects attributed to environmental reasons, and 28.3% of falls were attributed to balance and gait impairments (Figure 1C). As illustrated in Figure 1D, 42.1% of falls resulted in no injury, and bone fractures occurred in 8.5% of falls during the study period. Women experienced falls about 30% more frequently than men. A logistic regression analysis shows that women were more likely to suffer from a severe injury, i.e., bone fracture, when they fell outdoors (OR=1.71). After adjusting for anemia, there was a higher probability of severe injurious fall outdoors (OR=1.82).Conclusions: Our findings offer new insights into the patterns of falls by location, sex, and injury type. This may help to

suggest ways of preventing falls. It is reasonable to recommend that older adults train their balance and specifically balance reactive responses to a situation whenever balance is lost accidentally and unexpectedly.Funding:European Union Horizon 2020 program (Grant Agreement n° 634869).

P01-C-20 - Identifying the methods and metrics used to assess and describe sedentary behaviour in people with cognitive impairment: A systematic review

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Background: Greater sedentary behaviour (SB) is associated with adverse outcomes including loss of functional independence, disability, and dementia. Few studies have investigated SB in people with cognitive impairment (PwCI), including those with mild cognitive impairment (MCI) and dementia. While both conditions involve cognitive decline, the severity of impairment determines the ability to perform daily tasks independently. Limited evidence suggests PwCI are more sedentary than typical aging populations, highlighting the need to reduce SB to promote health and mitigate disability and dependency. Developing effective interventions requires accurate and reliable estimates of SB, understanding its influencing factors, and indices which are sensitive to change. Although advances in digital technologies provide reliable methods to measure SB, current research often relies on self-reported measures which are prone to recall bias. Moreover, the lack of synthesised literature limits understanding of SB patterns, volumes, and variations in PwCI, particularly across disease progression and in relation to clinical and socio-ecological factors. This review aims to identify digital methods and metrics for assessing and characterising SB in PwCI.Methods: We searched peer-reviewed publications that investigated PwCI with a mean age ≥50 (to include young onset dementias), reporting exclusively on SB metrics using device-based methods in PwCI diagnosed by a standardised and recognised cognitive assessment or clinician. The search excluded studies where participants reported subjective or undefined cognitive impairment or self-reported SB, and sole investigations of physical activity and/or sleep. A comprehensive search of electronic databases (EMBASE, MEDLINE, PsychInfo, Scopus, Web of Science) retrieved 2822 articles, to be systematically reviewed by two independent reviewers. Following the title search, 138 abstracts were selected for abstract review. The ongoing abstract screening will further refine the articles to subsequently complete quality assessments of each article that meet the inclusion criteria.Results: This review will report (1). the methods employed to assess SB in PwCI, (2). the metrics used to describe SB in PwCI, (3). the volumes, durations, patterns and variability of SB in PwCI, (4). the disease specific and socio-ecological associations of SB in PwCI, where applicable. Conclusion: The results of this review will guide future selection of digital tools and measures to assess SB in PwCI. The literature will be synthesised to assess the current state of research and identify areas that require further

exploration. Recommendations will be identified to advise the most appropriate development of protocols to measure and investigate SB in PwCI. The findings of this review may be used to inform how we measure and monitor SB in PwCI, supportive of personalised care across the spectrum of cognitive impairment and care settings.

P01-C-21 - Influence of reinforcement and error feedback on step exploration during gait in older adults

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BACKGROUND: Learning a new motor skill requires exploration and correction, processes that might be influenced by different types of feedback. Previous work on walking in young adults indicated that feedback about success/fail (reinforcement) increased exploration whereas feedback about magnitude and direction (error) decreased exploration of step length and width. The goal of this study was to examine whether older adults use reinforcement and error feedback in a similar manner.METHODS: Fifteen participants (8 females and 7 males, 63.3 ± 6.3 years) walked on a self-paced instrumented treadmill with a 180º virtual reality screen showing an endless path. Participants first walked on the self-paced treadmill for a 5-minute familiarization period. They then walked for 2 minutes to determine individual left footstep length/width variability and in a subsequent 2-minute they experienced a mapping period, when a white rectangle displayed with a central horizontal/vertical line indicated their step length/width. Participants then performed the experimental conditions, error/reinforcement feedback. In the error feedback condition, a gray target was presented, and participants were required to place the line indicating step length/width on each step within this target. For the reinforcement condition, the gray target was presented but the line indicating step length/width was invisible, and each time participants stepped within the target, it became blue. A counter was displayed to show a running total of successful steps. These experimental conditions were 5 minutes each and the order of the error and reinforcement and step length and width was counterbalanced. Lag-1 autocorrelation coefficients of the left length and width were calculated for baseline as well as each feedback condition. Higher/lower lag-1 autocorrelation coefficient indicates greater/lesser exploratory behavior, respectively. RESULTS: Statistical analysis revealed differences in the step length autocorrelations between conditions. Lag-1 autocorrelation was lower for the error (0.27) compared to the baseline (0.47) and reinforcement (0.47) conditions. For the step width trials, pairwise comparisons showed no differences between conditions, with lag-1 autocorrelation values close to zero. CONCLUSION: Exploratory behavior in step length was similar in both baseline and reinforcement conditions, suggesting that maintaining upright stance may be a form of reinforcement feedback inherent to walking. Autocorrelations were

markedly reduced in the error condition, indicating that older adults made more intentional adjustments in step length when error feedback was available. Autocorrelations during step width were close to zero in all conditions, indicating tight regulation of step width. These differences in step length and width exploration may be related to the challenge of maintaining upright stability during walking in older adults, which is prioritized in the medial-lateral direction.FUNDING: This work was supported by São Paulo Research Foundation (FAPESP # 2024/04852-6 and #2024/01132-2) and the UNIDEL Foundation at the University of Delaware.

P01-C-22 - Prefrontal cortex activity and gait characteristics during complex gait dual-tasking in young, middle, and older adults

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Background & Aim: Daily life involves directing attention between simultaneous tasks, such as walking while talking. This “dual-tasking” (DT) feels automatic, but is known to be distracting and increases demands on cortical attentional networks. The prefrontal cortex (PFC) directs executive function, including the division of attention between motor and cognitive tasks. Due to age-related brain changes, older adults (OA) over age 65 rely more on the PFC than young adults (YA) such that they process balance-distractor conflicts differently with an increased requirement for executive function. However, it is not known if middle-aged adults (MA; age 50-64) experience changes in attention allocation and cortical efficiency impacting gait behaviour, balance, and fall risk. This work aims to characterize changes in PFC activity linked with age-related attentional shifts in relation to complex gait in middle-aged adults.Methods: In this preliminary analysis, PFC activity was assessed using functional near-infrared spectroscopy (fNIRS) during a complex gait DT in an augmented reality (AR) enhanced environment involving virtual obstacles with and without cognitive distraction. Gait and attention were challenged in adults aged 18-79. Participants walked at a comfortable pace on a pressure sensitive gait mat to capture spatiotemporal metrics while navigating virtual obstacles and while a word-recall distractor was delivered through a mobile phone. Throughout, fNIRS measured PFC activity. It was hypothesized that PFC activity in MA will differ from YA and OA wherein MA will show intermediate activity patterns, and that MA will modulate gait to an extent between that of YA and OA. Results: Preliminary results from YA (n=25, mean age 23.2±4.5 years, 12 female), MA (n=20, mean age 56.8±4.2 years, 13 female) and OA (n=10, mean age 71.8±4.4 years, 4 female) indicate no age-dependent difference in PFC activity. However, there is a condition effect ($p < 0.001$) such that walking with obstacle navigation has the highest level of PFC activation. No sex differences are present. All groups decreased gait velocity and cadence and increased kinematic variability with the introduction of obstacles and distraction.Conclusions: Middle-aged adults are an understudied population in balance and mobility research with unidentified neurophysiological mechanisms and behavioural compensations. This knowledge gap

requires investigation to inform fundamental understanding of the aging brain. At this preliminary stage, these data indicate that there are no differences in brain activity across groups in spite of behavioural differences across conditions. Funding: Funding from NSERC, VISTA, and Connected Minds.

P01-C-23 - From resting-state to movement: The role of cortical networks in Parkinsonian gait

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Gait impairments in Parkinson's disease (PD) arise from disruptions in automatic motor control, requiring compensatory engagement of cortical networks. This study compared resting-state functional connectivity in specific cortical regions (frontal, central, parietal, occipital, and temporal) between people with PD and healthy individuals and explored its potential association with multidimensional gait domains. Twenty individuals with PD and 19 healthy controls participated. Resting-state electroencephalography was recorded, and functional connectivity was analyzed using local efficiency measures. Spatiotemporal gait parameters were assessed to calculate scores for five gait domains. Spearman correlations were used to evaluate the association between regional connectivity and gait domains. Individuals with PD exhibited reduced functional connectivity in frontal and central regions compared to healthy controls. Connectivity in the frontal region significantly correlated with the pace domain in PD, highlighting its role in compensatory mechanisms for maintaining gait speed. In healthy controls, broader correlations were observed: parietal and occipital connectivity were associated with pace and rhythm, suggesting more integrated and adaptive network functionality. Current findings highlight the distinct roles of cortical regions in regulating gait domains and the compensatory mechanisms employed in PD. The findings underscore the potential for using connectivity-based biomarkers to identify gait impairments and guide targeted interventions, such as neuromodulation and rehabilitation, to enhance mobility and quality of life for individuals with PD. Future research should focus on longitudinal designs and task-based paradigms to capture dynamic changes in cortical connectivity during gait. This research was supported by the São Paulo Research Foundation (FAPESP) [2014/22308-0; 2017/19845-1], and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior—Brasil (CAPES)—Finance Code 001.

P01-C-24 - Gait-specific attentional profiles of older adults potentially identify adaptive and maladaptive use of conscious movement processing

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Background and aim: The mechanism underlying cognitive-emotional influences on fall risk among older adults is unclear. Concern about falling (CAF) in older adults is

associated with multiple adverse outcomes and is an independent predictor of future fall-risk. CAF is accompanied by conscious movement processing during gait, increased gait-related (somatic) anxiety, ruminations and processing inefficiencies. These factors can be quantified using the Gait-Specific Attentional Profile (G-SAP), a questionnaire which evaluates the cognitive and emotional factors associated with walking, but the extent to which they vary among older adults, as well as with personal characteristics, is unknown. Particularly, conscious movement processing may be used by some older adults as an adaptive strategy mitigating fall risk, while it may be associated with increased attentional cost and other adverse outcomes in others. Therefore, the aim of the current study was to characterize phenotypes of gait-specific attentional profiles in older adults, using a Hebrew version of G-SAP (G-SAP-H). Methods: The G-SAP was forward-backward translated to Hebrew (forming G-SAP-H) while maintaining conceptual equivalence. Then, N=131 older adults (median age 75y; 67.9% females) completed the G-SAP-H, along with measures of trait anxiety, balance confidence and fall risk. Internal consistency was evaluated using Cronbach's alpha, validity was assessed using spearman's correlations. Cluster analysis was used to form phenotypes of gait-specific attentional profiles, and MANOVA and ANOVA models were used to assess characteristics of these groups. Results: G-SAP-H was internally consistent (alpha>0.6 for all sub-scales) and demonstrated moderate-strong correlations with fall risk, balance confidence and trait anxiety (r range: 0.31-0.67; $p<0.01$). The cluster analysis model divided the sample into 3 clusters (low-stress: n=77, 58.8%; high-anxiety: n=38, 29.0%; movement-focused: n=16, 12.2%). The three clusters varied in the four G-SAP-H sub-domains ($F(8,250)=60.6, p<0.001$). Compared with the other clusters, the movement-focused cluster demonstrated the highest level of conscious movement processing, with high balance confidence and low anxiety. Finally, clusters varied in terms of fall risk, balance confidence and trait anxiety as well ($F(6,252)=20.6$, $p<0.001$). Specifically, results demonstrated that members of the movement-focused cluster had balance self-efficacy and anxiety which were similar to those of the low-stress group, but their fall risk was higher than that of the low-stress group, and lower than that of the high-anxiety group (Figure 1). Conclusions: G-SAP-H is internally-consistent and valid. The phenotypes of older adults identified support the framework of the perceived control model of falling by suggesting that for some older adults, conscious movement processing may be an adaptive strategy contributing to decreased anxiety and improved balance confidence. Future work is needed to accurately identify older adults in this group, as well as to evaluate fall risk prospectively and determine whether group classification may change over time.

P01-C-25 - Cortical activity and step accuracy during visually cued gait in older adult fallers

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Background & Aim:Gait requires visually guided step adjustments to safely negotiate the environment. Unfortunately, older adults (OAs) make inaccurate step adjustments, which are a leading cause of falls. During obstacle avoidance, OAs exhibit elevated prefrontal cortex (PFC) activity, suggesting cognitive compensation to support step adjustments. Higher PFC activity during complex gait predicts falls in OAs. The posterior parietal cortex (PPC) is implicated in visually cued gait control, but the PPC's role in fall risk is poorly understood. The aim of this preliminary study was to compare step accuracy, as well as PFC and PPC activity in OA non-fallers and fallers during visually cued (VC) and perturbed visually cued (VCP) gait. We hypothesized that step accuracy would be worse, and that PFC and PPC activity would be greater in fallers than non-fallers in both conditions.Methods:Nine OA non-fallers (70.0±3.4yrs, 6F) and 4 OA fallers (69.8±3.8yrs, 2F) completed two 3-minute treadmill gait conditions at preferred speed: VC and VCP gait. Fallers reported ≥1 fall within 1 year of their visit. Projected stepping targets were used, attuned to participants' foot size, step length, step width, and gait speed. During VCP gait, perturbed targets randomly moved in the anterior-posterior or lateral direction upon coming within 130% of step length from the participant. Step error was calculated as the distance between the center of the foot and the center of a stepping target at midstance. Functional near-infrared spectroscopy quantified relative concentration changes in deoxygenated and oxygenated hemoglobin (ΔHbO2) for the PFC and PPC. Two-way mixed ANOVAs tested for group and condition effects, followed by post-hoc t-tests within each condition. Cohen's d effect sizes were calculated for group comparisons.Results:Step error was greater during VCP gait than VC gait. ($p<0.001$). During VCP gait, a large step error effect ($d=0.96$) was observed between non-fallers (48.1±14.8mm) and fallers (60.8±7.4mm), and a large effect ($d=1.13$) was observed in the PFC ΔHbO2 difference between non-fallers (0.20±0.29μM) and fallers (-0.11±0.22μM). PPC ΔHbO2 group differences demonstrated a small effect ($d=0.42$) during VCP gait (non-fallers, -0.12±0.23μM; fallers, -0.27±0.58μM) and a medium effect ($d=0.50$) during VC gait (non-fallers, -0.02±0.17μM; fallers, 0.15±0.65μM).Conclusion:These preliminary findings suggest that OA fallers have poorer step accuracy than non-fallers, underscoring increased fall risk. Reduced PFC activity among fallers may suggest an inability to deploy cognitive compensation to support step adjustments. That PPC activity was higher in fallers during VC gait, but lower during VCP gait, suggests fallers may disengage in response to the higher visuospatial processing demands of VCP gait, contributing to worse stepping performance. Extending these findings with a larger faller group is necessary to draw more definitive conclusions.Funding:NIA R21AG075489

P01-C-26 - Dual-task cost to gait speed may reflect cognitive reserve in older adults

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Background: Cognitive reserve (CR) is defined as the ability to maintain better-than-expected cognitive performance relative to one's age or level of brain pathology, and is often quantified by achieved educational level and lifetime involvement in cognitive stimulating activities. The dual-task cost (i.e., decrement) to gait speed—observed when an individual is walking and becomes engaged in an additional cognitive task—reflects the ability of an individual to effectively allocate available brain resources to maintain task performance under increased demands on the locomotor control system. We therefore hypothesized that the DTC to gait speed may serve as an objective and functional surrogate of CR in older adults. Methods: Baseline data were analyzed from a clinical trial of noninvasive brain stimulation targeting ambulatory adults aged≥65 years who presented without dementia, yet who exhibited mild-to-moderate impairments in both physical and executive function as defined by a Short Physical Performance Battery score≤10 and a Trail Making Tests B score≤75th percentile of age- and education-matched norms. CR was assessed by the validated CR Index Questionnaire, which focuses on lifetime education and life-long cognitive, social and physical engagement. Gait was assessed under 'normal' quiet walking at preferred speed, and during simultaneous execution of verbalized serial subtractions of 3s from a random 3-digit number. The dual-task cost to gait speed was defined as the percent change in gait speed between normal and dual-task conditions. Results: Data from 71 participants (aged 76±6 years; 43 females; BMI 29±6 kg/m2; Montreal Cognitive Assessment (MoCA) total score 25±3) were included. The DTC to gait speed was 12.1±8.6% (normal gait speed: 0.95±0.18 m/s m/s; dual-task gait speed: 0.83±0.18 m/s). Regression analyses adjusted for age and BMI revealed that individuals with higher CR exhibited lower dual-task cost to gait speed (r=-0.27, p=0.029) (Fig. 1). This relationship remained significant when the model was further adjusted for individual variance in global cognitive function as measured by the MoCA (r=-0.26, p=0.032), or executive function as induced by the adjusted Trail Making Test performance (Test B-A) (r=-0.28, p=0.026). In contrast, CR was not correlated with gait speed derived from either of the separate walking conditions. Conclusions: Our results indicate that in older adults with mild-to-moderate functional limitations, a relationship exists between dual-task cost to gait speed and CR, that is independent of global cognitive function, including executive function specifically. One's ability to maintain walking performance when dual-tasking may reflect CR in this population. Future research is warranted to determine if the observed relationship generalizes to older adults without functional limitations, and to identify the characteristics of brain function shared by dual-task cost to walking and one's level of cognitive reserve.

P01-C-27 - Gait speed but not stride variability is associated with cognition during midlife

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Background and aimsIn older adults, impairment in gait domains such as speed and variability, is associated with falls, cognitive decline, and dementia. However, longitudinal changes in these gait domains are not yet fully understood. Reduced gait speed could reflect early neural inefficiencies or compensatory mechanisms in the prefrontal cortex and related networks. In contrast, gait variability, often considered a marker of motor control and stability, may remain stable until more advanced neural and musculoskeletal impairments emerge. Nonetheless, the dynamics of changes in gait variables and their links to cognition during midlife—a critical period for understanding the aging process—have yet to be fully described. Thus, this study aimed to examine the association between cognitive function and gait characteristics in healthy midlife adults.MethodsA cross-sectional study with healthy midlife adults. Gait indices (walking speed and stride length covariance) were measured using APDM Mobility lab in a one-minute single-task walk. Cognitive capacity was measured using the Trail Making Test (TMT) and the Color-Word Stroop Test (CWST).ResultsA total of 95 participants (age 45.6±0.7, 48% women) were included in this analysis; bivariate correlation tests revealed a significant positive association between TMT, CWST and gait speed (TMTa: $r=-0.23$, $p=0.03$; TMTb: $r=-0.27$, $p<0.01$; CWST1: $r=0.30$, $p<0.01$; CWST2: $r=0.26$, $p=0.01$). No significant relationships were found between gait stride length covariance and the cognitive tests. After controlling for age and education within a linear regression model, only CWST result was associated with gait speed ($b=0.31$, $p=0.004$).ConclusionsThis study demonstrates that gait speed, but not gait variability, is associated with cognitive performance as early as midlife. These findings raise important questions about the distinct underlying mechanisms driving changes in gait speed versus variability and their implications for cognitive function. Midlife offers a unique opportunity to study these interactions, paving the way for interventions to mitigate cognitive and motor decline. Further research is needed to delineate the mechanisms linking gait variables to cognition, and to identify the critical periods when these changes begin to manifest.Acknowledgments and FundingAll authors declare that they have no competing interests; the study was supported by NIH [R01HL088884], the Israeli Science Foundation grant [1065/16], and the Israel National Institute for Health Policy Research [2018/202].

P01-C-28 - An open-source, externally validated neural network algorithm to recognize the daily-life gait of older adults based on lower-back sensors

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Background: Accurate gait recognition from daily physical activities is a critical first step for further fall risk assessment and rehabilitation monitoring based on inertial sensors. However, most models are based on healthy young adults ambulating in structured conditions. Objective: This study aimed to develop an open-source and externally validated algorithm of daily-life gait recognition for older adults. The effects of the amount of data channels and data augmentation on model performance will also be explored. Methods: A convolutional neural network was trained for gait recognition. The data for model training was lower-back sensor data from 20 older adults (mean age 76 years old), with annotated synchronized activity labels in semi-structured and daily-life conditions. The data was randomly split into training, validation, and testing datasets by participants, and the model was trained multiple times using these different splits. The model was trained based on data from six channels (accelerations and angular velocities) and three channels (accelerations) under conditions with and without data augmentation, respectively. External validation was evaluated based on lower-back sensor data collected from 47 stroke survivors (mean age 72.3 years old) in balance and walking tests. Results: For the testing dataset, the median accuracy ranged from 94% to 98%, precision from 63% to 85%, sensitivity from 95% to 97%, F1-score from 76% to 90%, and specificity from 94% to 98%. For the external validation dataset, the median accuracy ranged from 97 to 100%, precision from 99.9% to 100%, sensitivity from 73% to 100%, F1-score from 85% to 100%, and specificity 100%. Data augmentation had limited influence on the performance of the 6-channel model, and the 3-channel model with data augmentation performed comparably. In contrast, the 3-channel model without data augmentation exhibited the poorest sensitivity and F1-score. Conclusions: We provide an accurate, open-source, and externally validated daily-life gait recognition algorithm for older adults based on lower–back-worn inertial sensor data. When the sample size is limited for model training, we suggest adding angular velocities data and using data augmentation as the second choice.

P01-C-29 - Closing the gap: Accurate gait speed estimation from wrist-worn accelerometer in older adults using self-supervised learning

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BACKGROUND AND AIM: Gait speed, often considered the “sixth vital sign”, plays a crucial role in assessing mobility and predicting age-related health outcomes. Wearable technology advancements have enabled remote gait speed monitoring in real-world settings. Traditionally, lower back or lower extremity accelerometers were preferred due to their accuracy in capturing walking patterns. However, these placements may be unpractical and uncomfortable, reducing compliance in large-scale studies. Wrist-worn accelerometers, commonly found in smartwatches, present a practical alternative but have struggled to capture detailed gait metrics due to the complexity of wrist signals.Previous efforts to estimate gait speed from wrist-worn accelerometers have focused on healthy young adults in controlled environments, limiting usefulness for older populations or those with gait impairments. A key challenge has been the reliance on supervised machine learning models, which require extensive labeled data that is difficult to obtain in real-life conditions.METHODS: To address this, we extended our ElderNet model, which leverages self-supervised learning. ElderNet was pre-trained on the UK Biobank dataset (containing one-week wrist accelerometer data from over 100,000 participants) and fine-tuned on labeled data from the Mobilise-D study. The Mobilise-D dataset includes 85 participants, with conditions such as Parkinson's disease, proximal femoral fracture, chronic obstructive pulmonary disease, congestive heart failure, multiple sclerosis, as well as healthy older adults. In this study, we extended and trained ElderNet for a new application: estimating daily living gait speed.RESULTS: We trained and tested the model using an 80-20 data split. On the test set, ElderNet achieved a mean absolute error (MAE) of 9.6 cm/s, an R^2 of 0.84, and an ICC(2,1) of 0.91. External validation with 11 healthy young adults showed similar performance (MAE = 8.3 cm/s, R^2 = 0.82, ICC(2,1) = 0.92), demonstrating the model's robustness (Fig. 1). ElderNet outperformed the current state-of-the-art model and achieved a lower MAE compared to a lower-back-based algorithm tested on the same cohort (10 cm/s).Construct validity tests further supported ElderNet’s sensitivity to clinically meaningful gait differences. Using data from the RUSH Memory and Aging Project (around 1,000 participants wearing wrist accelerometers for 10 days), ElderNet successfully detected lower median gait speeds in participants with mobility disabilities and parkinsonism (both $p < 0.001$).CONCLUSIONS: These findings highlight ElderNet's potential as a reliable tool for daily living gait speed assessment, particularly in older adults. By matching the accuracy of traditional lower-back-based methods, it bridges the gap for the use of wrist-worn sensors. This advancement may improve multi-day mobility monitoring for clinical studies and for routine health monitoring in aging adults.

P01-D-30 - Lateralized modulation of cortical beta power during human gait is related to arm swing

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Background and aimHuman gait is a complex behavior requiring dynamic control of upper and lower extremities that is accompanied by cortical activity in multiple brain areas. Gait phase-dependent modulations of cortical neural activity have been shown in several electroencephalography (EEG) studies. However, how neural activity at different frequencies in different brain areas contributes to the activation of upper and lower limb muscles at specific times in the gait cycle is not fully understood. Our aim was to investigate the contribution of beta (15-30 Hz) and gamma (30-50 Hz) band EEG activity to arm swing movement during the gait cycle. MethodsTwelve healthy young adults walked on an instrumented treadmill in two conditions: (1) with arms swinging normally and (2) with arms crossed across the chest. 64-channel EEG was recorded together with EMG, ground reaction forces, and full-body kinematics. At EEG sensor level, event-related time-frequency spectra were computed with respect to the moment of right heel strike, and time-normalized across the gait cycle. Cortical sources of beta and gamma band activity were then reconstructed using dynamical imaging of coherence sources (DICS) beamforming, contrasting the early double support and swing phases, and the moments before and after heel strike. ResultsResults revealed a clear pattern of event-related desynchronization in the swing phase and event-related synchronization in the double support phase of each leg in both walking with and without arm swing, in particular in the beta band. These modulations source-localized to the sensorimotor cortex ipsilateral, but not contralateral, to the leading leg when walking with arm swing. The lateralization disappeared in the condition with constrained arms, together with an increase of activity in bilateral supplementary motor areas. By contrast, gamma band modulations that localized to the presumed leg area of sensorimotor cortex around the heel strike events were unaffected by arm movement. ConclusionsOur findings demonstrate that arm swing is accompanied by considerable cortical activation that should not be neglected in gait-related neuroimaging studies. Acknowledgements and fundingThis project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 Research and Innovation Program ("Learn2Walk"; grant agreement no. 715945) and the Dutch Organization for Scientific Research (NWO) VIDI grant ("FirSTeps"; grant agreement no. 016.156.346).

P01-D-31 - Is perception of postural instability impaired in people with Parkinson's disease?

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Background and aim: In people with Parkinson's disease (PwPD), postural instability (PI), especially in the backward direction, is a common and debilitating symptom. Their reactive stepping responses to balance perturbations are often underscaled, and sometimes even completely absent, increasing fall risk. While PD-related hypokinesia and its underlying mechanisms are well-documented, it can only partly explain these deficits. We examined the role of impaired estimation of perturbation impact on stability (i.e. instability perception) as an alternative mechanism. Previous findings suggest that midfrontal theta dynamics (3–8 Hz) play a crucial role in monitoring postural stability. This study investigated midfrontal theta dynamics during reactive balance control in PwPD and healthy controls (HC), and tested the hypothesis that the relationship between perceived and actual instability differs between groups.Methods: To assess cortical dynamics during postural instability, high-density EEG (126 channels) and kinematic data (8-camera 3D motion capture) were recorded from 11 PwPD (64.1 ± 5.2 years) and 15 HC (65.2 ± 5.6 years) during 90 low-intensity forward perturbations (0.5 m/s^2), evoking a feet-in-place (FiP) strategy. We reconstructed midfrontal activity using Independent Component Analysis and source localization. Theta peak power was extracted per trial in a 100 ms window around the individual N1 latency using the Hilbert transform. Biomechanical outcomes included the instantaneous (i.e. at theta peak power latency) and minimal Margin of Stability (MoS). Single-trial data were synchronized and analyzed with linear mixed-effects (LME) models including random slopes per subject if they improved model fit.Results: PwPD showed lower MoS than HC, with significant reduction of 2.12 cm at theta peak latency, whereas no between-group differences were found in theta peak power or minimal MoS. LME analysis showed a negative relationship between theta power and stability, with higher theta power linked to lower MoS values ($p<0.001$). Moreover, PwPD showed significantly lower theta power compared to HC at similar instability levels for both instantaneous ($p=0.016$, random slopes) and minimal MoS ($p=0.022$, fixed slopes). Both models explained substantial variance (minimal MoS: $R^2=0.665$; instantaneous MoS: $R^2=0.773$), but the minimal MoS model was more consistent across subjects, as it used fixed slopes.Conclusions: These findings suggest that midfrontal theta dynamics reflect not only current but also impending instability, supporting their role in monitoring stability relative to an internal model. In PwPD, the relative reduction in theta activity may reflect a diminished perception of instability, which may explain the inadequate balance reactions observed in daily life. Future studies should investigate theta dynamics under more destabilizing conditions to further explain the impaired instability perception in backward stepping deficits in PD.

P01-D-32 - EEGManySteps: Investigating the influence of gait on EEG recordings

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BACKGROUND AND AIMUnderstanding the neural mechanisms underlying human gait is crucial for advancing rehabilitation and mobility research. EEGManySteps is an international collaborative initiative designed to investigate the influence of gait on EEG recordings. This project directly addresses the challenges of variability in gait-related EEG research due to diverse experimental conditions and data processing choices. By pooling archival and newly acquired EEG data from laboratories worldwide, we aim to establish robust benchmarks for studying brain dynamics during walking.METHODSThe EEGManySteps project is structured into distinct Work Packages (WPs) to achieve its goals. WP1: Acquisition Protocols focuses on identifying and accessing existing datasets. WP2: Data Collection is responsible for designing a standardized protocol for simultaneous EEG recording during walking and a secondary cognitive task. WP3: Data Curation standardizes all datasets into BIDS format to ensure consistent gait event extraction and analysis. WP4: Analysis develops pipelines to analyze EEG dynamics during walking and cognitive task performance, enabling cross-laboratory comparisons. WP5: Dissemination handles paper writing, tutorials, and workshops. The project also has a steering committee and an advisory board.RESULTSThe primary goals of

EEGManySteps are to: 1) analyze step-specific time-frequency patterns by deriving gait events from multiple datasets and parameterizing potential influencing factors; 2) characterize gait artifacts across different systems by assessing signal quality during gait; 3) compare the influence of various preprocessing pipelines on gait-related spectral perturbations (GRSP) and event-related potentials (ERP) across multiple hardware setups; and 4) investigate gait-related modulation of secondary task correlates, replicating often-reported modulations of EEG dynamics during walking. In the context of this large-scale collaborative effort, the establishment of these outcomes is a significant achievement. The articulation and achievement of these goals constitute tangible results that advance the field, even before the specific EEG findings are fully analyzed and published.CONCLUSIONSEEGManySteps promotes Open Science and reproducibility by ensuring research materials, including datasets and software, are publicly accessible and well-documented. This collaborative effort aims to enhance the consistency and reliability of gait-related EEG research, hopefully improving the interpretability of results for future gait related EEG research.ACKNOWLEDGEMENTS AND FUNDINGWe thank the Steering Committee for their guidance and leadership. The Advisory Board has provided invaluable support and feedback.

P01-D-33 - Cortical markers of balance perturbations occur irrespective of the balance task

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Affiliations: Department of Neuroscience, Erasmus University Medical Centre, Rotterdam, The NetherlandsBackground: Human standing balance relies primarily on subcortical mechanisms to monitor and adjust the body's position in space. However, when necessary, cortical processes may also be engaged to refine control or adapt to changes in postural demands, particularly during external perturbations to balance. Two cortical markers—the balance N1 and midfrontal theta-band activity—are thought to reflect cortical engagement in executing reactive balance responses. For example, N1 amplitudes are higher for stepping than feet-in-place adjustments, and theta activity is thought to reflect the continuous evaluation of postural stability. This study evaluated whether balance N1 and theta activity, assumed to reflect the cortical processes underlying the active control of balance, actually depend on the engagement in a balance task.Methods: In Experiment 1, we used a robotic balance simulator to deliver support surface rotations unpredictable in timing and direction (i.e. toes-up or toes-down) during active (Balance Control) and passive (No-Control) conditions of standing. In the No-Control condition, participants passively experienced the replication of the perturbation and whole-body motion recorded from Balance Control trials. In Experiment 2, we systematically manipulated sensory and motor signals to examine their influence on cortical responses. Participants experienced support surface rotations in isolation or

together with whole-body motion (sensory signals) and produced isometric forces matching their balance load or remained relaxed (motor signals). EEG was recorded to quantify cortical responses to perturbations, and EMG was recorded from lower leg muscles to assess if cortical responses predict balance correcting muscle activity.Results: In Experiment 1, balance N1 amplitudes decreased slightly (~10%) and theta activity remained unchanged in the No-Control relative to the Balance Control condition, indicating that these cortical markers persist with limited variation even in absence of active balance engagement. This similarity in cortical responses occurred despite marked EMG decreases, suggesting that the cortical markers do not directly drive execution of reactive balance responses. In Experiment 2, balance N1 and theta activity were unaffected by motor signals but increased when sensory signals were limited to support surface rotations. This was surprising, given that these conditions least resembled balance, with participants' whole-body fully immobilized.Conclusions: These results challenge the assumption that active balance engagement or the continuous evaluation of postural stability through sensory or motor signals is necessary to elicit the N1 and midfrontal theta. They also refute the idea that cortical activity can be inferred solely from muscle activation patterns. Future studies are required to identify mechanisms by which the balance N1 may initiate or modulate motor responses during balance corrections.Acknowledgments and funding: This work was funded by the Dutch Research Council (NWO, VI.Vidi.203.066).

P01-E-34 - An AI-driven wearable approach to monitor speed and dynamic balance during dual-task walking for early detection of mild cognitive impairment in community-dwelling older people

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BACKGROUND AND AIMMild Cognitive Impairment (MCI) is a transitional stage between soundness of mind and dementia, affecting over 15% of older adults globally. Current diagnostic methods, such as neuropsychological tests and imaging, are impractical for rapid community screening. Older adults with MCI were found to exhibit altered gait speed and motion of the body's centre of mass (COM) relative to the centre of pressure (COP) during dual-task (DT) walking, suggesting these gait variables could be used to identify MCI. However, the screening accuracy of using these variables as biomarkers remains unclear; moreover, measuring them outside controlled laboratory environments is challenging. Recent advances in wearable technologies, namely inertial sensors (IMUs) integrated with artificial intelligence (AI), offer promising solutions for accurately capturing gait data and enabling further diagnosis in community settings. Thus, this study aims to develop and validate a novel AI-based approach to identifying MCI in older adults by monitoring gait speed and dynamic balance during DT walking using a single waist-worn IMU. METHODSTwenty-two patients with MCI and 22 healthy older adults were

recruited from the community. In each trial, participants wore a waist-mounted IMU and completed two consecutive 10-meter walk tests at their preferred speed: single-task (ST) walking and motor-cognitive DT with an arithmetic task. An artificial neural network model was developed to identify MCI by estimating gait speed and dynamic balance from single-trial IMU data. Dynamic balance was quantified using COM-COP inclination angles (IAs) and their rates of change (RCIAs). The model was pre-trained on 2,532 gait trials under various conditions from 48 subjects in previous studies conducted in a standardised gait laboratory, and fine-tuned on 274 trials from the current study. A leave-one-subject-out cross-validation approach was applied to evaluate model performance. Model accuracy in predicting gait speed and IA-related variables was assessed using relative root-mean-square errors (rRMSE), while its ability to detect MCI was evaluated via accuracy, sensitivity, and specificity. RESULTSThe proposed approach showed low prediction errors for speed and balance variables, with mean rRMSEs for the model-predicted speed, IA, and RCIA being 3.3%, 3.5%, and 4.1%, respectively. It also showed great performance in identifying MCI, achieving accuracy, sensitivity, and specificity of 91%, 95%, and 86%, respectively. CONCLUSIONSThis study demonstrates the feasibility of detecting MCI in older adults by assessing speed and dynamic balance during DT walking using an IMU with AI techniques. By considering gait speed and balance variables as biomarkers, the proposed approach offers a simple, accurate, and wearable method for early screening of older individuals at risk for dementia. ACKNOWLEDGEMENTS AND FUNDINGThis study was funded by the Ministry of Science and Technology in Taiwan.

P01-E-35 - Building physical resilience in older adults with mild cognitive impairment

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Background and Aim: Mild cognitive impairment (MCI) is among the most prevalent geriatric condition. It is associated with decline in cognitive function, physical function, brain health, and greater risk for dementia. Physical reserve is a recent construct of resilience that quantifies the ability of an individual's brain to actively maintain one's physical function in spite of aging- or disease-related deteriorations. Recent evidence demonstrated that greater reserve protects against falls and mitigates postural instability secondary to white matter lesions. These findings suggest enhancing physical reserve is critical towards promoting health of older individuals with MCI. To-date, how and if physical reserve can be enhanced remains equivocal. Thus, this study aimed to examine the effects of different types of physical exercise on physical reserve, and to investigate the potential underlying neural mechanism.Methods: This was a secondary analysis of a 6-month, 2x2 factorial randomized controlled trial comprised of a subset of 41 older adults with MCI who completed the intervention as well as MRI scanning at study baseline and endpoint. Study participants were randomized to one of four groups: (1) 4x

per week balance and tone (n=8; BAT); (2) 2x per week aerobic training (n=10; AT) + 2x per week BAT; (3) 2x per week resistance training (n=10; RT) + 2x per week BAT; (4) 2x per week AT + 2x per week RT (n=13). Comprehensive neuropsychological battery and mobility assessments were completed at baseline and endpoint. Changes in cognitive and physical function were calculated as endpoint - baseline performance. We quantified physical reserve as the unexplained variance in 30 second Sit-to-Stand test adjusted for age, ADAS-Cog-Plus, hippocampal volume, and intracranial volume. Brain networks of physical reserve were identified via functional network mapping using the resting-state fMRI. Analysis of covariance models were used to assess group differences in changes in physical reserve (adjusted for baseline physical reserve capacity), and changes in brain network connectivity (adjusted for number of functional comorbidities, ADAS-Cog-Plus, and baseline network connectivity). Results: After adjusting for baseline physical reserve, relative to the BAT group: (1) AT+BAT group showed significant improvement in physical reserve (p=0.05); (2) RT+BAT group showed trend level improvement in physical reserve (p=0.07); (3) AT+RT group showed greatest improvement in physical reserve (p<0.01). At trial endpoint, only the AT+RT group showed significant association between increased physical reserve and better Trail Making Test score (r=-0.63, p=0.01). Additionally, there was a significant association between increased physical reserve and better Short Physical Performance Battery score (r=0.57, p=0.03; SPPB) only for the AT+RT group. Compared with individuals with improved physical reserve, those who did not improve had greater PR at baseline. Results from physical reserve brain mapping showed that relative to individuals who exhibited improved physical reserve, those who did not improve PR had significant increase in Dorsal Attentional Network connectivity (p=0.04) after 6 months (Figure 1). Conclusion: Our findings provides insights into how exercise may build physical resilience in older adults with MCI, wherein the benefits of exercise may be related to altering the Dorsal Attention Network coupling patterns.

P01-E-36 - Spatio-temporal walking parameters as predictors of dementia subtypes

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Background and Aim: Dementia risk exponentially increases as individuals get older, with Alzheimer's disease (AD) subtype being the most prevalent. Accurate AD dementia diagnosis typically relies on costly biological biomarkers and extensive neuropsychological assessments often unfeasible in daily clinical practice due to limited resources and time constraints. Emerging evidence suggests that gait variability parameters may aid in identifying individuals with AD in the whole spectrum of cognitive decline. However, it remains unclear whether spatio-temporal gait parameters, including spatial and temporal variability, can differentiate non-AD (NAD) from AD only among individuals with dementia. It is also unclear whether adding a dual-task during gait assessments would improve identification capabilities of gait parameters, as a dual-task

can be a stressor of cognitive processes, especially executive functions, frequently more affected in individuals diagnosed with NAD. We hypothesize that gait parameters during single-task can accurately differentiate NAD from AD and that dual-task gait conditions would improve its accuracy. Methods: Data from the Gait and Brain Study included 484 participants aged 65 and older, of whom 57 had dementia (AD=42, 78.1±6.2 years (38.1% female); NAD=15, 78.9±6.4 years (53.3% female)). Gait parameters analyzed were speed, stride length variability (SLV), and stride time variability (STV) measured using a 6-meter electronic walkway (Zeno Walkway-Protokinetics) under single-task and cognitively demanding dual-task walking conditions (counting backward, serial 7s subtraction, and animal naming). Binomial logistic regression was employed to identify significant associations between gait parameters and dementia subtypes. Predictive capability of significant gait parameters associated with dementia subtypes were then assessed using Receiver Operating Characteristic (ROC) curves.Results: AD and NAD did not significantly differ in age, education, body mass index, grip strength, fall history, number of medications, and number of comorbidities ($p > 0.05$). Binomial regression analysis revealed significant associations between increased SLV and NAD, with AD as the reference group. This association was found in (single-task: OR = 1.773, 95% CI 1.173–2.680, p = 0.007); dual-task counting backward (OR = 1.433, 95% CI 1.082–1.897, p = 0.012); dual-task serial seven subtraction: (OR = 1.163, 95% CI 1.029–1.314, p = 0.015). ROC curve analysis revealed that only SLV could accurately and significantly identify individuals with NAD in single-task (AUC = 0.802, 95% CI0.635–0.968, p = 0.001, cutoff = 3.2%); counting backward (AUC = 0.700, 95% CI0.533–0.865, p = 0.027, cutoff = 4.3%); and serial 7s subtractions (AUC = 0.807, 95% CI 0.678–0.937, p = 0.001, cutoff = 3.5%). Other gait parameters were not significantly associated with dementia subtypes. Conclusions: Among all gait parameters assessed, only SLV accurately identified individuals with NAD under single-task. SLV in single and dual-task conditions had very similar discriminatory capabilities. Therefore, a dual-task does not add any clinically meaningful identification capability to SLV. These findings suggest that SLV, tested under either single-task or dual-task, may serve as a sensitive and clinically feasible marker of NAD.AcknowledgmentsSão Paulo Research Foundation (FAPESP), Brazil (Grant # 2024/07236-4). The Gait and Brain Study is funded by project grants from the Canadian Institutes for Health and Research (CIHR; MOP211220, PJT153100). FAPESP and CIHR played no role in the design, execution, analysis and interpretation of data, or writing of this study.

P01-E-37 - Investigating progression of gait in mild cognitive impairment subtypes

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Background and Aim: Mild cognitive impairment (MCI) refers to a transition state between healthy cognition and dementia. MCI consists of several subtypes, including single- and multi-domain (SD- and MD-) amnestic MCI (aMCI) and non-amnestic MCI (naMCI). aMCI most often advances to Alzheimer's disease (AD), while naMCI typically progresses to non-AD dementias1,2. Gait is impaired in dementia prior to diagnosis and is affected by dementia subtypes3,4,5. Previous research has identified gait differences between aMCI and naMCI, however, further research is needed to characterize patterns of gait progression in MCI subtypes6. Therefore, the aim of this study is to explore differences in gait progression between MCI subtypes over time.Methods: This study included 382 individuals with MCI (180 SD-aMCI, 48 SD-naMCI, 134 MD-aMCI, 20 MD-naMCI) from the Mayo Clinic Study of Aging and Alzheimer's Disease Research Center. We also included 382 age-, sex-, and education-matched healthy controls (HCs). Each participant walked at their normal pace without walking aids on a pressure sensor walkway. Gait outcomes included mean and variability of step time, step length, stride velocity, stride width, swing time, and double support (%). Linear mixed models were used to examine the effects of MCI subtype and time (median follow-up = 15.4 months) on gait outcomes, while adjusting for sex, age, education, height and follow-up duration.Results: We found interaction effects for step length ($p = 0.02$) and step time variability ($p = 0.01$), such that MD-aMCI and SD-naMCI subtypes demonstrated decreases in step length and increases in step time variability over time. MD-aMCI also exhibited decreases in step time over time ($p = 0.04$). Compared to HCs, all MCI subtypes had reduced stride velocity and step length, as well as increased step time, double support (%) and variability in step time and swing time ($p < 0.05$ for all). Finally, the MD-aMCI group alone demonstrated greater variability in step length ($p = 0.02$) and stride velocity ($p < 0.001$) than HCs across time points.Conclusions: Our findings demonstrate distinct progression patterns in gait impairment across MCI subtypes. The MD-aMCI subtype demonstrated the most pronounced gait deterioration, which suggests a link between multi-domain cognitive impairment and gait decline. It is surprising that gait progression deficits were not also found in the MD-naMCI group, however, this may reflect the heterogeneity of MCI, which can have various aetiologies that may influence gait differently. Overall, our findings highlight the potential utility of gait assessments in identifying individuals at high risk of dementia progression. Further longitudinal studies are needed to determine whether gait deficits predict progression to different dementia subtypes in individuals with MCI.Acknowledgments and Funding: The Mayo clinical cohort is funded by these NIH grants: UO1 AG006786 (MCSA), P30 AG062677 (ADRC), and U01 NS100620.

P01-F-38 - Behavioral indicators of kinesiophobia and pain representation in chronic low back pain: Preliminary results

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Background and aimLow back pain is one of the leading causes of disability (GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, 2018). When symptoms persist for more than three months, it's classified as chronic low-back pain (CLBP). Most people with CLBP have no identifiable cause and multiple contributors were identified (Hartvigsen et al., 2018). One of them is kinesiophobia, which contribute to the persistence of painful symptoms and disabilities (Duport et al., 2022). Kinesiophobia is usually assessed with questionnaires like the Tampa scale for kinesiophobia (Kori et al., 1990). But it is unknown if behavioral indicators of kinesiophobia can be measured in other ways than questionnaires in particular in CLBP.One way to assess behavioral response to emotional context is posturography. The main objective of this study is to compare the postural automatic responses to the mental simulation of everyday situations identified as painful in participants with non-specific CLBP and healthy volunteers.MethodsParticipants with non-specific CLBP and healthy matched volunteers were recruited to take part in an experimental session, during which participants were asked to stand still on a force plate and to perform a mental simulation task using pictures of daily living activities from the Phoda picture database. Pictures were chosen to form two levels of pain conditions suggesting either high pain (HP) or low pain (LP) in line with previous ratings of perceived pain level in other studies. Participants observed 6 blocks (3 HP, 3 LP) of 4 images. Each picture was shown for 12 seconds and preceded by a fixation cross.ResultsTo date, 17 subjects were recruited (8M, 9F, mean age 25±9), 9 in the CLBP group, 8 in the control group. Posturographic data are presented in Table 1. Using a two-way RM ANOVA, there is a significant effect of level of pain for COP-ML (F(1,15)=7.58, p=0.015) and for SD-COP-ML. (F(1,15)=7.16, p=0.017). There is no significant effect for group.Table 1: Posturographic data.GroupeCLBPCTRLConditionLPHPLPHPCOP-AP0.12 ± 1.090.54 ± 1.730.39 ± 1.390.34 ± 2.29SD-COP-AP3.36 ± 1.603.24 ± 0.843.30 ± 1.093.48 ± 1.57COP-MLa-0.11 ± 0.750.39 ± 0.60-0.13 ± 0.550.37 ± 0.36SD-COP-MLa1.68 ± 0.710.54 ± 0.181.67 ± 0.580.54 ± 0.19aSignificant effect for level of pain (high pain vs. low pain). With AP: antero-posterior; CLBP: chronic low back pain group, COP: center of pressure; CTRL: control group; HP: high pain; LP: low pain; ML: mediolateral and SD: standard deviation.ConclusionsThe fact that significant differences appear for the ML component could be explained by the nature of the stimulus, which involved imagining scenes with potential movement of the back. This is a potential cofounding factor, if postural response is more sensitive to mental imagery rather than to emotional response. This hypothesis needs to be verified by further studies. Enrollment is still ongoing and larger groups may provide additional information.

P01-F-39 - Examining the influence of movement reinvestment and affective disorders on gait behaviour in functional gait disorders

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Background and aim: Functional gait disorders (FGD), while common, pose diagnostic challenges due to their complex phenomenology. Patients present with abnormal movements during gait that appear sporadically, fluctuate in severity, and result in severe disability. Previous work found that individuals with FGD experience an excessive inward focus of attention. This movement reinvestment may contribute to symptom presentation, as distraction with a secondary task yields symptom improvement. Patients report greater movement reinvestment and affective symptoms compared to healthy controls, noting feelings like anxiety to be prominent symptom triggers. The current study aimed to explore how movement reinvestment and affective symptoms differ between FGD patients and matched controls, as well as understand the association between these qualities and gait performance when completing a secondary task and while under a threat of shock. Methods: To date, 11 FGD patients and 10 matched controls completed 11 walking trials on a pressure-sensor walkway. Trials consisted of a 6 m walk, 180 degree turn, and 6 m walk back to the start position. Participants walked normally (N), while completing a secondary task (DT), and while under a threat of shock (S). Internally-focused attention was quantified by the Movement-Specific Reinvestment Scale (MSRS). Conscious Movement Processing (CMP) subscale, Movement Self-Consciousness (MSC) subscale, and total MSRS scores were used. The Hospital Anxiety and Depression Scale (HADS) quantified affective symptoms. Gait variables of interest are step length, step width, step length variability, step width variability, and double support duration. Results: FGD patients scored higher on MSRS and HADS. No significant associations between MSRS and HADS scores in either group were found. Compared to N, decreased step width in patients during DT was associated with greater total MSRS ($p = 0.007$, $tau = -0.67$) and MSC scores ($p = 0.009$, $tau = -0.66$). Increased velocity in patients during DT was associated with greater CMP scores ($p = 0.04$, $tau = 0.54$). Compared to N, decreased step width variability in patients during S was associated with greater total MSRS scores ($p = 0.046$, $tau = -0.54$). Similarly, decreased step width variability in controls during S was associated with greater total MSRS ($p = 0.046$, $tau = -0.54$) and CMP scores ($p = 0.04$, $tau = -0.55$). Conclusion: FGD patients show clear attentional and affective disturbance. Improvement in gait behaviour when completing a secondary task points to the involvement of movement reinvestment in FGD symptomology. Rather than inducing anxiety, the threat of shock may have served as a secondary task, as patients also showed improved gait when shock was present. Future work should further investigate movement reinvestment and the threat of shock to parse out their impact on movement in FGD. Acknowledgements and Funding: Natural Sciences and Engineering Research Council of Canada (NSERC)

P01-F-40 - Better global cognition, slow processing speed, slow gait, and poor functional strength predict high concerns about falling among older adults with poor mobility living in the community or residential care facilities

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Background and aim: Older adults with poor mobility often have concerns about or fear of falling (FoF), which places them at a higher risk for mental and physical health declines, as well as falls. Recent preliminary evidence indicates that poorer global cognition may be linked to FoF in healthy older adults; however, it is unclear if this relationship exists among older adults with poor mobility or the relationship between other domains of cognition and FoF. We aimed to identify predictors of high FoF among older adults with poor mobility. Methods: 85 adults ≥65 years who had self-reported poor mobility with no neurological conditions from the community and residential care facilities (low-to-moderate FoF: n=40, 77.6±7.3 years, 65.0% female; high FoF: n=45, 81.8±8.6 years, 53.3% female) participated. Participants reported demographic information and completed a battery of assessments: global cognition (Montreal Cognitive Assessment (MoCA)), set-shifting (Trail-Making Test B-A), immediate recall (Rey Auditory Verbal Learning Test Trial 5), processing speed (Digit Symbol Substitution Test), depression (Geriatric Depression Scale), perceived health status (Visual Analogue Scale), gait speed (over 4m), and functional strength (5x sit-to-stand). Participants reported their FoF using the 16-item Falls-Efficacy Scale-International (FES-I); we used previously defined cut-points to differentiate between participants with low-moderate concerns (FES-I: 16-27 points) and high concerns (FES-I: 28–64 points). A binary logistic regression was performed to determine the predictors of high FoF. We controlled for age, sex, and education. All independent variables had a variance inflation factor of <2.0 and were correlated with FoF. Results: The model's classification accuracy was 88.9% ($\chi 2(8)=65.80$; $R2=0.56$, $p<0.001$). The predictors of high FoF were: better MoCA score [OR=1.86, CI=1.17,2.94], greater depression [OR=4.48, CI=1.68,11.92], slower gait speed [OR=0.001, CI=<0.001,0.09], poorer 5x sit-to-stand score [OR=0.41; CI=0.20,0.86], with a trend for lower DSST [OR=0.92; CI=0.84,1.01, p=0.08]. Conclusions: This is the first study to demonstrate that better global cognition paired with slower processing speed may contribute to high FoF. In contrast, previous work found that poorer global cognition was associated with FoF, but did not investigate processing speed. Better global cognition may be related to high FoF due to greater awareness of imminent postural threats paired with slow processing speed to promptly respond to these threats. We also confirm previous findings that depression, slow gait, and poor functional strength predict high FoF. Our findings may inform screening and monitoring procedures for older adults with poor mobility who have high FoF.Acknowledgments and Funding: This study was funded by an Augusta University and Georgia State University Clinical Translational Seed Grant (AUGSU00014).

P01-F-41 - The effects of mental fatigue on decision-making for collision avoidance

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Background: Changes to the internal state of the observer can influence the perception of affordances and subsequent decision-making. Mental fatigue (MF), caused by prolonged cognitive activity, impairs cognitive performance (Boksem & Tops, 2008). While physical fatigue has been found to slow response time (RT) during an aperture crossing task (Snyder & Cinelli, 2019), the effect of MF on collision avoidance remains underexplored. Our study aimed to determine whether MF impacts decision-making in a virtual reality (VR) collision avoidance task. We hypothesized that MF would slow RT and decrease accuracy during a crossing order task (COT).Methods: Twenty-six (14 males, 12 females) young adults ($\bar{x}$ = 20.6 ±1.2 years) were randomly assigned to either a MF or Control group. In a virtual environment (VE), participants walked toward a 90cm wide doorway while a virtual person (VP) approached from the opposite side. When the participants were 2m from the doorway, the screen went blank, and they were instructed to quickly and accurately indicate whether they would pass through the doorway before the VP. The VP approached at one of 4 speeds; 0.8, 0.9, 1.1, or 1.2x the participants' average walking speed. Participants completed 20 randomized trials followed by a 30-minute intervention: 1) Stroop task for the MF group; or 2) a documentary for the Control group. A Psychomotor Vigilance Task (PVT), measuring RT, was administered pre- and post-intervention to measure MF levels. Participants then completed 20 more COT trials. RT and accuracy were the primary outcome measures.Results: Mixed design ANOVAs were conducted to analyze PVT RT and COT RT and accuracy. Analysis of the PVT RT revealed a significant increase (p = .002, ηp^2 = .33) in the MF group (Pre: $\bar{x}$ = 0.31 ± 0.03s; Post: $\bar{x}$ = 0.35 ± 0.03s) compared to the Control group (Pre: $\bar{x}$ = 0.32 ± 0.02s; Post: $\bar{x}$ = 0.32 ± 0.02s). Analysis of the COT revealed a main effect of time (p = .03, ηp^2= .19), such that both groups exhibited faster RT pre- to post-intervention (Pre: $\bar{x}$ = 0.52 ± 0.24s; Post: $\bar{x}$ = 0.47 ± 0.21s) (Figure 1). Accuracy significantly improved (p < .001, ηp^2 = .48) from pre- to post-intervention for both groups (Pre: $\bar{x}$ = 88.4% ± 17.8%; Post: $\bar{x}$ = 95.0% ± 12.4%) (Figure 1). There was a significant main effect of speed condition on accuracy (p < .001 ηp^2 = .44), such that the 1.1x ($\bar{x}$ = 80.1% ± 22.3%) was the most difficult compared to all other conditions (0.8: $\bar{x}$ = 99% ± 5.4%; 0.9: $\bar{x}$ = 93.6% ± 11.9%; 1.2: $\bar{x}$ = 94% ± 11%) (Figure 1).Conclusion: Although MF was successfully induced, it did not impair COT performance (i.e., faster RT and improved accuracy over time). These improvements may be due to increased task familiarity or sensitivity to the approaching VP's gait cues. Overall, MF may not have fully saturated young adults' cognitive resources and did not impair their decision-making for collision avoidance in this context.Acknowledgments: This study was funded by NSERC.

P01-F-42 - Effects of prioritization of cognitive vs. motor tasks in anxiety-inducing virtual high elevations on gait performance

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Background and AimDaily activities require concurrent management of cognitive and motor demands in anxiety-inducing settings (walking and talking while street-crossing). Attentional Control Theory (ACT) suggests mobility-related anxiety places demands on attentional resources, leading to declines in cognitive and/or motor performance. Extemporaneous speech is a well-practiced cognitive task that does not compete with sensory input and bears social consequences that may encourage prioritizing cognition over locomotion in healthy adults, even with anxiety. The purpose of this study was to determine if prioritizing speech versus equally prioritizing gait and speech influenced cognitive-motor processes in anxiety-inducing settings. MethodsParticipants wore a wireless head-mounted display (HMD) and ankle trackers (HTC Vive, Bellevue, WA) showing a walkway (Unity 3D) matched to the real-world (0.4 x 5.2m). After familiarization, participants walked for one-minute in two settings: a low VR setting (ground level) followed by a high VR setting that induces anxiety (15m elevation). Participants selected 6 of 18 topics they could talk about and were randomly assigned a topic for each dual-task (DT) walk, the order of single (ST) vs. DT conditions were counterbalanced across participants, but they always walked at low before the high heights. Participants were randomized into two groups, the Equal group instructed to equally focus on walking and talking, and the Cognitive group instructed "don't pay attention to your walking performance, instead only focus on talking, making sure you are talking as much as possible...it doesn't matter what you say, just that you keep talking." Step speed was extracted from 3D tracker and HMD position. Linear mixed effects regression compared speeds between Group (2 levels: Equal (reference), Cognitive), Task (2 levels: ST (reference), DT), and Elevation (2 levels: Low (reference), High). Results Eighteen adults (11 women, mean (SD): age[years]=24.1(6.5), mass[kg]=78.9(13.2), height[cm]=169.2(11.9), Equal n=9, Cognitive n=9), were included. An interaction effect was detected for gait speed (p=.045); in the DT, the Equal group walked at slower speeds at low versus high height (p=.011), The Cognitive group did not change between low and high height in the DT (p=.498) (Fig. 1). There was no difference between low and high height for Cognitive (p=.110) or Equal groups (p=.705) in the ST.ConclusionAgreeing with ACT, experiencing mobility-related anxiety while walking and talking led to trade-offs in cognitive-motor function. The Equal group was unable to maintain focus equally, shifting to prioritizing gait performance under anxiety, evidenced by increased gait speed at high heights during the DT. The Cognitive group maintained DT gait in anxiety-inducing settings, perhaps using a compensatory strategy by focusing on speech. Future studies should examine cognitive costs and prioritization of the speech task in impaired groups.

P01-F-43 - The influence of reinvestment on visual-perceptual judgements of stair steepness

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Background/Aims Accurate perception of stair steepness plays a critical role in ensuring safe locomotion and interaction with the environment. Visual judgements of stair steepness, however, are often consciously overestimated, likely serving to minimise risk and conserve energy. While motor adaptations can compensate for perceptual biases, these overestimations may still influence behavioural responses and decisions during stair navigation. Reinvestment, defined as an individual's propensity to consciously monitor and control their movements, has been shown to disrupt automatic motor processes and may interfere with perceptual judgements. This study aimed to investigate whether individuals with high propensity for reinvestment exhibited altered visual-perceptual estimations of stair steepness under different conditions of cognitive load.MethodsPreliminary results include 22 participants out of a planned 40 (12 males; mean age = 26±4years). Participants first completed the Movement Specific Reinvestment Scale (MSRS),which assesses the propensity for conscious monitoring and control of movements. The MSRS comprises two subscales: Conscious Motor Processing, which reflects a tendency to consciously control movements, and Movements Self-Consciousness, which reflects the tendency to monitor movement style. Following completion of the MSRS, participants made visual-perceptual estimations of stair steepness from both the top and bottom of two staircases: a controlled laboratory staircase and a 'real-world' staircase. These estimations were performed under two conditions: a single-task condition, in which participants focused solely on estimating stair steepness, and a dual-task condition, in which participants completed a concurrent cognitive task involving counting backward in 3s.ResultsParticipants consistently overestimated the steepness of the laboratory staircase (34°) when making visual-perceptual judgements from both the top and the bottom of the staircase, and under both single- and dual-task conditions (all p's < .05). In contrast, no significant overestimation was observed for the 'real-world' staircase (38°) across any conditions (all p's> .05). Participants with a higher propensity for conscious motor processing (as measured by the MSRS) perceived the 'real-world' staircase to be steeper when viewing from the bottom under single-task conditions (p = .05). Scores on the Movement Self-consciousness subscale were not significantly associated with stair steepness estimations in any condition.ConclusionThese preliminary findings suggest that visual-perceptual overestimations of stair steepness are influenced by context, with overestimation occurring for the laboratory but not the real-world staircase. This discrepancy may be due to the laboratory staircase being 4°shallower, as overestimations are typically more pronounced for shallower stairs.Additionally, differences in familiarity, environmental cues, or perceived risk may contribute.Individuals with a higher propensity for conscious motor processing exhibited altered steepness estimations, particularly under single-task conditions, where cognitive resources may be more focused on perception, emphasizing the role of reinvestment in perceptual judgements. Future research should examine whether these altered perceptual judgements lead to changes in gait parameters that could potentially influence fall-risk when navigating the stairs.

P01-F-44 - Interactions between cognition, voluntary motor tasks, and postural control during a visuomotor dual-task

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Aim: Balancing while performing a secondary task is essential in daily life. However, the effects of concurrent cognitive or motor tasks on postural control are not fully understood. The aim of this study was to explore the dual-task effects of cognition and voluntary motor control on balance by observing postural stability and task performance under varying levels of cognitive and motor challenges. Methods: Healthy adults (n=9) stood on a motorized sway-referenced (SR) force plate with SR-gain set to 0 (fixed surface) or +2 while wearing a virtual reality (VR) head-mounted display (HMD). While balancing, subjects completed no task, Simon task with joystick, or Simon task with pointing. During the Simon task, an arrow was displayed in one of four quadrants (top, bottom, left, right) on the HMD screen with an arrow aiming one of four directions (up, down, left, right). Subjects indicated the direction the arrow was aiming (not the arrow's quadrant location) by using the joystick on the VR controller or by pointing their hand to that direction in VR space. Subjects completed 1 practice trial of each task while seated, followed by 1 trial in each of the 6 conditions in a random order. Arrows presented during the Simon task were congruent (e.g., a right-facing arrow displayed in the right quadrant) or incongruent (e.g., a right-facing arrow in the left quadrant). Varying cognitive difficulty within a condition provided a way to differentiate between cognitive or voluntary motor effects on posture. A repeated-measures ANOVA was used to compare center of pressure (CoP) sway area across 2 surface (fixed or SR+2) x 2 motor (joystick or pointing) x 2 cognitive (congruent or incongruent) conditions. Results: CoP sway area was significantly greater during Simon-pointing compared to Simon-joystick conditions ($F_{1,8}=26.0$, $p<0.001$), and significantly greater when incongruent arrows were presented than when congruent arrows were presented ($F_{1,8}=7.00$, $p=0.029$). As expected, the unstable SR+2 surface conditions showed significantly greater sway area than fixed surface conditions ($F_{1,8}=64.8$, $p<0.001$). Interestingly, a significant interaction effect was observed between surface, motor, and cognition levels ($F_{1,8}=5.91$, $p=0.041$). The more challenging cognitive task (incongruent arrows) only caused a significant increase in sway area during the more challenging surface and motor conditions (Fig. 1). There were no significant differences in accuracy on the Simon tasks between conditions. Conclusion: These results enhance our understanding of cognitive-motor interactions during postural control dual-tasks in healthy adults. These processes only interfered with balance under challenging complex conditions, despite cognitive performance being unaffected. Future studies should observe how these interactions change in older adults or clinical populations with balance deficits, which can inform effective balance training

or rehabilitation using dual-task paradigms. Acknowledgements: BSF# 2019222 & 2023319

P01-F-45 - Conscious and unconscious interoception shape the emotional influences on postural control

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Postural control relies on the integration of autonomic and somatic processes to maintain balance. Although emotional states—particularly arousal and valence—are known to modulate postural sway, findings across studies remain inconsistent. Interoception, defined as the perception of internal bodily signals, may help explain these variabilities. Two indices of interoception—heartbeat-evoked potentials (HEPs) and heartbeat counting accuracy (IAcc)— reflect unconscious and conscious processing of cardiac signals, respectively. This study investigated how these distinct facets of interoception mediate the effects of emotional arousal and valence on postural control.Twenty-one healthy male participants completed a resting-state standing task for HEPs measurements, followed by a heartbeat counting task (HCT) to assess IAcc. In the main experiment, participants stood on a force plate while viewing affective images from the International Affective Picture System (IAPS), presented in randomized blocks across two dimensions: High vs. Low Arousal and Pleasant vs. Unpleasant Valence. Electrodermal activity (EDA) was recorded as a physiological marker of arousal, and heart rate as an index of valence. Postural sway was assessed using center of pressure (COP) measures—standard deviation (SD) and mean velocity (MV) in the anterior-posterior (AP) and medial-lateral (ML) directions—analyzed via a two-way repeated-measures ANOVA (arousal × valence). Correlation analyses were conducted to link changes in COP variables with HEP amplitudes and IAcc scores.Subjective ratings (Self-Assessment Manikin) and physiological measures (EDA, heart rate) confirmed successful modulation of arousal and valence. Under higher arousal, mean velocity in both AP and ML directions decreased, suggesting decreased sway speed under emotionally arousing conditions. Correlations analysis showed that higher HEP amplitudes were positively associated with increased ML sway variability (SD) ($\rho = 0.481$, pFDR = 0.0389; Fig. A), while higher IAcc was associated with greater decreases in MV across both AP and ML directions when transitioning from low to high arousal (MV (AP): $\rho = –0.604$, pFDR = 0.0292; MV (ML): $\rho = –0.486$, pFDR = 0.0366; Fig. B &C).These results indicate that unconscious and conscious pathways of interoception differentially influence emotional effects on postural control. Unconscious interoceptive processing, indexed by HEPs, may exacerbate lateral sway variability under high-arousal states, whereas conscious interoceptive accuracy, indexed by IAcc, intensifies the reduction in sway velocity. These mechanisms may inform interventions for clinical populations with emotional dysregulation or balance impairments.

P01-F-46 - Cortical activity during cognitive and motor tasks in mild traumatic brain injury

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Background and Aim Mild traumatic brain injury (mTBI) is associated with several motor and non-motor symptoms. These include depression, changes in cognitive function such as memory loss and gait and balance impairments. Symptoms generally subside but they can persist chronically (>12 weeks) in some cases. Clinical assessments of mTBI are currently based on self-report or subjective tools, such as the Sports related Concussion Assessment Tool (SCAT-5) or the Glasgow Coma Scale (GCS) that may miss subtle deficits. There is a need to develop simple and effective objective assessments for mTBI that may be able to detect subtle impairment to can aid clinical assessment [1]. Functional near-infrared spectroscopy (fNIRS) measures oxygenated haemoglobin (HbO2) and provides a marker for cortical activity. Cortical regions such as the prefrontal cortex (PFC), supplementary motor cortex (SMA), primary motor cortex (M1), primary somatosensory cortex (S1) and the primary visual cortex (V1) are known to be involved in cognitive, motor, sensory and visual function. Therefore, fNIRS may provide insights into This project aims to compare cortical activity during cognitive and motor tasks in individuals with mTBI to controls using fNIRS. Methods Sixteen individuals with mTBI and 18 healthy controls completed a series of cognitive and motor tasks, specifically computerised button-pressing digital vigilance (DV), simple (SRT) and choice reaction time (CRT), single (ST) and dual-task (DT) gait, and balance under different sensory load. Inertial sensors measured gait and balance, and a computerised battery measured cognitive reaction time. A 24-channel fNIRS system (with short separation channels) was used to measure HbO2 levels across the prefrontal cortex (PFC), supplementary motor cortex (SMA), primary motor cortex (M1), primary somatosensory cortex (S1) and the primary visual cortex (V1). A Linear mixed effect model (LMEM) compared differences in HbO2 between groups. Results No differences were found between mTBI and healthy groups for demographics, cognitive or visual function. Individuals with mTBI had significantly lower cortical activation in the M1 ($p=.020$) and V1 ($p=.016$) cortices during cognitive reaction time tests compared to controls. However, there were no differences in reaction time performance between groups. This may suggest that mTBI may have subtle cortical deficits during cognitive testing that is not detectable using task performance alone. Cortical activity was not different between groups for either of the walk trials and did not change between ST and DT walking conditions for mTBI. However, healthy controls did significantly increase SMA activity ($p=.011$) during DT walking compared to the ST walking. Moreover, significantly increased foot strike angle ($p=.040$) was found for those with mTBI in both ST and DT conditions compared to controls. This may indicate that mTBI are not able to change cortical activity in response to task

complexity increases (i.e., DT) unlike controls, as they may have reached their cortical resource limit during usual ST walking (due to their compensatory gait pattern). No group or task differences were found for cortical activity during different balance conditions and balance measures were not significantly different between mTBI and controls. Conclusion Initial findings suggest that cortical activity during cognitive and motor tasks may offer a new method for evaluating subtle impairments in brain function associated with mTBI. Further research is needed to validate these results in a larger cohort.

P01-F-47 - The role of response inhibition, working memory, and cognitive flexibility in standing balance control

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BACKGROUND and AIM: Poor cognitive functioning, in addition to sensory-motor deficits, is linked to postural instability in the elderly. Quiet stance balance control requires continuous monitoring and adjustments of body's position to maintain stability; needing higher-order cognitive processes such as executive function (EF). While a decline in overall EF is associated with impaired postural stability, the role of each of the 3 EF sub-domains in the control of balance, namely, response inhibition (RI): inhibition of prepotent response; working memory (WM): storing, manipulation, and updating of information; and cognitive flexibility (CF): switching flexibly between changing rules, is not known. The present study investigated the role of each EF sub-domain in quiet standing and whether the 3 EFs contribute similarly or differentially to the control of human balance. METHODS: 25 healthy young adults (21 males, age = 25.12 ± 3.86 years) participated in: i) seated single cognitive block with 3 EF tasks (visual-verbal): Stroop (RI), 1-back (WM), and Plus-minus (CF) (pseudorandomized); ii) single motor block: maintaining balance during quiet standing on a force platform; and iii) dual cognitive-motor block: performing each EF task while maintaining standing balance (pseudorandomized). Percent accuracy and reaction time on EF tasks and center of pressure (COP) metrics were computed, with respective cognitive and motor costs (in %). Repeated measures ANOVAs with post-hoc tests were conducted, mean ± SD reported. RESULTS: Cognitive performance was maintained during dual-tasking for each EF sub-domain, with no differences between cognitive costs across sub-domains (all $p > 0.05$). Overall, sagittal plane COP mean velocity and mean frequency were greater during dual than single task, indicating worsening of balance control. Motor cost on COP mean velocity was greater for CF than WM ($p < 0.017$) and similar between CF and RI and RI and WM (RI: 30.3 ± 40.3, WM: 16.2 ± 23.1, CF: 40.2 ± 52.1). Motor costs on COP mean frequency for both CF and RI were greater than WM ($p < 0.017$) with no differences between costs for CF and RI (RI: 58.9 ± 65.6, WM: 17.0 ± 43.5, CF: 41.3 ± 57.1). CONCLUSIONS: Deterioration of balance and maintenance of cognitive performance during dual-tasking under each EF task indicates that all 3 EF sub-domains contribute to postural control, with cognitive prioritization being the default preference in young adults.

Moreover, a disparity in motor costs accompanied by similar cognitive costs across EF sub-domains reveals a differential role of the 3 EFs in standing balance control. Specifically, RI and CF seem to play a larger role than WM in quiet stance balance, presumably towards a more fine-tuned active regulation of COP to maintain stability. Collectively, these findings signify the nuanced role of EFs in human postural control and may form the basis for targeted EF-based rehabilitation interventions. FUNDING: DST-SERB CRG/2020/005911

P01-F-48 - "Postural control and emotions – are center of pressure parameters affected by emotional imagery in healthy individuals?"

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Background and aimThe relationship between postural control and emotions is intricately intertwined in our behaviors (e.g., stiffening strategies when exposed to threat). However, it is very complex and largely unexplored. A potential way to elucidate the effects of emotions on postural control is through script-driven emotional imagery, which is known to be a valid and reliable way to induce emotions. As it has not yet been used in the research field of postural control we aimed to examine the effect of script-driven emotional imagery on center of pressure (CoP) in healthy individuals.MethodsParticipants listened to four emotional imagery scripts by means of stories exposed through headphones. The first was a neutral script, the other three were designed to induce emotions of acceptance, hostile-resistance, and relaxation. The subjects were instructed to imagine the stories as vividly as possible while standing upright on a foam pad with their eyes closed and arms hanging next to their body in a darkened room. Each emotional imagery script consisted of a baseline, imagery, and recovery phase. After each script, the subjects rated valence (pleasant to unpleasant), arousal (excited to calm), and dominance (dominated to in control) with the Self-Assessment Manikin (SAM) to check whether emotion induction was successful. Postural control was quantified by various CoP parameters: mean sway and standard deviation of sway, total sway, and sway velocity in both anteroposterior direction (AP) and mediolateral direction (ML), as well as the 95% confidence interval of the total sway area. Effects of the emotional imagery scripts on CoP and whether or not the emotions were successfully induced were analyzed using a mixed model. For CoP, the mixed model was based on difference scores between the baseline and imagery phases of each script.ResultsBased on the SAM, the scripts successfully induced the intended emotions, as participants felt less pleasant ($p < 0.0001$), more aroused ($p < 0.0001$), and less in control ($p < 0.0001$) during the hostile-resistance script compared to the acceptance and relaxation scripts and during the acceptance script compared to the relaxation script. However, with an exception for mean CoP sway AP, which was smaller during the relaxation script in comparison to the acceptance script ($p = 0.04$), none of the scripts revealed any effect on CoP variables. ConclusionAlthough script-driven emotional imagery was successfully induced in healthy individuals, the scripts minimally affected postural control. These findings may suggest that healthy individuals adopt flexible compensation strategies (both postural and emotional) to successfully adjust for induced perturbations.

P01-F-49 - Sleep disturbance and gait health in patients with chronic neck pain: Cross-sectional observations

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Background and Aims: Neck pain is the second most common musculoskeletal pain condition with significant medical/socioeconomic burden. We aimed to understand how sleep disturbance affects physical function and gait dynamics in patients with chronic neck pain (CNP), and to explore the mediating effects of sleep disturbance on the pathway of CNP to altered physical function. Methods: A total of 60 individuals with CNP and 41 non-CNP controls were recruited in a cross-sectional study. Participants completed an in-clinic visit with questionnaires and standard physical function tests. Results: Individuals with CNP were observed to have significantly worse sleep measured by PROMIS-29 sleep disturbance T scores (median = 56.1, IQR = 3.6, $p<0.001$), compared to those without CNP (median = 43.8, IQR = 6.2), in addition to the significantly worse physical measures. Linear regression models showed that the negative effects on sleep were significantly associated with the presence of neck pain ($\beta = 13.3$, $p<0.001$), pain severity ($\beta = 2.1$, $p<0.001$), and neck disability index ($\beta = 0.61$, $p<0.001$) in models adjusted for age, sex, and BMI. Meanwhile, sleep disturbance negatively affects physical and gait measures. Mediation analysis showed that sleep disturbance is a significant mediator on the causal pathway from pain to altered gait dynamics. Conclusion: In the treatment of CNP, efforts on the improvement of sleep quality are important and beneficial for physical function and gait, which should also be highlighted as whole-person health strategies.

P01-F-50 - Effects of difference of sensory modality in cognitive task on postural control

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BACKGROUND AND AIM: Daily life involves performing motor tasks and cognitive tasks simultaneously. Therefore, understanding how cognitive loads influence postural control is essential for developing new fall-prevention interventions. Several studies suggest that the influence of cognitive tasks on postural control varies depending on the sensory

modality used. However, the cognitive tasks used in these studies differ not only in sensory modality but also in task content. Therefore, this study aimed to examine the effects of sensory modality in cognitive tasks on static postural control under conditions that excluded differences in task content. METHODS: We conducted a randomized, single-blind design in 25 healthy young adults. Participants were instructed to maintain a quiet stance on a force plate under three cognitive task conditions: a single-motor task (Control), a paced visual serial addition task (Visual), a paced auditory serial addition task (Auditory). The 95% confidence area of the center of pressure (COP) in the horizontal plane (Sway area) were calculated. In addition, the power spectrum density (PSD) and the mean power frequency (MPF) were obtained from the COP displacements in the anteroposterior (AP) and mediolateral (ML) directions. Furthermore, PSD was divided into four distinct frequency bands: Ultra-low, Very-low, Low, and Moderate. We used one-way repeated-measures ANOVA with the factor cognitive condition (Control, Visual, and Auditory). Bonferroni pairwise comparison was performed when appropriate. RESULTS: A significant main effect of cognitive condition was observed for Sway area, MPF in the ML direction, and PSD of moderate frequency band in the ML direction ($p = 0.001$, $p = 0.024$, and $p < 0.001$, respectively). Participants demonstrated significantly smaller Sway area under both Visual and Auditory conditions compared to the Control condition ($p = 0.011$ and $p = 0.007$, respectively). In addition, the PSD of moderate frequency band significantly increased under the Visual condition compared to the Control condition ($p < 0.001$). On the other hand, the PSD of moderate frequency band significantly increased under the Auditory condition compared to both Control and Visual condition ($p < 0.001$ and $p = 0.041$, respectively), with significant higher MPF than that in the Control condition ($p = 0.038$). CONCLUTION: Our findings suggest that both visual and auditory cognitive tasks induced a stiffness strategy during a quiet stance. However, auditory cognitive tasks exerted greater influence on postural control than visual cognitive tasks. This sensory specificity may be explained that auditory cognitive tasks may require more attentional capacity, reducing the capacity available to maintain postural stability. ACKNOWLEDGEMENTS AND FUNDING: This study was supported by Grant-in-Aid for Early-Career Scientists (20K19371, 24K20491) from the Japan Society for the Promotion of Science.

P01-G-51 - Older adults actively regulate passive dynamic stability during complex locomotion

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BACKGROUND & AIM: During unobstructed walking, humans maintain a consistent level of passive dynamic stability, quantified as the anterior-posterior margin of stability (MOSAP), at heel strike. This behavior is optimized to reuse existing kinetic energy, enabling efficient forward motion with low energy cost. In obstructed walking, however, MOSAP varies from step to step [1]. Young adults (YA) actively coordinate step length and

the center-of-mass state (XcoM) to regulate MOSAP when approaching and crossing obstacles. These adjustments reflect a balance between efficiency and stability: YA invest additional energy to sustain forward motion while reducing the risk of falling in the event of a trip [2]. Since healthy aging is associated with loss of motor control, our aim was to quantify how older adults (OA) control MOSAP during unobstructed and obstructed gait. We hypothesized that like YA, OA will actively regulate step length to maintain an invariant MOSAP (H1), but with weaker synergies reflecting reduced control (H2).METHODS: 25 YA (21±3 years) and 23 OA (68±4 years) performed two walking tasks: 1) clear walkway and 2) obstacle crossing (~22 cm) (20 trials of each task; 6 m walkway). MOSAP was computed as the difference between step length (SL) and extrapolated center of mass (XcoM). The variance in SL and XcoM was divided into VUCM, which preserves MOSAP, and VORT, which alters it. The synergy index ΔVz was computed as the z- transformed value of 2(VUCM-VORT)/(VUCM+VORT). ΔVz > 0 indicates the presence of a MOS-stabilizing synergy, with higher values indicating stronger synergies. T-tests determined if synergies were present, and three-way ANOVAs determined if ΔVz, VUCM and VORT were influenced by age, task, and step.RESULTS: The synergy index was significantly greater than zero for all steps, tasks and ages ($p<0.01$), supporting H1. Significant task × step interactions were observed for synergy index ($p=0.002$), VUCM ($p<0.001$), and VORT ($p<0.001$; Fig 1). The synergy index was lower during obstacle-crossing compared to unobstructed walking, but only during lead (step0) and trail (step+1) crossing steps. There was no effect of age on MOSAP, not supporting H2. VUCM was higher for step0, step+1, and step+2, and VORT was higher for step0 and step+1. CONCLUSION: Both age groups actively controlled MOSAP on clear and obstructed walkways. The absence of age-related differences suggests that OA preserve their ability to regulate passive dynamic stability during complex tasks. The reduction in synergy index during crossing steps indicates greater difficulty in maintaining MOSAP when environmental demands are high. However, for these steps, higher MOSAP variability (VORT) is partially offset by greater compensatory adjustments between step length and XcoM (higher VUCM) indicating preserved flexibility in the neuromotor control of this task with aging. REFERENCES[1] Hal et al. (2019). J Biomech, 84, 147-152[2] Kulkarni et al. (2023). PloSOne, 18(4)

P01-G-52 - The influence of walking speed on lateral margin of stability during 180-degree turning in healthy young adults

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BACKGROUND AND AIM: Recently, non-linear walking has garnered increasing attention as a more challenging locomotor task compared to linear walking (Madrid et al., 2023). Dynamic stability during walking is commonly assessed using the Margin of Stability (MoS) (Hof, 2005). Tyler et al. (2023) evaluated MoS during circular walking at a self-selected speed by establishing appropriate local coordinate systems. This study aimed

to investigate the influence of walking speed on lateral MoS during non-linear walking tasks incorporating 180-degree turns, similar to the Timed Up and Go test.METHODS: Sixteen healthy adults performed non-linear walking tasks. The non-linear walking task required participants to walk 5 m forward from the starting position, turn around a marker in either clockwise (CW) or counterclockwise (CCW) direction, and return to the starting position. Three walking speed conditions were established: preferred (P), fast (F: 1.5 times the preferred speed), and slow (S: 0.7 times the preferred speed). Reflective markers were attached to the whole body, and motion capture was performed at 250 Hz. The walking path was estimated by approximating the center of mass trajectory with a sixth-order polynomial (Dingwell, 2023). Based on the estimated walking path, turning angles were defined for each step. For CW and CCW conditions, the steps with the largest turning angles for both left and right legs were extracted for analysis. Step length, width, duration, and velocity, and lateral MoS at the beginning of the swing phase were calculated for the extracted steps. In the CW/CCW condition, the right leg was recategorized as internal/external and the left leg as external/internal. Simple main effect tests for walking speed and post-hoc pairwise comparisons were conducted for each turning direction and stepping leg.RESULTS: In both CW and CCW tasks, lateral MoS was significantly smaller for steps where the external leg was the swing leg compared to those where the internal leg was the swing leg. As walking speed increased, lateral MoS for steps where the external leg was the swing leg decreased to negative values (CW task, Slow: 27.5 ± 16.8 cm, Preferred: -6.8 ± 24.4 cm, Fast: -65.2 ± 34.2 cm; CCW task, Slow: 24.8 ± 14.3 cm, Preferred: -11 ± 23.2 cm, Fast: -103 ± 53.4 cm). Differences between all walking speeds were statistically significant (ps < 0.001). The difference between CW and CCW tasks was significant in the Fast condition (d = 1.47, pholm = 0.003).CONCLUSIONS: During turning at preferred or faster walking speeds in healthy adults, negative lateral MoS was observed, indicating dynamic instability toward the stance leg side (turning direction). This implies that normal or faster turning involved cross-steps, characterized by a controlled "falling" mechanism of an inverted pendulum toward the turning direction.ACKNOWLEDGEMENTS AND FUNDING: This work was supported by JSPS KAKENHI Grant-in-Aid, Grant Number: 24K02840 and 24K14530

P01-G-53 - Evaluation of temporal and spatial joint coordination in idiopathic toe walkers and its association with clinical metrics

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BACKGROUND AND AIMIdiopathic Toe Walking (ITW) is a condition characterised by persistent toe-walking without known causes1. While single-joint deviations compared to healthy individuals, such as ankle, knee, and hip angles, have been studied extensively2, interdependence of joints remains underexplored. This study investigates the temporal and spatial joint coordination, particularly at the ankle-knee (AK) and knee-hip (KH) in ITW children, and their association with common clinical metrics. The AK pair

was chosen for its role in propulsion and shock absorption; and the KH pair for its role in balance and propulsion3. METHODS This retrospective study analysed 90 children (45 ITW, mean age 12.2 ± 3.5 years; 45 typically developing (TD), mean age 10.1 ± 3.3 years). Kinematic data were collected using a Vicon 3D motion capture system with the Plug-in-Gait model. Flexion-extension movements in the sagittal plane were examined. Temporal coordination was assessed via mean absolute relative phase (MARP)4, while spatial coupling was evaluated via vector coding (VC)5. Group differences and their correlations with clinical metrics (Gait Profile Score (GPS)6 which quantifies overall gait deviation relative to normative kinematic data, static/dynamic range of motion (ROM)) were analysed using t-tests and Pearson's coefficients across key gait phases including initial contact and loading response (ICLR), mid-stance (MS), terminal stance (TS), pre-swing (PSw), initial swing (ISw), mid-swing (MSw), and terminal swing (TSw). RESULTS Compared to TD, ITW exhibited a reduction in right ankle-knee MARP during PSw and ISw ($p < 0.04$) and bilateral knee-hip MARP at ICLR ($p < 0.05$). Ankle-knee VC reduced bilaterally at ICLR, MS and TS ($p < 0.03$), while knee-hip VC decreased bilaterally at ICLR and TS ($p < 0.01$). Reductions in ankle-knee MARP and VC suggested disruptions from limited dorsiflexion, causing tighter coupling and reduced knee contribution, while reductions in knee-hip during ICLR and TS indicate compensatory knee action due to restricted hip extension and ankle mobility. Static ROM had no significant correlation with MARP but a mild correlation with bilateral ankle knee VC at ICLR ($r \approx 0.3$). Dynamic ROM was mildly correlated with knee-hip MARP at ICLR ($r \approx 0.3$) and with knee-hip VC at ICLR ($r \approx 0.30$–0.45). GPS had no significant correlation with MARP and was mildly correlated with ankle-knee VC at ICLR on both sides ($r \approx -0.5$), and at PSw on the left side ($r \approx -0.30$). Mild correlations between GPS, ROM, and coordination metrics highlighted the limitations of traditional measures in capturing joint- and phase-specific deficits, while weak correlations with static ROM emphasise the need for dynamic assessments to understand gait abnormalities.CONCLUSIONSThis study quantified the differences in ankle-knee and knee-hip coupling in ITW children, providing phase-specific insights into ITW gait mechanics which may help to target interventions. REFERENCES[1] Oetgen, Matthew E., and Sean Peden. "Idiopathic toe walking." JAAOS-Journal of the American Academy of Orthopaedic Surgeons 20.5 (2012): 292-300. [2] Caserta A et al. Children with idiopathic toe walking display differences in lower limb joint ranges and strength compared to peers: a case control study. J Foot Ankle Res. 2022 Sep 12;15(1):70. [3] Fukui, Tsutomu, Yasuhisa Ueda, and Fumiko Kamijo. "Ankle, knee, and hip joint contribution to body support during gait." Journal of Physical Therapy Science 28.10 (2016): 2834-2837. [4] Dussault-Picard, C., et al. "Lower-limb joint-coordination and coordination variability during gait in children with cerebral palsy." Clinical Biomechanics 98 (2022): 105740. [5] Silvernail, Julia Freedman, et al. "Comparisons of segment coordination: an investigation of vector coding." Journal of Applied Biomechanics 34.3 (2018): 226-231. [6] Baker, Richard, et al. "The gait profile score and movement analysis profile." Gait & posture 30.3 (2009): 265-269.

P01-G-54 - Usual and dual-task gait in older women cancer survivors who completed chemotherapy more than 12 months ago

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Background and Aim: More than half of newly diagnosed cancer patients are aged 65 years or older. Among various cancer treatments, chemotherapy is strongly associated with functional decline, beginning at the start of treatment and persisting even years after chemotherapy ends. Gait speed is considered a crucial indicator of an individual's general health and a predictor of negative outcomes such as falls, functional decline, and death. However, the literature lacks studies investigating the late effects of chemotherapy on spatial and temporal gait parameters, specifically in older adult cancer survivors. Therefore, the aim of this study was to compare the parameters of usual and cognitive dual-task gait between older women cancer survivors who completed chemotherapy and older women without a history of cancer.Methods: A cross-sectional study included 50 older women without a history of cancer (G0) and 15 older women cancer survivors who had undergone chemotherapy 12 to 30 months ago (G1). Usual and cognitive dual-task (naming animals while walking) gait parameters were measured using the GAITRite System electronic walkway. Multivariate linear regression models, adjusted for cognition level, were used to investigate associations between groups and gait parameters. Univariate associations between groups and each gait variable (usual and dual-task gait) were also evaluated.Results: The Wilks' Lambda test revealed a significant association between groups and gait parameters in both usual gait ($p = 0.012$) and dual-task gait ($p = 0.001$). The univariate analysis showed that G1 had impairments in all parameters of usual gait and cognitive dual-task gait compared to G0.Conclusion: Older women cancer survivors who have undergone chemotherapy may benefit from extended follow-up to avoid negative outcomes such as falls and functional decline. Furthermore, improving the different parameters of usual and dual-task gait, as well as reducing the cost of the dual-task, may be important therapeutic objectives for older women cancer survivors.

P01-G-55 - The association between sensory integration and gait speed in community-dwelling older adults: Insights from a systematic review with meta-analysis

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Background and Aim: Walking is a daily fundamental activity that relies on coordination between sensory and motor systems. The nervous system integrates input from the

visual, somatosensory, and vestibular systems -a process known as sensory integration (SI)-, which is essential for gait1,2. Aging often leads to declines in sensory systems that potentially contribute to changes in gait among older adults. However, this association is yet to be investigated. Therefore, this study aimed to investigate the relationship between SI and gait speed in healthy older adults.Methods: PubMed, Web of Science, and PEDro databases were searched until April 2024. The studies including healthy older adults and evaluating SI and gait speed were deemed eligible. The quality of the studies was assessed with Quality in Prognosis Studies (QUIPS). Correlation coefficients between gait speed and postural sway during standing with eyes open on a firm surface (EOF), eyes closed on a firm surface (ECF), eyes open on a compliant surface (EOC), eyes closed on a compliant surface (ECC) were extracted, along with coefficients between the Romberg (RQ= ECF/EOF) and Proprioception Quotients (PQ=EOC/EOF) (representing reliance on vision and the somatosensory system, respectively) and gait speed3. The outcome measurements were grouped as sway area (incl. elliptical area and trunk sway area) and sway velocity (incl. sway velocity of the trunk and mean center of pressure velocity). Results: Eleven studies comprising 630 participants (mean age 72.96 years, age range 60-102 years, 66.82% female) were included in the systematic review. All studies displayed a high risk of bias. The findings revealed a significant association between gait speed and sway area in EOF (pooled r:-0.235, 95%CI: -0.340-(-0.13), p<0.001), ECF (pooled r:-0.165, 95%CI: -0.278-(-0.053), p:0.004), EOC (pooled r:-0.198, 95%CI: -0.316-(-0.086), p<0.001), ECC (pooled r:-0.186, 95%CI: -0.316-(-0.06), p:0.004) (Figure 1). No association was present between gait speed and sway velocity in EOF and ECF as well as RQ and PQ (Figure 1).Conclusions: A significant negative correlation was observed between sway area under sensory challenging conditions and gait speed, indicating that greater sway is associated with slower gait speed and, consequently, an increased fall risk4,5. On the other hand, gait speed was surprisingly not linked to RQ or PQ. The finding may stem from the population, as the healthy older adults in this study might not rely on a single sensory system. Furthermore, this finding may also be attributed to the lack of measurements for SI in dynamic contexts, as measurement of SI in static conditions may not fully capture the demands of gait. Thus, future research should prioritize evaluating SI during dynamic tasks that better mimic the demands of gait. Keywords: Aged, gait, sensory function, and stabilometryReferences1. Horak, F. B., & Macpherson, J. M. (2011). Postural Orientation and Equilibrium. In Comprehensive Physiology (pp. 255–292). https://doi.org/https://doi.org/10.1002/cphy.cp1201072. Fitzpatrick, R., & McCloskey, D. I. (1994). Proprioceptive, visual and vestibular thresholds for the perception of sway during standing in humans. The Journal of Physiology, 478(1), 173–186. https://doi.org/https://doi.org/10.1113/jphysiol.1994.sp0202403. Yang, F., & Liu, X. (2020). Relative importance of vision and proprioception in maintaining standing balance in people with multiple sclerosis. Multiple Sclerosis and Related Disorders, 39. https://doi.org/10.1016/j.msard.2019.1019014. Kyrdalen, I. L., Thingstad, P., Sandvik, L., & Ormstad, H. (2019). Associations between gait speed and well-known fall risk factors among community-dwelling older adults. Physiotherapy Research International, 24(1), e1743. https://doi.org/https://doi.org/10.1002/pri.17435. Johansson, J., Nordström, A., Gustafson, Y., Westling, G., & Nordström, P. (2017). Increased postural sway during quiet stance as a risk factor for prospective falls in community-dwelling elderly individuals. Age and Ageing, 46(6), 964–970. https://doi.org/10.1093/ageing/afx083

P01-G-56 - Advance knowledge of postural demands modulates rapid stepping behaviour

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Introduction: The ability to make reflexive stepping movements in response to sudden visual stimuli is essential for flexible interaction with our inherently dynamic environment. We recently showed that salient visual stepping targets evoke rapid bursts of muscle activity, called express visuomotor responses (EVRs), aiding fast step initiation under low postural demands. However, when anticipatory postural adjustments (APAs) are necessitated due to high postural demands, EVRs are generally suppressed (Billen et al., 2023). Yet, due to the blocked design of this study, participants knew the postural demands in advance. Thus, these findings may not directly translate to daily life, where postural demands are much more unpredictable. In the current study, we explored whether advance knowledge of postural demands modulates EVR and APA magnitudes during step initiation.Methods: We adapted the emerging target paradigm (Billen et al., 2023) where healthy young adults (N = 19) stepped rapidly to visual targets presented randomly in front of the left or right foot at varying step eccentricities (Figure 1A) while measuring EMG from bilateral gluteus medius (GM). Stepping anterolaterally or anteromedially involved low or high postural demands, respectively. To manipulate foreknowledge, each participant performed a total of 480 stepping trials during a blocked (solely low or high demanding steps) and an intermixed stepping condition (mixed low and high demanding steps), in counterbalanced order. EVR and APA magnitudes were quantified as the average normalized stance-leg GM activity between 100-140 ms and stepping-leg GM activity between 140-200 ms, respectively. We used repeated measures ANOVAs to investigate the effects of step eccentricity and condition (blocked vs. intermixed) on EVR and APA magnitude.Results: We observed higher EVR and lower APA magnitudes during the blocked compared to the intermixed stepping condition, yet the effects of condition differed between step eccentricities (Condition x Eccentricity, EVR: $p = .019$; APA: $p = .011$). Post-hoc t-tests revealed significant differences only for low postural demand steps (EVR: $p = .021$ (Target 3); $p = .04$ (Target 4), APA: $p = .019$ (Target 3)) (Figure 1B).Conclusion: Our results suggest that foreknowledge of low postural demands lets people “safely” launch EVRs while suppressing APAs, thus prioritizing speed over balance. Conversely, when lacking foreknowledge, people tend to prioritize balance over speed. This may be particularly relevant for people with Parkinson’s Disease, in whom postural control is often impacted while EVRs were shown to be relatively spared (Billen

et al., 2024). Their aetiology could lead to an increased risk of falls if no foreknowledge of postural requirements is available.Funding: This work was supported by a Radboud University Medical Centre Research Grant to I. Giesbers.

P01-G-57 - Corticospinal excitability during unpredictable mediolateral gait destabilisations

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Background: Unpredictable disturbances during gait, particularly in the mediolateral direction, challenge stability and are a common contributor to falls. Although the corticospinal tract is critical for gait and postural control, its response to such instabilities remains unknown. Aim: To quantify corticospinal excitability of proximal and distal leg muscles during unpredictable mediolateral destabilisation of gait.Methods: Single-pulse transcranial magnetic stimulation was delivered over the primary motor cortex of 15 healthy individuals at a random instant every 3-5 strides during steady-state and mediolaterally destabilised treadmill gait. Full body kinematics were recorded. Stimulations where the coil was >5 mm from the target location on the head were excluded (<3% of total). An average of 212 and 215 stimulations per participant were included in the steady-state and destabilised conditions, respectively, distributed across the gait cycle. Responsiveness of the corticospinal tract was quantified from responses to cortical stimulation (motor evoked potentials; MEPs) recorded from seven muscles using surface electromyography: tibialis anterior (TA), medial gastrocnemius, lateral gastrocnemius (LG), rectus femoris (RF), biceps femoris (BF), gluteus medius (GM), adductor magnus (AM).Results: Step width was greater (128 ± 2 mm vs 105 ± 3 mm) and more variable and stride duration was shorter (1.09 ± 0.03 vs 1.15 ± 0.04 s) and more variable during destabilised gait. Dynamic instability was greater (local divergence exponent (3.17 ± 0.18 vs 2.68 ± 0.30), along with greater foot placement control at midstance and greater foot placement error. Muscle activity was higher during destabilised gait for TA, LG, RF, BF, GM and AM. Absolute MEP amplitudes were higher for RF, BF, GM and AM. After normalisation to the ongoing EMG, MEP amplitudes were higher during destabilised gait for these same muscles, although for a smaller portion of the gait cycle and primarily only during periods of low muscle activity (Figure). Normalised MEP in TA was also higher during destabilised gait at the transition from stance to double support. Discussion: Participants adopted a more cautious walking strategy when destabilised. This was accompanied by greater muscle activity and larger MEPs in proximal muscles. The unchanged MEP size in distal muscles may reflect the method of destabilisation, whereby the unpredictability of constant random surface shifts limited the effectiveness of ankle strategies, leading participants to adopt a more cautious walking strategy with heightened readiness of the hip and knee muscles to maintain stability. The predominance of differences in normalised MEPs during periods of muscle quiescence may indicate that corticospinal input to motor neurones is particularly

important in these periods.Funding: Royal Society International Exchange Award to JD & SB; Cardiff University Taith Student Mobility Award to RH.

P01-G-58 - Impaired perturbation perception or motor execution? Neuromechanistic causes of timber falls in older adults with mild cognitive impairment

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Background and Aim: Older adults with mild cognitive impairment (OAwMCI) fall 2x more than cognitively intact older adults (CIOA), which could be due to impaired reactive balance control (i.e., motor responses to external perturbations). When exposed to slip-like perturbations, our lab has shown that OAwMCI have higher fall rate and lower reactive center of mass stability than CIOA. Further, we observed that some OAwMCI have extremely delayed initiation of reactive stepping, resulting in a "Timber"-like fall into the harness. This study used neuromuscular analysis to investigate potential causes of Timber falls in OAwMCI, including impaired perturbation perception (delayed response triggering indicated by muscle onset latencies) and/or motor execution (altered muscle synergies).Methods: We included 36 OAwMCI (55-90 yrs, Montreal Cognitive Assessment (MoCA) 18-25), 37 CIOA (MoCA≥26), and 20 young adults (YA, 18-35 yrs). A large treadmill support surface perturbation was delivered in stance. Timber falls were identified if participants fell (>30% body weight in harness) without initiating a step until after the perturbation ended (>380 ms). Onset latencies were calculated for the bilateral biceps femoris (BF), vastus lateralis (VL), medial gastrocnemius (MG), and tibialis anterior (TA) and each muscle was compared between groups using 1-way ANOVA. Muscle synergies were extracted from perturbation onset to recovery step touchdown with non-negative matrix factorization; their structural similarity was compared between groups using Pearson's correlation coefficient (r). Results: 36% of OAwMCI had Timber falls (MCI:Timber), and 64% had intact reactive stepping (MCI:Step); CIOA and YA had none. Fall rate was highest in MCI:Timber ($\chi 2=45.15$, $p<0.01$, Fig. 1). Onsets of all stepping limb muscles and stance MG were delayed in MCI:Timber vs. those with intact stepping ($p\leq 0.03$). Cluster analysis revealed 6 muscle synergies (M1-6, Fig. 1). M4 (mainly stepping MG) was only recruited by MCI:Timber and was structurally different than synergies involving the stepping MG in those with intact stepping (M3, M5) ($r<0.834$). MCI:Timber did not recruit M6 (mainly stepping VL in later swing phase), which could help take a long backward recovery step. Conclusions: Our results show that increased prevalence of Timber falls in OAwMCI could be attributed to problems with both triggering and executing reactive stepping. Impaired processing/integration in the sensorimotor cortex in OAwMCI could delay perturbation detection and subsequent triggering of reactive stepping. Further, neural pathology in motor areas (e.g., cerebellum, brainstem, cortex) could impair the selection, scaling, or execution of descending motor commands, resulting in ineffective muscle synergies for restoring stability. Fall prevention

interventions for OAwMCI may consider targeting sensorimotor perception and ways to improve reactive stepping.Acknowledgements and Funding: R01AG073152, PI: Tanvi Bhatt.

P01-G-59 - A protocol to study the impact of conditioned pain modulation on the nociceptive withdrawal reflex in walking

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Background: Conditioned pain modulation (CPM) is a process by which one painful stimulus reduces the pain perceived due to another stimulus. CPM changes the responses seen in the nociceptive withdrawal reflex (NWR) elicited in sitting. Yet, it is unknown how CPM impacts NWR during walking, where the NWR is critical for protecting the body from noxious stimuli and maintaining balance and effective locomotion. The cold pressor test is the most common conditioning stimulus used for studying the impact of CPM on NWR [1], but it is not suitable for walking on a treadmill, as water spillages could damage equipment. Cold gel may be a viable alternative to the water in a cold pressor test, as implemented in an fMRI [2]. A tourniquet can also be used to induce ischemic pain in the study of CPM, but is not routinely used in walking. Aim: To study the impact of CPM on the NWR during walking.Methods: Our goal was to replicate the cold pressor gel used in fMRI [2]. Varying concentrations of arrowroot and xanthan gum were mixed with salt and diluted in 1 litre of water. The mixtures were frozen for 6-12 hours and allowed to defrost to a temperature of 1-5°. A pilot participant placed their hand in the gel for 3 mins and rated their pain on a numeric pain scale (NPS) every minute while their hand was in the gel and after they removed their hand. To study ischemic pain, a manual sphygmomanometer was inflated to 1.5 times a different pilot participant's systolic blood pressure. They rated their pain on a NPS every 5 mins while walking on a treadmill. Results: The gel consistency was smoother and thicker with the xantham gum vs. the arrow root. However, the gel required ~1.5 hours to defrost to the required temperature. The participant reported ~6/10 pain with their hand in the gel during minute one, after which the gel warmed around their hand and pain decreased (~3/10). When the hand was removed from the gel they reported no pain. The participant initially reported 4/10 pain with the manual sphygmomanometer, which rose to 6/10 by the end of the 5-minute walk. We are evaluating the impact of CPM elicited using an ischemic pain stimulus on the NWR during treadmill walking and results will be available by the Congress.Conclusions: The cold gel method was discounted as a viable CPM method for treadmill walking as pain dissipated when the hand was removed from the gel and it was not feasible to keep the hand in the gel while walking without disrupting gait. The manual sphygmomanometer was well tolerated and is a quick and cost effective means of inducing pain when studying the effects of CPM. References: [1] Dhondt, et al. (2019), CLIN J PAIN. 35.9: 794-807. [2] Lapotka et al. (2017), MAGNET RESON MED. 78.4: 1464-1468.Funding: EPSRC Chronic Pain Neurotechnology Network+

P01-G-60 - The role of expectation in the cortical processing of imbalance

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BACKGROUNDMany clinical balance disorders (e.g., persistent dizziness, fear of falling etc.) are characterised by distorted perceptions of instability, whereby individuals perceive themselves to be more unstable than they actually are. There is emerging evidence that such inaccurate perceptions may be driven by strong top-down expectations of imbalance. Yet, the neural mechanisms through which expectations (of instability) affect perception of balance are unknown.METHODSTwenty-one healthy young adults (M=25.0±4.9 years, 10 men) stood on a force plate-embedded moveable platform while mobile EEG was recorded. Participants experienced two blocks of 60 discrete anterior-posterior perturbations to posture. In each block, the majority (N=45) of perturbations was either of small or large magnitude, and participants were instructed to expect such perturbations. These perturbations were interspersed with 15 pseudo-randomised catch trials that violated expected size. Sequence and condition order were counterbalanced. We hypothesised stronger expectations of imbalance would bias perception and neural processing towards instability, reflected in anticipatory EEG activity and enhanced post-perturbation N1 amplitudes.RESULTSIn line with previous research, perceptions of instability were strongly shaped by expectation: participants felt significantly more unstable when expecting to receive larger perturbations to balance ($p=.014$). In contrast, the cortical N1 response was shaped by the actual size of perturbation received (i.e., sensory information; $p<.001$) rather than expectation ($p=.553$). However, expectation did shape high frequency EEG (beta and gamma) activity both before and immediately after perturbation onset. Specifically, participants exhibited reduced anticipatory EEG beta prior to perturbation onset, followed by reduced EEG gamma after the perturbation onset.CONCLUSIONSThese findings suggest that expectations exert a strong influence on perceptions of instability – and that these effects appear driven by modulations in anticipatory and early-phase evoked high-frequency EEG activity. Ongoing work is exploring if similar mechanisms are present in clinical disorders underpinned by distorted perceptions of instability, such as persistent postural-perceptual dizziness.

P01-G-61 - Neural mechanisms underlying dual-task locomotor performance and the effects of different training strategies in children: A scoping review

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Background and aims: Most of our daily activities involve dual-tasking, which requires the simultaneous processing of environmental information and motor actions. By 7 years of age, children experience distinct cognitive-motor development. Their locomotive

abilities begin to resemble that of adults (Assaiante, Neurosci Biobehav Rev, 1998), while higher-level cognitive processes termed "executive functions" continue to develop at different trajectories (Best & Miller,Child Dev, 2010). For example, inhibition (ability to reject incorrect cues and respond accurately) improves earlier than either working memory (ability to store and manage information) or task shifting (ability to switch between cognitive systems) (Best & Miller, ibid). Literature has shown that some training paradigms consisting of cognitively demanding physical activities (e.g. tag and football games) enhance executive functions in children (van der Niet & Smith, Pediatr Exerc Sci, 2016) however impact of training on adaptive locomotor abilities show mixed results (Hocking et al., J Exp Child Psychol, 2020). This scoping review aims to synthesize current scientific knowledge regarding the neural mechanisms underlying executive function cognitive tasks coupled with locomotor tasks in healthy children between 7 to 12 years of age; optimal training strategies to improve dual-task locomotor performance within this population will also be examined.Methods: Electronic searches were conducted for peer-reviewed publications, published between January 1980 to December 16, 2024, using the following databases: PubMed, PsycINFO, CINAHL and Family & Society Studies Worldwide. The search string used was: (("dual task*" OR dualtask* OR "multi task*" OR multitask* OR "physical cognitive" OR "motor cognitive" OR "cognitive physical" OR "cognitive motor") AND (child* OR kid OR kids OR "pre adolescent" OR preadolescent) AND (locomotion OR motion* OR movement* or walk* OR gait OR "physical activity") AND (cognition OR cognitive OR "executive function")).The abstract screening and full-text reading ensured publications addressing the simultaneous performance of locomotor tasks and cognitive tasks were included.Results: This search resulted in a total of 546 articles (PubMed:264, PsycINFO:131, CINAHL:110, Family & Society Studies Worldwide:41).Conclusions: Preliminary findings indicate that during the execution of cognitive-locomotor tasks children often prioritize the motor task, resulting in a greater decrease in cognitive task accuracy compared to young adults (Schott & Klotzbier, Front Psychol, 2018). This suggests that children experience differences in underlying neural mechanisms of cognitive-locomotor task performance compared to adults. Acknowledgements and Funding: Librarian Jacqueline Kreller-Vanderkooy; NSERC Discovery grant awarded to LAV.

P01-G-62 - Coordination of upper and lower limb muscle activity during walking in healthy young adults

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BACKGROUND AND AIMHuman gait exhibits characteristics similar to those of quadrupedal animals, marked by regular and rhythmic limb movements. Previous studies have suggested that the coordinated activity of upper and lower limb muscles during walking is regulated by shared subcortical and cortical pathways. Coherence analysis of electromyography (EMG) signals has been identified as a valuable method for evaluating the driving sources of this coordination. While studies in healthy older adults have demonstrated common descending inputs to the upper and lower limb muscles during walking, investigations into these control mechanisms in young adults remain scarce. This study aims to explore the coordination of upper and lower limb muscle activity during walking in healthy young adults.METHODSFifteen healthy young adult males (mean age: 25.4 ± 3.4 years) participated in the study. Participants walked 10 meters on a flat surface multiple times at a comfortable pace while wearing wireless surface EMG sensors with integrated triaxial accelerometers and angular velocity sensors. These sensors were attached to the bilateral posterior deltoid, tibialis anterior, rectus femoris, and hamstrings. A total of 20 gait cycles were used for the analysis. Muscle activity was normalized to the maximum EMG signal during walking. Wavelet coherence analysis was used to calculate intermuscular coherence between upper and lower limb muscles across 12 muscle pairs, including both ipsilateral and contralateral combinations. The alpha band (8–15 Hz), indicating subcortical pathway involvement, and the beta band (15–30 Hz), reflecting cortical pathway involvement, were extracted as the frequency bands of interest.RESULTSIncreased intermuscular coherence was observed across all upper and lower limb muscle pairs. Contralateral coherence was notably heightened during the early stance and late swing phases of the gait cycle, coinciding with the overlapping peaks of muscle activity. In contrast, ipsilateral coherence remained low throughout the gait cycle. Coherence increases were most prominent in the alpha band, with partial increases also observed in the beta band.CONCLUSIONSThe findings demonstrate that contralateral intermuscular coherence during walking is synchronized with muscle activity, suggesting that the coordinated activity of upper and lower limb muscles is influenced by common subcortical and cortical inputs. The timing of coherence increases in young adults differs from that observed in studies on older adults, indicating that the neural control mechanisms governing upper and lower limb coordination during walking may change with age.ACKNOWLEDGEMENTS AND FUNDINGWe thank the staff of the Kio Univercity Neurorehabilitation Research Center for their advice and help. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

P01-G-63 - The importance of age-specific base-of-support models for dynamic balance analysis

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Background and aim: Falls are too common in older people. Biomechanical human balance models, e.g. the extrapolated center of mass, describe if the body's center is controlled relative to the base of support formed by the feet, or if a compensatory step is needed to regain balance (Fig 1A). These measures can potentially identify people at risk of falling, but they lack an accurate model of the foot's functional base-of-support (fBOS) or how the fBOS changes with age [1]. Therefore, the aim was to evaluate changes in the fBOS size with age, frailty level and movement ability. Methods: We assessed 34 older (76±6 [66-89] yrs; Clinical Frailty Scale: n=20 non-frail (L1&2), n=10 managing well (L3); n=4 mildly frail (L4) [2]), 14 middle-aged (50±7 [41-63] yrs) and 39 young (26±5 [21-39] yrs) participants. Each foot's ground forces and foot markers were recorded. The fBOS was defined as the convex hull enclosing the maximum voluntary excursion of the centre-of-pressure during slow, standing circular leaning movements without foot movement, normalized to marker-based foot dimensions [3]. Walking ability was defined as preferred walking speed and Short Physical Performance Battery (SPPB) score. Results: The median fBOS was only 25 [9-38]% of the marker-based foot outline for young persons (Fig 1B&C). The fBOS size further decreased with age (pKruskal-Wallis<0.001): the older group's fBOS was 54% of the young group (pmean_rank_values<0.001) and 58% of the middle-aged group (ppmean_rank_values=0.009) due to a reduction in fBOS length rather than width (Fig 1C). This corresponds to a difference in margin of stability (Fig 1A) of 4.7 cm in young to 6.5 cm in older people when comparing the fBOS edge to the commonly used heel marker for an average 30 by 10cm foot. Data suggests that a smaller fBOS size was related to a higher frailty level (pKruskal-Wallis=0.06, Fig 1F) and reduced movement ability (speed: Tau=0.34, pKendall_correlation=0.006; SPPB: Tau=0.27, pKendall_correlation=0.04; Fig 1D,E). Conclusion:This study shows the importance of an accurate fBOS model for balance analysis, as the base of support changes with age and frailty level. The relation to movement ability suggests that foot-floor interactions are important to perform daily life activities. Note that the median fBOS border is difficult to derive in double stance, but age differences were mostly found in the fBOS length. The next steps to address our limitations are to validate these static fBOS models during dynamic conditions, measure more frail persons to create frailty-specific models and establish the specific models' effect on dynamic balance outcomes. The presented age-specific fBOS models can be used to fit other studies' marker data to increase the accuracy of biomechanical dynamic balance analysis. Acknowledgements and fundingLHS: NUAcT, Rosetrees/Stoneygate fellowship; HEIAGE project funded by Carl-Zeiss foundation. References[1] Watson et al (2021), BMC Musculoskelet Disord[2] Rockwood et al (2005), CMAJ[3] Sloot et al. (2020), Front Sport Act Liv

P01-G-64 - Neural control of muscle activities during obstacle avoidance

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BACKGROUND AND AIMCortical involvement during the execution phase of obstacle avoidance has been clearly demonstrated in cats. However, it remains unclear how neural systems, including the brain, control muscle activities during obstacle avoidance in humans. This study aimed to identify the contribution of the common synaptic drives to motor units during obstacle avoidance, using coherence analysis between a-pair electromyography (EMG) signals (EMG-EMG coherence). METHODSFourteen healthy volunteers walked on a treadmill with and without obstacle avoidance. During obstacle gait, subjects were instructed to step over an obstacle with their right leg while walking that would randomly and unpredictably appear. Surface EMG signals were recorded from the following muscles of the right leg: the proximal and distal ends of tibialis anterior (TAp and TAd), biceps femoris (BF), semitendinosus (ST), lateral gastrocnemius (LG), and medial gastrocnemius (MG). Beta-band (13-30 Hz) EMG-EMG coherence was analyzed. RESULTSBeta-band EMG-EMG coherence of TAp-TAd during swing phase and BF-ST during pre and initial swing phase when stepping over an obstacle were significantly higher compared to normal gait (both $p < 0.05$). Beta-band EMG-EMG coherence of TAp-TAd, BF-ST, and LG-MG during stance phase were not significantly different between the two gait conditions (all $p > 0.05$). CONCLUSIONSThe present findings show that beta-band EMG-EMG coherence of ankle dorsiflexor and knee flexor muscles increase when stepping over an obstacle, suggesting increased common synaptic drives contributes to visually guided gait modifications. It also may reflect an increased cortical contribution to modify the gait patterns to avoid an obstacle. The findings of the present study would contribute to the better understanding of neural control of muscle activities during obstacle avoidance and the development of a rational intervention strategies to prevent tripping-related falls.

P01-G-65 - Horizontal moments are anticipatory compensated prior to the isometric force production in an upper limb

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BACKGROUND AND AIM: Anticipatory postural adjustments (APAs) are predictive components of whole-body movements. If the central nervous system predicts perturbations associated with an intended motor task of the upper limb, the onset of ground reaction forces (GRFs) would precede that of upper limb forces. While the compensation of linear forces during APAs has been extensively studied, the anticipatory control of horizontal moments—arising, for example, when pulling a handle at an angle—remains unveiled. This study investigates whether and how horizontal moments are compensated during the APA phase. METHODS: Twelve right-handed, able-bodied adults (23 ± 2 years, 10 males, 2 females) performed an isometric handle-pulling task with either hand. The pulling force, targeted at 5% of body weight, was measured using a force sensor. The pulling direction was straight, inward, or outward (45° angles, respectively). GRFs and moments under the left and right feet were measured using two force plates. The onset of hand force was defined as the time when the hand force norm exceeded 5% of its peak. Any changes in GRFs and moments observed before this onset were considered part of the APA. The GRFs and moments during APA were compared between the pulling hand (left and right) and pulling direction (left, straight, and right) using two-

way repeated measures ANOVAs. One-dimensional statistical parametric mapping (SPM1D) was applied to compare horizontal moments across pulling directions. RESULTS: For each hand and pulling direction, GRFs and moments were directed opposite to those applied to the hand. The SPM1D analysis revealed that condition-specific GRFs and horizontal moments preceded the hand moment signal by up to 35 ms. Additionally, asymmetric GRFs were observed under the left and right feet, contributing to the net horizontal moments during the APA phase. CONCLUSIONS: The findings demonstrate that GRFs and horizontal moments are anticipatorily controlled to counteract both linear and rotational perturbations associated with handle pulling. The condition-specific observed ground reaction moments during the APA phase were generated by altering the amplitude and direction of GRFs under each foot. Future researches should investigate APAs for rotational perturbations in the horizontal plane in populations with asymmetric motor functionality, such as children, older adults, and individuals with pathological conditions. ACKNOWLEDGEMENTS AND FUNDING: This work was supported by JSPS KAKENHI Grant-in-Aid, Grant Numbers: 24K02840 and 24K14530

P01-G-66 - Postural control and EEG during quiet standing with different attentional focus conditions

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1) Background and aim: Attentional focus has an important effect on motor learning and performance. Adopting an external focus leads to better postural control than an internal focus, as seen by decreases in postural sway amplitude and variability. A concurrent cognitive task tends to externalize focus even more, leading to greater reductions in postural control measures. The current experiment aimed to use electroencephalography (EEG) to determine how attentional focus affects brain electrical activity during postural control. I hypothesized that an external focus and concurrent cognitive task would lead to better postural control compared to an internal focus and to quiet standing without focus instructions. I also hypothesized that EEG would show changes in alpha and beta spectral power related to the conditions of quiet standing.2) Methods: Six young adults (aged 20–40 years) stood on a force platform while wearing a 64-channel scalp EEG system. They stood quietly under four conditions: quiet standing without specific focus, internal focus on minimizing movements of their ankles, external focus on minimizing the movement of markers attached to their ankle joint, and with a concurrent cognitive task which consisted of counting the occurrence of a single digit in a 3-digit number sequence. Centre of pressure data allowed me to calculate sway variability and sway amplitude, which were compared across conditions. I pre-processed EEG and quantified EEG spectral power across the four conditions in two frequency bands of interest (alpha, 8–12 Hz, and beta, 13–30 Hz).3) Results: Results reveal a significant effect of condition on sway variability in the medial-lateral direction (F = 4.30,

p<0.05) and a significant effect of condition on the amplitude of sway ($F = 3.85$, $p<0.05$). The external focus and concurrent cognitive task conditions had smaller medial-lateral sway variability than the other conditions. The concurrent cognitive task had smaller sway amplitude than other conditions. As illustrated in Figure 1, spectral power of the EEG data in the alpha and beta frequency bands indicate lowest spectral power in the external focus condition, and the highest spectral power in the concurrent cognitive task condition. 4) Conclusions: Preliminary results suggest that the external focus of attention and concurrent cognitive task both had a positive effect on postural control compared to the quiet standing and internal focus, but had contrasting effects on EEG spectral power in alpha and beta bands. The difference in EEG contributions supports the idea that different neural processes are involved in improved balance with an external focus vs. a concurrent cognitive task. Additional data collections are ongoing to enable a more advanced computational analysis for the study.This work is supported by the Manitoba Medical Service Foundation (MMSF; 2021-17) and the Natural Sciences and Engineering Research Council of Canada (NSERC; RGPIN-2024-06128).

P01-G-67 - Wavelet-based time-frequency analysis reveals age-related decline and fatigue-induced increase in beta-band intermuscular coherence in ankle muscles during gait

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Background and aim: The neuromuscular basis underlying the relationship between age-related gait and cognitive deficits remains poorly understood. Examining the potential age-effects on the (re)organization of neural drive to leg muscles following a mentally demanding cognitive task (i.e., mental fatigue) may help to clarify age-specific adaptations in the neuromuscular control of gait. By analyzing intermuscular beta-band (15–35-Hz) wavelet-based time–frequency coherence (WCA), we can infer the organization of the presynaptic drive that underlies the oscillatory coupling between muscles. The study’s aim was to determine the effects of age and mental fatigue on intermuscular beta-band WCA measured during treadmill walking. Methods: Healthy young (n = 14, age: 20–25 years, 5F) and older (n = 14, age: 66–77 years, 5F) walked on a treadmill (1.2 m·s-1) before and after a mental fatigue protocol, induced by 3 demanding mental tasks: The Psychomotor Vigilance Task, and the AX-Continuous Performance and the Stroop. The performance on tasks and self-reported fatigue were measured. Average and standard deviation (SD) of stride length, width, swing time, stance time, and cadence in 100 consecutive gait cycles were calculated. In the same cycles, we computed intermuscular beta-band WCA between the following muscle pairs: biceps-semitendinosus, rectus-vastus, gastrocnemius-soleus, tibialis-peroneus, rectus-biceps; tibialis-gastrocnemius. To examine the main and interaction effects of Age (Older vs. Younger) and Time (Pre vs. Post fatigue), Statistical Parameter Mappings F and

ANOVAs tests were applied. Results: Older vs. Young adults had 12–65% longer reaction time for the PVT and Stroop, and both age groups increased reaction time by 15% at the end of the protocol ($p<0.05$). Self-reported fatigue increased by 30% in both age groups ($p<0.01$). After mental fatigue, SDs of stride length and stance time increased in both age groups. Older vs. Young walked with decreased intermuscular beta-band WCA for tibialis-peroneus and tibialis-gastrocnemius (Age main effects – Table 1). After fatigue (Time main effects – Table 1), both participants (pooled data) increased intermuscular beta-band WCA between biceps-semitendinosus, rectus-vastus, tibialis-peroneus, gastrocnemius-soleus, and tibialis-gastrocnemius. Conclusion: We observed that while old age might weaken oscillatory coupling between selected ankle muscle pairs during gait, reflecting impairment in the organization of presynaptic neural drives to leg muscle pairs, intermuscular beta-band WCA measured during gait increased after mental fatigue independent of age. Thus, age and mental fatigue induce different and independent effects on intermuscular beta-band WCA measured during gait in healthy young and older adults' leg muscles. Acknowledgments: This work was supported by the IDOR/Pioneer Science Initiative [(www.pioneerscience.org)].

P01-G-68 - Walking energy expenditure and metabolic cost are elevated on treadmills compared to overground at faster speeds: A study on young Japanese females

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Background and Aim: Previous research has shown that at similar speeds, the energetics of walking are not similar between overground and treadmill. This is mainly true for elderly, (Parvataneni et al., 2009, Berryman et al., 2012) whereas not many studies have been conducted on young people. In our previous studies (Das Gupta et al., 2021, 2023) we showed that at preferred speeds, the energetics are same between overground and treadmill for young people, but not for elderly; especially if they are not well familiarized to walking on a treadmill. In this study, we wanted to explore (especially for non-preferred speeds) if the energetics are similar or different for young Japanese females between overground and treadmill. Based on previous work, we hypothesized that at comfortable speeds there will be no difference between overground and treadmill energy expenditure and metabolic cost. Additionally, we were explorative about slow and fast walking speeds and speculated that the two variables might differ for these two speeds between the two walking modalities. Methods: We used three walking speeds for this study, Slow (1.0 m/s), Comfortable (1.3 m/s) and Fast (1.5 m/s). Using a Minato Medical (Japan) system, we measured resting (seated), overground (OG) and treadmill (TM) oxygen consumption rates in 10 young females (mean age 21 ± 1.9 years, mean height 1.58 ± 0.04 m, mean weight 49.6 ± 5.4 kg). After a treadmill familiarization of 10 minutes, half of the participants first walked overground and then on a floor-level treadmill (with normal arm

swing) and the other half followed the reverse pattern. The walking speeds were randomized for both overground and treadmill walking. Gross and net energy expenditure (and metabolic costs) were calculated from the rates of oxygen consumption and Respiratory Quotient. The shoe-type was controlled in this study. Results: We found statistically significantly elevated gross and net energy expenditures and metabolic costs ($p<0.05$ and Bayes Factor (BF)>3) for only the fast walk condition on the treadmill compared to overground. Though the mean values of energy expenditure and metabolic costs were also higher on the treadmill for the slow and comfortable walking speeds, they were not statistically significant ($p>0.05$ and BF<3). At similar speeds, the number of gait cycles recorded were statistically significantly higher ($p<0.001$, BF>3000) on treadmills, possibly suggesting a higher cadence. The pictorial details of the key results are given in the attached pdf.Conclusions: This study shows that even for healthy young females, treadmill walking cannot be fully generalized to overground walking and the discrepancy is prominent at faster walking speeds. This suggests that at faster speeds, there is an additional energetic demand to stabilize the body and maintain balance on treadmills, thereby resulting in the elevated energy expenditure and metabolic cost.Funding: Personal grant of the last author

P01-G-69 - Postural classification of healthy walking across diverse age groups

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Background and aimUnderstanding the characteristics of healthy walking, which serve as normative data, is essential for identifying health-related pathologies and disorders. Gait characteristics are influenced by various factors, including physical attributes such as height, weight, muscle function, and age, all of which can affect posture during walking. Although a few previous studies have examined the characteristics of healthy walking, a comprehensive analysis of walking posture across diverse age and sex groups remains lacking. This study aimed to classify postural patterns in healthy human walking using an extensive gait database that includes individuals across a wide age range. We used previously collected kinematic and kinetic walking data from over 100 individuals aged from 20s to 70s (Kobayashi et al., 2019). MethodsThree-dimensional whole-body kinematic data were collected from 120 participants aged from 20s to 70s, with 10 males and 10 females in each age group. Participants walked along a 10-meter walkway at a comfortable speed, and the data were acquired using a three-dimensional motion capture system combined with force plates. Joint angles over a gait cycle for the pelvis segment, lumbar joint, and both the right and left hip, knee, and ankle joints were calculated and used for the analysis.Principal component analysis (PCA) was conducted on the segment/joint angle data, time-normalized across a gait cycle, to extract the primary features of individual walking postures. Cluster analysis was then applied to classify these principal components into several postural types in walking. Walking posture reconstructed from the principal components derived through PCA were analyzed to reveal the specific features and types of walking postures associated with each cluster. Demographic information such as age and biological sex, was used to understand the attributes of each cluster. ResultsWalking postures were classified into four clusters (Fig. 1). Clusters 1 and 2 included a higher proportion of male participants and were characterized by a larger posterior pelvic tilt and hip abduction compared to the other clusters. In contrast, Cluster 4 included more female participants and exhibited a larger anterior pelvic tilt and hip adduction. Cluster 3 featured a nearly equal number of male and female participants and showed average characteristics relative to the other clusters.The mean ages of the clusters were 48 years, 51 years, 42 years and 54 years, for Cluster 1, 2, 3, and 4, respectively. Cluster 3 predominantly consisted of individuals aged 20 to 40, whereas the other clusters showed no clear age-related distribution patterns. Conclusion These results suggest that walking posture can be categorized into four types, with biological sex as a primary influencing factor. This classification could be further characterized by differences in pelvic and hip movements. These findings may be useful for identifying deviations from healthy walking postures, particularly those associated with pathological conditions or movement disorders. Acknowledgements and fundingThis research received no specific grants from any funding agencies.

P01-G-70 - Evaluating foot placement strategy in response to whole body linear and angular momentum perturbation during treadmill walking – preliminary results

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BACKGROUND: Control of both linear momentum of the center of mass (COM) and whole-body angular momentum around the COM (referred to as angular momentum) is crucial for robust walking. This can be achieved by adjusting external forces and moments on the body, specifically the ground reaction force and center of pressure during gait as gravity is constant. Healthy individuals use strategies to change the ground reaction force, including adjusting foot placement and modulating muscle force in the stance limb resulting in changes in joint moments and ground reaction forces. Stability during movement is often analyzed using the extrapolated center of mass (XCOM), which accounts for both COM-position and velocity. However, most studies analyze balance strategies (i.e. foot placement) as a function of linear momentum and do not account for angular momentum. Likewise, the XCOM concept does not account for angular momentum control. Additionally, perturbation studies are typically done on a small treadmill, which may constrain foot placement and influence balance control strategies.AIM: To increase understanding of balance control during gait, we (1) evaluated whether XCOM position can explain foot placement after linear and angular momentum perturbations, and (2) if treadmill size influences balance recovery strategies. We hypothesized that (1) XCOM is not a reliable predictor of foot placement after angular momentum perturbations, and (2) if XCOM falls outside the treadmill boundary, the margin of stability will be negative, requiring multiple steps to recover balance. METHODS: Fourteen healthy subjects (4 men, mean weight: 70 ± 10 kg, height: 1.72 ± 0.06 m) walked on a large (250cm x 450cm) and small (170cm x 75cm) treadmill at slow (2km/h) and normal (5km/h) walking speeds. Perturbations were applied using motors attached to the pelvis (linear momentum perturbations) or both pelvis and shoulder in opposing directions (angular momentum perturbations) (Tan et al., 2020). Perturbations were applied at initial contact, lasted 300ms, had an average force of 70N, and were separated by 8 to 12 seconds. Kinematics were recorded with a Qualisys motion capture system, and perturbation forces were measured using force sensors. The primary outcome was foot placement location, compared to XCOM, calculated at heel-strike during unperturbed walking, and at first toe-off and heel-strike after perturbation. Statistical analysis involved repeated measures ANOVA to assess differences between conditions (small vs. large treadmill, and linear vs angular momentum perturbations).RESULTS: Foot placement was close to XCOM across all conditions, including during both linear and angular momentum perturbations. Both treadmill size and perturbation type influenced step width.CONCLUSIONS: Neither of our hypotheses were supported by the data. XCOM can predict foot placement after linear and angular momentum perturbations, and treadmill size influenced step width but not heel-strike and toe-off placement. The results may suggest compensation in the stance limb during perturbations, which could be reflected in muscle activity and kinematics.

P01-G-71 - Effects of dual tasking on digital turning parameters during a 180˚ turn while walking among people with mild cognitive impairment

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Background and aim: Decreased turning ability may be an early motor sign for those at risk of cognitive decline, and performing a concurrent cognitive task may highlight such difficulties. The aim of this study was to examine the effects of dual tasking on digital turning parameters (i.e., turn duration and peak angular velocity) during a 180° turn while walking, in people with mild cognitive impairment (MCI).Methods: The sample included 199 participants with MCI (Mean [SD] age 74.1 [7.1] years, 42.2% women). Turning 180˚ while walking (the first turn in the Timed up and Go test) was assessed as a single task and while dual tasking (subtraction task, -3), i.e. in comfortable pace. The included turning parameters were peak angular velocity (°/s) and turn duration (s), which were measured by using a lumbar sensor (Mobility Lab, Clario®). Assumptions of normality were met. Paired-samples t-tests were conducted to compare turning parameters for the single and dual task turn. Effect sizes (Cohen's d) were calculated. Results: While dual tasking, the turn duration significantly increased, i.e. they turned slower: mean 3.01s (SD = 0.64) versus 3.37s (SD = 0.77), $p < 0.001$. The effect size was 0.42 (95% CI= 0.27 – 0.56). Moreover, the peak angular velocity significantly decreased while dual tasking: mean

144.02 ˚/s (SD = 39.90) versus 113.15 ˚/s (SD = 34.67), p<0.001. The effect size was 0.98 (95% CI= 0.81 – 1.16). Conclusions: Dual tasking notably affects a 180 ˚ turn while walking in individuals with MCI, particularly peak angular velocity. Our findings suggest that dual tasking has a large effect on turn peak velocity and has a low (to moderate) effect on turn duration. Peak angular velocity of a 180˚ turn while walking seems a promising variable for future dual task studies in people with MCI.

P01-G-72 - The effect of acoustic startle reflexes on lower limb muscle coordination patterns during gait

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Background and aimThe acoustic startle reflex (ASR) is a protective flexion response to sudden loud sound stimuli and plays an important role in maintaining posture and preventing falls. ASR has been shown to modulate lower limb muscle activity in a phase-dependent manner during gait. Given that the reticulospinal tract (RST), a neural pathway underlying the ASR, influences spinal interneurons extensively, ASR could potentially alter muscle coordination patterns dynamically. This study aimed to investigate the phase-specific effects of ASR on lower limb muscle coordination during gait.MethodsSixteen healthy participants walked on a treadmill while being exposed to normal (80 dB) and acoustic startle (120 dB) stimuli during either the stance or swing phase of the gait cycle. Electromyograph were placed on the dominant leg's tibialis anterior, soleus, medial gastrocnemius, vastus medialis, rectus femoris, semitendinosus, biceps femoris, gluteus medius, and sternocleidomastoid muscles. Muscle coordination patterns (muscle synergies) were extracted from eight lower limb muscles using non-negative matrix factorization. Common synergies among participants were identified via hierarchical cluster analysis and, cosine similarity was used to compare synergy weightings across conditions.ResultsDuring the stance phase, ASR modulated lower limb muscle activity, with most muscles exhibiting facilitation, while the soleus and gastrocnemius were inhibited. Cluster analysis showed that during the stance phase, three muscle coordination patterns were identified in both the no-sound and sound conditions, while four patterns were identified under the startle condition. The additional pattern observed under the startle condition consisted of the tibialis anterior and hamstrings. The cosine similarity of this novel coordination pattern was significantly lower between conditions, whereas the other synergies remained consistent across conditions. For stimuli applied during the swing phase, four muscle coordination patterns were identified in each condition, and all patterns remained consistent across conditions.ConclusionsAlthough ASR selectively influences individual muscle activity, it largely preserves basic muscle coordination patterns. Notably, ASR during the stance phase induced a flexor muscle synergy typically associated with the swing phase, suggesting an enhancement of the flexion reflex. These findings contribute valuable insights into the neural control of gait and the phase-dependent modulation of muscle coordination by ASR.Acknowledgements and fundingWe sincerely thank the staff of the Kio University Neuro-Rehabilitation Research Centre for their valuable advice and cooperation throughout this study. This research did not receive any specific funding from public, commercial, or non-profit organizations.

P01-G-73 - Increased attentional resources may be required to maintain standing balance under conditions of altered visual and somatosensory feedback

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Background & Aim: Growing evidence implicates somatosensory impairment as a major contributor to balance and walking dysfunction among people with MS (PwMS). Somatosensory feedback is vital to detecting postural instability, providing an ongoing representation of the body's movements and interaction with the environment. Impaired somatosensation may require compensation to maintain balance, which could include greater attentional resources or increased reliance on vision to maintain posture. The dorsolateral prefrontal cortex (DLPFC) has been implicated in allocating attentional resources to maintain postural control, and activity in the DLPFC associates with better balance among older adults. However, whether increased DLPFC activity relates to somatosensory status is not known. Sensory reweighting is also known to shift reliance on feedback from less reliable modalities to those that are more reliable, thus it is possible that there may be greater reliance on visual feedback among individuals with impaired somatosensation or when somatosensory feedback is unreliable. Therefore, the purpose of this study was to evaluate the contribution of attentional resources and sensory reweighting to balance maintenance, as measured by changes in cortical activity, under conditions of altered sensory feedback during standing balance. These findings are part of an ongoing study also evaluating PwMS. Methods: Fifteen healthy, neurotypical participants aged 21-58 (1.7±0.1m; 69.9±17.8kg;13F) participated in the study, completing proprioception and vibration perception tests (VPT), and the modified Clinical Test of Sensory Interaction in Balance. Activity in the DLPFC, somatosensory and visual cortices was measured using fNIRS (NIRx Sport2), while inertial sensors (Moveo Explorer, APDM) tracked postural sway. Repeated measures ANOVA assessed vision and surface condition effects. Results: Somatosensory function was within normal range for all, but VPT worsened with age (r=0.63). Increased RMS sway and decreased sway smoothness (both P=0.008) were evident with vision occluded and compliant surface. Activity in the DLPFC increased with vision occluded and compliant surface (Vision X Surface:P=0.012). Visual cortex activity tended to decrease with vision occluded (P=0.11); however, the somatosensory cortex demonstrated no change. Conclusions: Increased DLPFC activity with altered vision and somatosensory feedback suggests increased reliance on attentional resources to maintain balance. Reduced activity in the

visual cortex under vision occluded conditions did not appear to be compensated by activity in the somatosensory cortex, however areas involved in sensory integration were not assessed and could demonstrate altered activity. Future investigations among PwMS and others with significant somatosensory impairment may provide further evidence to support a compensatory relationship between decreased somatosensation, and increased DLPFC and visual cortex activity.

P01-G-74 - The contribution of upper limbs when landing from a jump in young children

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Background and aim:Landing from a jump involves a complex control of the body segments to land smoothly and dissipate the energy accumulated during the aerial phase. The contribution of the upper limbs has been observed in adults during energy generation, but their contribution remains unknown during energy dissipation.1,2 The aim of the present study is to gain insight into the upper limbs contribution when landing from a jump and highlight the change during childhood.Methods:68 children (3-12 years) and 21 adults were asked to perform double-leg landings by hopping off a box of different heights (10, 30, 50 and 70 cm). No further instruction was provided about upper limbs movements. The energy of the center of mass of the body (ECoM) was computed from the ground reaction force (recorded by force plates) and the energy of the upper limbs (EUL) was computed from the kinematic (recorded by a Qualisys motion capture system). During the aerial phase ECoM cannot change but the distribution of energy among body segments can. To capture the behavior of upper limbs, the change in EUL during the aerial phase and the relative amount of energy (EUL/ECoM) at touchdown (TD) were investigated in adults and children as a function of box height (Fig. A).Results:Regardless the age, EUL increases during the aerial phase preceding TD, except when landing from a box of 10 cm (Fig. B). This increase is more pronounced for higher box heights. The ratio EUL/ECoM at TD tends to increase with the box height (Fig. C). In adults landing from a box of 70 cm, EUL/ECoM equals ~18%, exceeding the relative weight of the upper limbs which equals ~11–12% of the body weight.3 Interestingly EULtends to decrease during the aerial phase in the youngest children hopping off a box of 10 cm and EUL/ECoMat TD approaches the relative weight of the upper limbs.Conclusions:The energy of the upper limbs increases during the aerial phase preceding the ground contact, highlighting the active contribution of upper limbs when landing from a jump, especially when a large amount of energy has to be dissipated (higher box height). This energy redistribution strategy may enhance the involvement of upper limb muscles in the energy dissipation when landing. Note that in young children at the lowest height, the amount of energy of the upper limbs is similar to their relative weight, suggesting a more passive role compared to adults. Overall, the active contribution of the upper limbs in energy dissipation is augmented as the task becomes more challenging in adults and in children.

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P01-G-75 - Effects of dual-tasking on stepping strategy and inter-joint coordination during walking in older adult fallers and non-fallers

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Background and Aim Falls are a major public health concern among older adults, often leading to injuries, impaired mobility, and loss of independence. Many falls occur during walking. Therefore, understanding gait patterns between fallers and non-fallers may guide the development of fall prevention strategies. Dual-task walking, which involves a secondary task while walking, simulates daily challenges and is closely linked to fall risk. This study aimed to investigate the effects of dual-tasking on stepping strategies, inter-joint coordination, and coordination variability during walking in older adults with and without a history of falls.Methods Twenty community-dwelling older adults (10 fallers and 10 non-fallers), aged 65 and older, participated in a 2-minute walking test under three conditions: (1) Single-task walking at a self-selected speed; (2) Motoric dual-task walking while holding a glass of water; and (3) Cognitive dual-task walking while performing serial subtractions. Gait data were collected using inertial measurement units (IMUs) positioned on specific lower limb and pelvic sites to measure spatiotemporal parameters. Stepping strategy was quantified using the Length-Time Difference metric and inter-joint coordination was analyzed using vector coding, enabling comprehensive assessment of coordination patterns and variability during walking. The two-way repeated measures ANOVA was conducted to evaluate the effects of task conditions and group on these variables. Results Task-specific stepping adaptations were identified. Particularly, motoric dual-task prompted greater step length adjustments, whereas cognitive dual-task resulted in greater step time adjustments ($F=7.384$, $p=0.014$, $\eta_{2p}=0.291$). Fallers exhibited higher frequencies of anti-phase coordination in hip flexion-knee flexion and in-phase coordination in knee flexion-ankle dorsiflexion during the two dual-task conditions ($p \leq 0.042$). Task effects were evident in coordination variability, with reductions observed during dual-task conditions, especially for hip flexion-knee flexion pairing ($p \leq 0.022$), reflecting a shift toward a more conservative motor control strategy. Statistical parametric mapping analysis revealed significant task effects on coupling angle waveforms across critical gait phases, including heel strike, loading response, and toe-off, which are essential for postural control.Conclusions This study provided better understanding on the differences of stepping strategies and phase-specific coordination patterns between older adult fallers and non-fallers, particularly under dual-task walking conditions. The conservative motor control strategies observed in fallers suggest a prioritization of stability over adaptability, which may heighten fall risk

during complex walking tasks. The application of wearable IMUs successfully captured these dynamic gait adaptations, demonstrating their potential for real-world assessments of gait stability and variability.

P01-I-76 - From lab to life: Deprescribing Anticholinergic and sedative medications to improve mobility in older adults

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Background & aim: Medications with anticholinergic effects are associated with adverse events affecting both peripheral (dry mouth, dry eyes, constipation, and urinary retention) and central (confusion, dizziness, drowsiness, falls, and cognitive dysfunction) systems. Medications with sedative effects have been associated with impaired cognitive and physical function as well as an increased risk of falls. The cumulative effects of these medications can be quantified using the Drug Burden Index (DBI), where higher scores are linked to decreased physical function, including mobility. Mobility can be assessed in controlled laboratory settings and real-world environments using wearable sensors. We hypothesized that deprescribing these medications, defined as a dose reduction or medication discontinuation, improves physical function in both contexts. This study's objective is to evaluate the impact of reducing anticholinergic and sedative medication burden on mobility metrics in older adults. Specifically, this study aims at exploring the impact of reducing medication burden on physical function in older adults by refined mobility, posture and stability metrics, and to evaluate if mobility changes assessed in the lab (functional capacity) translate to mobility changes in real-life settings (functional performance).Methods: Community-dwelling adults aged 60 years and older with a DBI score ≥ 1 are recruited from four primary care clinics in Sherbrooke, Quebec, Canada. Participants engage in a personalized deprescribing plan targeting a reduction in DBI score ≥ 0.3 across at least three stages. At each stage, a laboratory visit is undergone. Laboratory mobility assessment include the 10-meter walk test, and the Timed Up & Go (TUG), measured using six APDM Opal sensors. Real-life mobility assessment is assessed using two Apple Watches®, worn on the wrist and opposite ankle, during walking hours for seven consecutive days contiguous to the laboratory assessments.Results: Data from the first 17 participants who completed the deprescription protocol (mean age = 70.9 ± 5.8 years; initial DBI = 2.52 ± 1.17; final DBI = 2.01 ± 1.04; Delta_DBI = -0.51 ± 0.48) revealed improved laboratory-based mobility in 71% of cases (Delta_TUG duration = -1.2 ± 1.0 s; Delta_STS5x duration = -0.9 ± 2.2 s; Delta_Gait velocity = + 0.1 ± 0.1 m/s; Delta_Gait Double-Support time = -1.3 ± 3.2 %). Among the subset of participants achieving the minimum DBI reduction of 0.3 (53% of the sample), the proportion of participants with improved mobility reaches 80% (Delta_TUG duration = -1.4 ± 2.4 s; Delta_STS5x duration = -1.4 ± 2.1 s; Delta_Gait velocity

= +0.1 ± 0.1 m/s; Delta_Gait Double-Support time = -2.3 ± 2.9 %). Cross-analysis suggests that laboratory gait improvements may result from a combination of increased cadence (Delta_cadence = +2.8 ± 5.5 steps/min) and longer step length (Delta_step length = +3.0 ± 4.4 cm). However, real-life assessments on these participants showed no significant change in daily step count (Delta_steps = -80 ± 1347 steps/day) and only minimal variation in active time (Delta_active time = 0.5 ± 4.3%). Nevertheless, initial estimates of real-life gait velocity point to a slight improvement (Delta_Gait velocity = 0.1 ± 0.0 m/s), potentially attributable to increased step length, which should be further verified.Conclusions: These results suggest that deprescribing anticholinergic and sedative medications can yield meaningful improvements in functional mobility capacity under controlled laboratory conditions. However, the transfer of these gains to real-world settings appears to be mitigated. This discrepancy underscores the need for advanced engineering models capable of better capturing real-life gait performance. From a clinical perspective, these results emphasize the importance of developing targeted strategies to bridge the gap between improvements in mobility capacity observed in the lab and actual functional gains in daily life among older adults.

P01-I-77 - Multisegmental joint kinematics of the foot when walking in textured foot orthoses

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Background and aim: A novel foot orthosis manufacturing technique has recently emerged which capitalizes on the physiological properties of foot sole cutaneous mechanoreceptors by adding texture to the skin-orthosis interface. Although the neuromechanical benefits of this textured orthosis has been well documented [1,2], the triplanar kinematics and kinetic effects to the foot-ankle complex has yet to be determined. Thus, the purpose of this study was to analyze the kinetic and triplanar motion of the tibia, rearfoot, midfoot and forefoot when walking in different textured foot orthoses designs. Methods: Twenty-five healthy young adults (24+6yrs) completed 10 level walking trials with texture applied to 6 different zones of a foot orthosis (full length, medial forefoot, lateral forefoot, medial midfoot, lateral midfoot and calcaneus) compared to walking in an identical smooth top covered foot orthosis. Triplanar kinematic data were collected (Optotrak Certus, Northern Digital Inc., Waterloo, ON, CAN) per segment and subdivided into initial contact, midstance and propulsive phases of stance using force plates (OR6-5-2000; AMTI, Watertown, Massachusetts, USA). Rigid bodies (ND4300, Northern Digital Inc., Waterloo, ON, CAN) were adhered to 5 anatomical landmarks (tibia, calcaneus, navicular, hallux and 2nd metatarsal head) to define 5 segments of interest: forefoot, hallux, midfoot, rearfoot and tibia. Cubic spine interpolation filled in kinematic gaps and data were processed with a 6Hz low-pass filter (Visual 3d, C-motion) prior to calculating segmental angular displacement and velocity in a custom program. Repeated measures ANOVAs with two within-subject factors (gait

timing and orthotic condition) were used to identify differences between measurements ($p<.05$). Results: Compared to non-textured orthoses (initial contact(IC): [mean(SD)] 2.4º(3.7º) inversion (in),-1.2 º(3.7º) eversion (ev), midstance(MS): 0.3º(3.4º) in,-2.8º(3.8º) ev, propulsion(PR): 2.6º(4.0º) in,-3.5º(4.3º) ev), texture placed under all zones of the foot significantly reduced rearfoot eversion from initial contact to propulsion. Tukey's HSD post-hoc analysis identified the largest frontal plane changes with texture placed under the medial forefoot (IC: 4.2º(4.1º) in,0.2º(4.8º) ev, MS: 2.5º(6.6º) in,-1.0º(6.2º) ev, PR: 6.0º(8.6º) in,-0.7º(9.0º) ev) and lateral midfoot (IC: 3.4º(3.7º) in,-0.6º(3.9º) ev, MS: 3.1º(8.5º) in,-0.3º(10.2º) ev, PR: 6.2º(9.8º) in,-0.5º(10.1º) ev). Conclusions: Consistent with previous evidence demonstrating increased tibialis posterior muscle activity with texture specifically placed under the lateral midfoot and medial forefoot at initial contact [1], these results further support our ability to capitalize on the topographical organization of foot sole skin to generate phase-specific modulation of the foot and ankle complex during walking. [1] Robb & Perry (2022). Exp Brain Res. Aug240(7-8); 2175-2189. [2] Robb & Perry (2024). Exp Brain Res. Feb242(2); 403-416.

P01-I-78 - How does challenging one's gait performance in a virtual reality environment compare to the real-world?

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Background and aim: Virtual reality (VR) offers controlled environments for rehabilitation, but its outcomes must translate to real-world scenarios. This study examines the specificity of VR interventions, focusing on task difficulty and gender differences in the transferability of gait speed (GS). This study aims to evaluate the transferability of GS from VR environments to real-world scenarios. Specifically, it investigates the impact of task difficulty and examines potential differences in this transferability between male and female participants.Methods: Participants performed natural walking tasks on beams of varying widths (10cm, 15cm, 30cm) and heights (0cm, 50cm, 90cm) within both real-life (RE) and virtual reality (VR) environments. Each participant completed three trials per condition. A motion capture system (Qualisys, SE) recorded each trial. The VR environment replicated the RE environment. Data analysis focused on comparing GS between the two environments to assess VR's validity as a platform for simulated behavioral interventions. We fitted a linear mixed model to predict GS with Condition, Sex, Height and Width (GS~Condition*Sex*Height*Width). The model included ID as random effects (~1|ID, ~1 + Height|ID, ~1 + Width|ID).Results: Thirty-nine participants (20F) aged 26.4 years (SD: 4) completed the study. For GS outcomes, the model's intercept corresponded to Condition = RE, Sex = Female, Height = 0 and Width = 0, is at 0.74 (95%CI [0.64, 0.85], $t(676)=14.13$, $p<.001$). Within this model: The effect of Condition [VR] is statistically significant and negative (beta=-0.10, 95%CI [-0.18, -0.02], $t(676)=-2.40$, $p=0.017$). The effect of Sex [Male] is statistically non-significant and negative (beta=-0.02, 95%CI [-0.16, 0.13], t(676)=-0.21, p=0.832). The effect of Height is statistically significant and negative (beta=-4.85e-03, 95%CI [-5.91e-03, -3.79e-03], t(676)=-8.97, p <.001). The effect of Width is statistically significant and positive (beta=0.02, 95%CI [0.01, 0.03], t(676)=5.30, p<.001). The effect of Condition [VR] × Height is statistically significant and positive (beta=3.80e-03, 95%CI [2.40e-03, 5.20e-03], t(676)=5.33, p<.001). The effect of Condition [VR] × Width is statistically non-significant and negative (beta=-7.56e-04, 95%CI [-0.01, 9.45e-03], t(676)=-0.15, p=0.884).Conclusion : This study highlights the transferability of GS from VR to real-world scenarios. GS was slower in VR, emphasizing the need for calibration to ensure ecological validity. Beam height negatively affected GS, while greater width increased it. Height effects were moderated in VR, but width effects remained consistent. Sex did not significantly influence GS, suggesting generalizability. These findings underscore the importance of designing VR environments that replicate real-world challenges for effective rehabilitation.ACKNOWLEDGEMENTS AND FUNDING: This study was funded by the New Brunswick Healthy Seniors Pilot Project, Public Health Agency of Canada and Research NB.

P01-I-79 - The dynamics of balance recovery post-stroke; a critical period, regression to the mean or inpatient rehabilitation

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Background and Aim: Balance is a critical aspect of post-stroke rehabilitation, directly affecting mobility, independence, and fall risk. Understanding changes in balance during the recovery process can help refine rehabilitation strategies. This study aimed to examine how the balance of persons with stroke (PwS) evolves over the first 6 months post-stroke, with a specific focus on potential time-dependent trends and influencing factors.Methods: Thirty-three PwS participated in a longitudinal study assessing their balance at 3 time points: within the first month post-stroke, at 3 months, and at 6 months. Balance was measured during narrow-based stance for 90sec on an electronic force-sensing mat. Participants were instructed to stand as still as possible to assess the steadiness of postural sway. Key balance metrics were based on center of pressure (COP) dynamics and included sway area, velocity range and standard deviation in both the anteroposterior and mediolateral directions. Results: Significant improvements in balance metrics were observed between the first and third months post-stroke (p<0.05). However, from the third to the sixth month, no changes were observed. First, we asked if the lack of effects in the 3-6 months period stems from a critical period in balance recovery or reflects the fact that a significant proportion of the PwS recovered their balance by the third month. We examined the 3-6 months recovery of the subjects grouped by their 3 months balance scores. This analysis showed no difference between the impairment groups, suggesting that the lack of improvement between 3 and 6 months

is not driven by a group average or a ceiling effect.Next, we asked if the 3-6 month dynamics is associated with the termination of rehabilitation. We therefore examined whether participation in outpatient rehabilitation affected this dynamics. Fourteen participants attended outpatient rehabilitation, while 19 did not. Both groups did not improve their balance (p>0.05).Conclusions: The findings indicate that the majority of balance improvements occur during the first three months post-stroke, followed by a period of minimal change, or even decline. The absence of differences between those who attended and those not attending outpatient rehabilitation, suggests that external rehabilitation factors may have limited influence on balance recovery during this phase. This raises broader questions: Is this a reflection of a natural critical period of balance recovery? Or could other external factors, such as the transition from inpatient to home-based rehabilitation settings, contribute to these trends? Further research is needed to disentangle the roles of natural recovery and rehabilitation environments in shaping post-stroke balance outcomes.

P01-J-80 - Effects of physical activity on brain white matter integrity are region-, dose- and age- dependent: Findings from the population-based Rhineland study

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Background and Aim: Physical activity (PA) has been associated with improved white matter (WM) integrity, yet previous studies have been limited by self-reported measures of PA and small sample sizes. Furthermore, it remains unclear whether the effects of PA on WM integrity are dependent on age, brain region, or PA-dosage. To address these gaps, we examined the association between accelerometer-based PA and indices of brain imaging-derived WM integrity in a large population-based cohort. Methods:We analyzed data of 4,191 participants (55.4% women, mean age: 55.4 years) with available PA and brain imaging data from the Rhineland Study, a prospective population-based cohort study in Bonn, Germany. We recorded PA using accelerometers and derived metabolic equivalent hours, as well as step counts and time spent performing sedentary, light-intensity and moderate-to-vigorous activities. Fractional anisotropy, mean diffusivity, orientation dispersion index (ODI), and neurite density index (NDI) were obtained from 3T MR images using the microstructure diffusion toolbox across the whole brain and across 27 white matter tracts. The association of PA with WM integrity was assessed using multivariate polynomial regression, while adjusting for age, sex, education, hypertension, body mass index and smoking status. Results:Higher PA was related to lower global mean ODI, with the association levelling off at higher amounts of PA (standardized blinear = -0.062 [-0.091; -0.033] and bquadratic = 0.024 [0.008; 0.0039], both $p \leq 0.003$). PA was linked to decreased NDI and ODI in motor tracts, largely independent of age (NDI: superior and inferior cerebellar peduncle, medial lemniscus and corticospinal tract (standardized bs ranging from -0.059 to -0.044, all $p < 0.001$); ODI: superior and middle cerebellar peduncle (standardized bs -0.051 and -0.063, respectively, both $p < 0.001$)). With advancing age, PA was associated with a stronger increase in NDI and a more pronounced decrease in mean diffusivity of association and commissural fibers. PA increased WM microstructural integrity in the splenium of corpus callosum, with the strength of the association increasing with higher age. Conclusions:PA is related to WM integrity in a nonlinear, age- and region-specific way. Sedentary and older individuals may benefit most from PA. Future work is needed to elucidate the regionally differential effects of PA.

P01-J-81 - Standing versus sitting down again: Does the task end-goal affect sit-to-stand performance?

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BACKGROUND and AIM: Sit-to-stand (Si-St), a critical functional activity, entails moving the body from a seated position to upright standing. Ability to repeatedly transition between sitting and standing is used to assess leg strength, mobility, and fall risk in elderly. While factors such as seat height, foot position, arm support play a role, it is not known how Si-St performance is affected by the task end-goal, i.e., standing only or sitting down again. The present study investigated the differences in Si-St motion when it is executed as a discrete task versus as part of a continuous cycle, with or without a pause [i.e., the Si-St component of the sit-to-stand-to-sit cycle (Si-St-Si)], and whether the differences are dependent on seat height (SH). METHODS: 10 healthy adults (7 males, age: 26.8 ± 3.97 years) participated in 3 blocks (pseudorandomized): 80%, 100%, and 120% SH (defined as % knee height). In each block, subjects executed the Si-St motion at their comfortable speed under 3 conditions (pseudorandomized): as a discrete task (Si-St_D); as part of a continuous Si-St-Si task with a brief pause (1-2 s) before sitting down again (Si-St-Si_P); and as part of a continuous Si-St-Si task with no pause (Si-St-Si_NP). Vertical ground reaction forces (VGRF) were recorded via 2 force plates, based on which start and end of Si-St motion were identified and it was divided into 5 phases (initiation, seat unloading, propulsion, deceleration, and rebound recovery with stabilization). Total duration of Si-St movement, its phase-wise durations (s), and weight-normalized peak foot VGRF were computed. Repeated measures ANOVAs with post-hoc tests were conducted. RESULTS: For Si-St-Si_NP, total duration of Si-St component (1.59 ± 0.32) and duration of only the stabilization phase (0.31 ± 0.10) were shorter than those of Si-St_D (1.74 ± 0.25; 0.45 ± 0.11) and Si-St-Si_P (1.75 ± 0.30; 0.43 ± 0.12), respectively (all $p<0.017$); with no differences between latter two tasks. Peak VGRF during Si-St component of Si-St-Si_NP (1.23 ± 0.09) was greater only than that during Si-St_D (1.20 ± 0.07) ($p<0.017$). These differences in Si-St performance were not affected by SH (no interaction effect). CONCLUSION: The performance of Si-St movement is affected by end-goal of the activity, specifically by end-position and presence/absence of a brief pause. Lack of differences between Si-St_D and Si-St-Si_P shows that in presence of a

pause, the Si-St movement is controlled similarly, irrespective of the end-position. However, absence of a pause, makes Si-St more challenging in balance (briefer rebound recovery and stabilization) than with pause and also more effortful (greater peak VGRF) than just the discrete task, indicating a substantial change in motor strategy used. Collectively, these findings provide insights into the clinical value of repeated Si-St activity in predicting fall risk and form a basis for developing targeted rehabilitation interventions. FUNDING: IITB-SCAN

P01-J-82 - Three-week video- and home-based training program for people with Ataxia

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Background and Aim: Progressive gait and balance impairment is a prominent and disabling feature in people with degenerative cerebellar ataxia. Exercise and physiotherapy are among the most effective support measures currently available. Targeted, intensive training programs have shown potential to improve mobility, reduce fall risk, and enhance well-being. We conducted a rater-blinded, parallel 3-arm randomized controlled trial with delayed-start-design (exploratory proof-of-concept study) in people with degenerative hereditary cerebellar ataxia. We examined whether the distribution of training sessions across the week, with equal total training time and content, affects the training effect, and how clinical characteristics interact with training success.Methods: Clinical (ataxia rating: SARA, impairments in activities of daily living: ADL, well-being: FAHW) and digital (force plate, motion capture system, smartphone) gait/balance measures were assessed before and after a three-week video-based gait/balance training: 4x20min/week training was performed in group Train20 (n=11, age 52.8±12.7 years [y], 6 female, 7 pure cerebellar, SARA 9.6±3.5) and 2x40min/week in group Train40 (n=11, 56.6±8.6y, 6 female, 5 pure cerebellar, SARA 7.9±3.8). 10/32 participants belonged to the control group (57.9±12.8y, 2 female, 9 pure cerebellar, SARA 8.2±3.3). Group differences at baseline and changes over time were analyzed using ANOVA. Linear mixed models assessed the influence of clinical variables on outcomes. Further exploratory analyses included intraclass correlation coefficients (ICC) and paired t-tests within each group.Results: Groups did not differ in age, gender, number of pure cerebellar ataxias, SARA score, amount of physiotherapy and sports/week ($p>0.155$). All force plate variables showed good to excellent test-retest reliability (ICC≥0.69). No significant interactions between group and measurement time were found for clinical or gait/stance variables ($p \geq 0.338$). Participants with higher initial disease severity or greater

ADL impairment improved significantly in feet-together stance (both p=0.04), and those with better well-being improved in normal (p=0.01) and backward gait (p=0.03). Exploratory analyses showed improvement only in Train40 in gait velocity (p=0.03), stride time (p=0.05) and double support proportion (p=0.03) in normal gait, and in step width of backward gait (p=0.01). Data from the motion capture system and smartphone are still being analyzed.Conclusions: Force plate data indicated that the training protocols did not yield overall improvements, regardless of training frequency. In subgroup analyses, people with higher initial disease severity, higher functional impairment, or better mental well-being showed significant benefits. Greater attention should be given to the impact of well-being to enhance motor training outcomes, and longer, less frequent sessions may offer greater potential for improvement in mild/moderate ataxia.

P01-J-83 - The influence of ankle joint angle and surrounding ankle muscles on hip muscles

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BackgroundHip abductor weakness is a common problem in patients with low back pain, knee osteoarthritis, and hip disorders, negatively affecting pelvic stability, gait control, and overall function. Side-lying hip abduction exercises are widely used to enhance gluteus medius activity and are considered safe and effective for patients who struggle with high-load or weight-bearing exercises (Bolgla et al., 2005). However, research on how ankle joint angles and muscle activity influence hip abductor muscles is limited. Clarifying these factors may contribute to improved rehabilitation strategies.PurposeThis study aims to clarify the effects of ankle joint angles and associated muscle activity (distal) on the strength and activity of hip abductor muscles (proximal).MethodsFifteen healthy male adults (age: 29.1 ± 5.4 years) volunteered for the study after providing informed consent. Surface EMG electrodes were placed on the tensor fasciae latae (TFL), gluteus medius (G-med), gluteus maximus (G-max), tibialis anterior (TA), and medial gastrocnemius (MHGM). Signals were sampled at 1,000 Hz using VitalRecorder2, band-pass filtered (10–500 Hz), and normalized to %MVC. Participants performed maximal hip abduction exercises in a side-lying position. Ankle positions were set to three angles (neutral, dorsiflexion, and plantarflexion), and for each angle, three activation states were assessed: no activation, maximal dorsiflexion effort, and maximal plantarflexion effort, yielding nine conditions. Hip abduction strength was measured with a handheld dynamometer secured to the bed with a belt. Two-factor repeated-measures ANOVA was conducted to evaluate the effects of ankle angles and activation conditions on hip abduction strength and EMG activity. ResultsHip abduction strength was significantly higher in dorsiflexion compared to neutral and plantarflexion ($p < .001$). TFL and G-med activity showed the highest values during dorsiflexion, particularly under maximal dorsiflexion effort. EMG amplitudes of the G-max were also higher in dorsiflexion but were less pronounced compared to TFL and G-med. (Table1)ConclusionThe results indicate that ankle dorsiflexion enhances hip abductor muscle activity and strength. This may be due to increased fascial tension in structures such as the Lateral Line and Superficial Back Line, which stabilize the hip muscles. Dorsiflexion also optimizes lower limb alignment, aiding force generation in the hip abductors. Clinically, this approach may improve hip abductor training for patients with mobility limitations or during post-surgical recovery.AcknowledgementsWe received tremendous support and cooperation from many individuals throughout the execution of this research. We would like to express our deepest gratitude to all those who assisted us. We are especially grateful for the invaluable advice, guidance, and efforts devoted to providing an optimal experimental environment. We take this opportunity to extend our heartfelt thanks to everyone involved in this study.

P01-K-84 - Biomechanical predictors of loss of balance during handstand and handstand-walking

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1) Background and aimVarious biomechanical indicators of standing and walking balance have been suggested for predicting fall risk in populations with balance impairments [1]. However, falls are rare events that are almost never measured in a laboratory context, making it difficult to establish a direct causal link between the supposed balance indicator and the actual fall. In this study, we recorded subjects standing and walking on the hands, resulting in a large number of losses of balance. We evaluated common balance metrics, and identified which metrics were predictive of loss of balance.2) MethodsSixteen subjects practicing gymnastics recreationally were recruited. They performed 2 handstand trials and 2 handstand walking trials, in which they traversed a 3-meter walkway. In each trial, they had 3 minutes to perform as many attempts as they wanted.Ground reaction forces (GRF) and full-body kinematics were recorded. Loss of balance was defined as one of the feet touching the ground. The position of the whole body Center of Mass (CoM) was estimated by combining GRF and kinematic information [2]. The torque of the GRF around the CoM was calculated [1].During handstand-walking, the placement of the hand was predicted from the CoM state at the preceding midstance [3]. The error in hand placement was compared between successful steps and steps followed by a loss of balance.3) ResultsA total of 523 losses of balance were recorded. In 423 of these cases, subjects lost their balance backwards. In such instances, an increase in the backwards torque around the CoM was observed starting 400 ms before the movement of the foot that was lowered.During handstand-walking, hand placement error was significantly larger in steps followed by a loss of balance than in successful steps.4) ConclusionThe control of rotational momentum and the control of foot placement [1,3] have been suggested as indicators of standing and walking balance. Here we show that an increase in torque around the CoM (causing an increase in rotational momentum) precedes loss of balance in both

handstand and handstand-walking. Moreover, we show that impaired hand placement can result in loss of balance, thus validating these two balance indicators as direct causal mechanisms for loss of balance.5) References1. R. Neptune, A. Vistamehr, J Biomech Eng (2018), doi:10.1115/1.4042170.2. C. Le Mouel, Improved accuracy of the whole body Center of Mass position through Kalman filtering (2024), biorXiv, doi:10.1101/2024.07.24.604923.3. B. L. Rankin, S. K. Buffo, J. C. Dean, Journal of Neurophysiology. 112, 374–383 (2014).

P01-K-85 - Using digital mobility outcomes (DMOS) extracted from a lower-back device worn for 1 week to assess fall risk in diverse cohorts: Prospective results from the mobilise-d study

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BACKGROUND AND AIM: Falls are a leading cause of injury and disability, particularly in patients with neurological conditions like Parkinson's disease (PD) and multiple sclerosis (MS). Previous work in aging and pilot studies suggests that DMOs can assess fall risk. We aimed to 1) assess fall risk, over 1 year, in two large and diverse cohorts of patients with PD and MS, 2) identify the most important features influencing fall risk in these two diverse groups, and 3) compare the performance of the DMOs to that based on clinical tests of fall risk. METHODS: This analysis was based on patients with PD (n=500; age: 65.6±9.5; 35% female; MDS-UPDRS III: 26.6±12.5) and MS (n=514; age: 52.2±10.8; 65% female; EDSS: 5, IQR: 4-6) using Mobilise-D datasets (www.mobilise-D.eu) and features extracted from a lower-back device worn for 1 week. Three different combinations of potential predictors were analyzed: (1) DMOs, (2) clinical data (e.g. SPPB, 6MWT, MDS-UPDRS3, EDSS), and (3) DMOs combined with clinical data. All models also included basic predictors: age, sex, and fall history. Based on monthly self-reporting during the year following the baseline, patients were classified into fallers (2+ falls) or non-fallers (0 falls). Day-level aggregations (sum, median, std, 10, and 90 percentiles) were applied to 80 DMOs (e.g. gait speed, cadence, regularity, asymmetry). Daily predictions were averaged for each subject. Three machine learning models (SVM, Random Forest, and XGBoost) were trained on 80% of the dataset for PD, MS, and the combined dataset. Two feature selection methods were applied, resulting in six separate models. Final predictions were obtained by applying majority voting across the predictions of all six models. The AUC was used as the performance metric and was evaluated on a separate, unseen 20% of the data. RESULTS: In PD, the AUC values were 0.75, 0.67, and 0.76 using DMOs, clinical measures, and DMOs+clinical measures, respectively. AUC values for MS

were 0.71, 0.76, and 0.70 using DMOs, clinical measures, and DMOs+clinical measures, respectively. In the combined dataset, the AUC values were 0.72, 0.75, and 0.75, using DMOs, clinical measures, and DMOs+clinical measures, respectively (Fig 1a,c,e). Using the DMOs, sensitivities were 0.91, 0.83, and 0.95 at thresholds of 0.2, 0.5, and 0.4, for the PD, MS, and combined datasets, respectively. Fall history and age significantly contributed to predicting future falls in all datasets, while important DMO features varied between the datasets (Fig 1b,d,f). CONCLUSIONS: The DMOs demonstrate strong predictive performance, outperforming clinical measures alone in PD. This suggests that DMO-based ML models could offer a practical solution for fall prediction in remote testing or in situations where clinical testing is not available. Different DMOs were associated with fall risk in PD and MS, however, the analysis of the combined dataset suggests that a generalized model can be obtained. ACKNOWLEDGEMENTS AND FUNDING: This work was supported in part by the Mobilise-D project that has received funding from the Innovative Medicines Initiative 2 Joint Undertaking (JU) under grant agreement No. 820820. This JU receives support from the European Union's Horizon 2020 research and innovation program and the European Federation of Pharmaceutical Industries and Associations (EFPIA).

P01-K-86 - A ‘case-mix’ approach to understand health resource utilization trajectories among older adults at high risk of falls: A secondary analysis of a randomized clinical trial

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Background & aim: We conducted a secondary analysis to determine health resource utilization (i.e., cost) case-mixes from older adults at high risk of falls, longitudinal cost trajectories among participants from a randomized clinical trial. We identified baseline predictors 1) intervention group; 2) age; 3) biological sex; 4) cognitive function; or 5) physical function based on case-mix cost trajectories.Methods: This study was a secondary analysis of 343 older community-dwelling adults at high risk of future falls who participated randomized controlled trial. We used a self-report questionnaires and monthly cost-diaries to prospectively track total healthcare resource utilization costs over 12 months. All costs were reported in 2019 Canadian Dollars. Case-mixes, groups of individuals that followed similar cost trajectories, were visually defined using 12-month longitudinal trajectories; we used latent class growth modeling. Baseline predictors 1) intervention group; 2) age; 3) biological sex; 4) cognitive function; or 5) physical function of cost trajectories were examined.Results: Four distinct case-mixes were identified. The “high-cost, decreasing” was distinguished by a high baseline HRU (~$2500 CAD), which decreased over 12 months. The “low-cost, stable”, was

characterized by a low baseline HRU (~$500 CAD), which was stable across 12 months. The "low-cost, increasing", also started with a low baseline HRU (~$500 CAD), which increased substantially over 12 months. The "lowest-cost, decreasing", was characterized by the lowest baseline HRU (i.e., <$500 CAD) and decreased over 12 months. Intervention group (i.e., usual care or Otago Exercise Program) significantly moderated case-mix trajectory for the "high-cost, decreasing" group with individuals in the OEP group significantly decreasing HRU over 12 months while those in usual care showed a modest increase in HRU. Age group (i.e., below or above the median age of 82 years) significantly moderated case-mix trajectory for the "low-cost, increasing" group, whereby participants with less than median age substantially increased HRU over 12 months; participants with greater than median age did not appear to change over 12 months. Biological sex moderated the trajectories for "low-cost, stable" and "lowest-cost, decreasing" groups. Specifically, males in "low-cost, stable" decreased HRU over 12 months while female HRU did not appear to substantially change. For "lowest-cost, decreasing" group, female HRU decreased at a greater rate over 12 months than for males. Only males were in "high-cost, decreasing" group. There were no significant moderating effects of baseline cognitive status. Frailty significantly moderated the case-mix trajectory of HRU for "low-cost, increasing", whereby frail participants HRU cost decreased more rapidly over 12 months than non-frail participants. Discussion: Individuals at high risk of falls demonstrate patterns of health resource utilization that can be characterized into distinct case-mixes. The Otago Exercise Programme, biological sex, and frailty moderated unique case mixes of older adults at high risk of falls.

P01-K-87 - Lower limb prosthesis users' descriptions of injurious falls extend beyond an injury that requires medical treatment

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Background and aim: Falls remain a major health concern for lower limb prosthesis (LLP) users, with more than 50% reporting one or more falls a year, and 20 to 40% of those falls resulting in physical injury.1-3 Injurious falls experienced by LLP users are traditionally identified as those that require medical treatment from a physician or a visit to an emergency room.1-4 Recent research suggests that LLP users may consider a wider range of consequences - such as minor injuries, emotional or psychological harm, and damage to their prosthesis - as indicative of injurious falls.5,6 The current criteria for identifying injurious falls may therefore be too narrow, and in need of revision to avoid underestimating the frequency of injurious falls among LLP users. The aim of this qualitative research study was to explore LLP users' perspectives and identify shared experiences related to injurious falls.Methods: 24 LLP users from across the United States participated in semi-structured interviews conducted via video conferencing. A phenomenological approach was used to code and analyze interview transcripts and identify key themes.Results: Three themes emerged: 1) injurious falls encompass not only bodily damage but also psychological consequences and damage to the prosthesis; 2) injurious falls affect which activities LLP users engage in, how often they engage in them, and the strategies they adopt to perform them safely; 3) treatment from a physician is not required for LLP users to consider a fall injurious.Conclusions: LLP users' descriptions of injurious falls encompass a broader range of experiences than the current literature suggests. These include consequences unique to LLP users, such as damage to the prosthesis. Results of this qualitative research study provide a foundation for developing a rubric for differentiating "injurious" from "non-injurious falls", and improving measurement of health outcomes that matter to LLP users. Improved measurement of injurious falls may also enable more nuanced and meaningful evaluations of fall prevention interventions.[1] Chihuri S, Wong CK. (2018) Inj Epidemiol 5(1) [2] Kulkarni J, et al. (1996) Physiotherapy 82(2) [3] Tobaigy M et al. (2023) PM&R. 15(4) [4] Chihuri S et al. (2021) Prev Med Rep. 24 [5] Kim J et al. (2022) Disabil Rehabil. 44(15) [6] Sawers A et al. (2022) PloS One.17(7)

P01-K-88 - Perturbation-based balance training on treadmills: A scoping review of training protocols for falls prevention in older adults

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Background: Falls, frequently caused by slipping and tripping while walking, are a leading causeof injuries among older adults. Perturbation-based balance training (PBT) on treadmills hasemerged as a task-specific approach to prevent falls. However, standardized training protocols forPBT are lacking. This scoping review aims to summarize existing research on treadmill based PBTprotocols and their underlying theoretical justification for the training parameters used, therebyguiding future standardization efforts.Methods: A systematic search was conducted on January 10, 2024, across PubMed, Europe PMC,Web of Science, CINAHL and ClinicalTrials.gov to identify randomized controlled trials (RCTs),pilot studies and study protocols examining treadmill based PBT in healthy older adults, andindividuals with stroke, Parkinson's disease or multiple sclerosis. Two independent researchersscreened the studies and extracted relevant data. Key parameters, such as treadmill type, trainingperiod, number and duration of sessions, specific duration of perturbation training, treadmill beltspeed, perturbation characteristics (type, number, frequency, timing), as well as training intensity,perturbed leg and the theoretical justification behind these choices, were summarized.Results: A total of 619 studies were identified, of which 16 met the eligibility criteria (11 RCTs, 3pilot studies and 2 study protocols). These studies included 1430 participants with 677 participantsin PBT groups. Two trials involved 42 individuals post stroke with 26 participants being in PBTgroups. The training periods ranged from a single session to six weeks, with one to three sessionsper week lasting between 20 and 30 minutes. During a PBT session, 24 to 40 perturbations wereinduced, comprising both treadmill belt accelerations and decelerations, as well as mediolateraldisplacements. Most studies (n = 10) adjusted the intensity of the perturbations individually.Perturbation frequency, timing and the perturbed leg, as well as the theoretical justificationunderlying these choices, were rarely reported.Conclusions: Previous research has employed highly heterogeneous and often pragmatictreadmill PBT protocols, which predominantly lacked information regarding their trainingparameters and theoretical justifications. To enhance comparability across studies, theselimitations must be addressed in future research. Where pragmatic approaches are necessary dueto a lack of existing knowledge, this should be clearly stated. Given that PBT presents a promisingapproach for effective falls prevention in older adults, more high-quality research is needed toestablish a solid evidence base for its structured implementation in clinical care.

P01-K-89 - Towards a systematic review and individual participant data meta-analysis of fall risk assessment through wearable inertial sensors

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BACKGROUND AND AIMFalls are a leading cause of years lived with disability all around the world. Current approaches for fall prevention are based on fall risk assessment. The Falls and Technology Working Group of the World Guidelines for Fall Prevention and Management for Older Adults has identified as a research priority the need to form "a consensus on identifying objective biomarkers of fall risk via gait and balance assessment." The current study aims to assess the prognostic ability of biomarkers based on wearable inertial sensors data to predict falls.METHODSWe systematically searched for literature reviews about sensor-based fall prediction. Starting from these reviews, we retrieved articles describing datasets of ≥ 20 community-dwelling individuals with prospective data from wearable inertial sensors and on falls. We extended our search to five data portals, looked manually for additional references, and advertised our search in meetings and conference presentations. We then invited the authors of the included articles to contribute their datasets for an individual-participant data (IPD) meta-analysis on fall prediction based on wearable inertial sensors.RESULTSWe identified 59 articles describing 48 datasets from 23 countries involving between 21 to 32,619 participants (median 144.5, total 56,150). Most datasets (37) had inclusion criteria reflecting the general older adult population, while others targeted specific populations, including subjects with Parkinson's disease (5), multiple sclerosis (2), stroke (2), and others (4). Between 1 and 10 (median 1) wearable inertial sensors were used for motion evaluation

during functional tests in the laboratory/clinic (19 datasets), during real-world daily activities (12 datasets), or both (17 datasets). Each article proposed 0-592 (median 7) sensor-based biomarkers (i.e., features extracted). The participants were followed up for fall ascertainment for 6-60 months (median 12 months). Mean prevalence of fallers was 33%. Of all sensor-based biomarkers, 27% were deemed associated with falls according to either a statistical hypothesis test or a feature selection procedure.Thus far, 20 authors have accepted our invitation to join the IPD meta-analysis with their datasets. We are currently mapping the available datasets to signal processing pipelines to replicate and test the list of biomarkers proposed in the literature as associated with falls.CONCLUSIONSThe corpus of available datasets is expected to represent a valuable resource for testing the performance of existing wearable sensor-based biomarkers for fall risk estimation and for developing fall risk models beyond the state of the art.ACKNOWLEDGEMENTS AND FUNDINGThis research was co-funded by the Italian Complementary National Plan PNC-I.1 "Research initiatives for innovative technologies and pathways in the health and welfare sector" D.D. 931 of 06/06/2022, "DARE - DigitAl lifelong pRevEntion" initiative, code PNC0000002, CUP: B53C22006450001.

P01-K-90 - Environmental falls prevention: Developing architectural standards based on long-term wet slip resistance assessments

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[1] Intertile Research

Background and AimFalls on pedestrian surfaces remain a leading cause of injury in both public and institutional environments, particularly among older adults and medically vulnerable individuals. While most research aims to limit the vulnerability of at-risk groups, little is done to ensure pedestrian surfaces will provide sufficient slip resistance for economically reasonable lifecycles. A common checklist approach to safety relies on subjective, non-standardised assessments of surface safety—such as informal 'foot-rubbing' by clinicians or inspectors—rather than reproducible, science-based evaluations of surface traction under wet conditions. This poster challenges poor practices and outlines a more rigorous, lifecycle-aware framework for designing and regulating pedestrian surfaces to prevent environmentally induced falls. The aim is to contribute to the development of a new architectural design standard based on long-term wet slip resistance performance, accounting for both environmental exposure and variable user traction demands.MethodsThis work synthesises expert analysis of current standards (e.g., AS 4586, AS 4663, SA HB 197, EN 16165, and ISO 15686), recent lifecycle studies of flooring materials, and field evidence of surface degradation post-installation. The method includes a gap analysis of existing slip resistance classification systems, their failure to anticipate wear-induced performance loss, and a review of the suitability of materials related accelerated wear conditioning (AWC) treatments for preparing specimens for slip resistance testing. The analysis is further informed by participation in national and international standards development bodies, including committees focused on slip resistance and access for people with disabilities.ResultsThe findings reveal that many common safety evaluation practices are subjective and deficient, neglecting critical aspects related to the presence of water, the efficacy of maintenance practices, and the progressive changes in surface microtexture. Where the gait of elderly and at-risk populations is assessed under safe conditions, the resulting traction demand profiles may be misleading and quite divorced from tribological safety metrics. A service life planning approach involves a process of environmental classification so that locations with different micro-environments, or agents that can cause degradation, can be identified, enabling detailed design that meets the project performance requirements where due allowance is made for maintenance. Design guides may identify specific locations that are subject to more demanding conditions, but there is little published data to reflect how individual products resist degradation when exposed to various agents, how their surface microtexture changes, and the associated slip resistance responses. Audits may reveal significant changes in slip resistance but without any adequate characterization of the surface condition. Where pedestrian surfaces are specified on the basis of ex-factory products satisfying slip resistance criteria, many may transition from “compliant” to hazardous within a short period, even though the potential danger may not then be recognised for prolonged periods. Several people may walk over a high-risk surface before someone does so using a gait that demands more traction than is available. ConclusionsTo reduce fall risks arising from slips on wet or contaminated worn floors, safety regulation must evolve beyond initial slip resistance testing of ex-factory products and towards a standard that addresses performance retention under expected service and maintenance conditions. Reliance on subjective tactile assessments fosters a dangerous illusion of safety and fails to protect vulnerable users. Although approval has just been granted for the development of new Australian slip resistance standards that will be based on wet slip resistance benchmarks and product appropriate AWC protocols, there are still a wide range of knowledge gaps to be addressed. How reliably do AWC protocols produce the wear and corrosion that occurs in different micro-environments? There is also a need for a more nuanced understanding of user-environment interactions. What was the available traction when injurious slips occurred? However, the acceptance of a new lifecycle-oriented paradigm (to ensure that surfaces remain sufficiently safe throughout their intended service life) is itself a productive development. There will undoubtedly be a need for several incremental improvements as further data becomes available.

P01-K-91 - Identifying the association between fall frequency in young adults and transient peaks in air pollution

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Background and Aim: Falls are associated with personal (e.g., sex) and environmental (e.g., weather) factors. Environmental pollution has recently been identified as a fall-risk factor, with a positive association between chronic pollution exposure and fall-risk in young adults [1]. However, it is unknown if transient exposure to reduced air quality is associated with falls. Our aims were to determine 1) if transient exposure to pollution is associated with increased fall frequency in young adults and 2) if this association is altered by sex. Methods: 308 adults (224 women, 19.9 ± 1.1 yrs, range 18-27 yrs) participated for four months, across eight cohorts from 2014-2019 [2]. Respondents prospectively reported falls with a daily survey; average response rate was 90%. We combined each subject's responses into weekly counts, integrating them with corresponding daily air quality index (AQI) measures (local AQI values ranged from 12 to 101 units; obtained from the U.S. Environmental Protection Agency). We compared peak AQI of the preceding week to falls in the current week; we selected peak AQI to document transient exposure effects. A zero-inflated Poisson (ZIP) model with a subject random effect was used to describe the relationship between the number of falls, sex, and AQI. The model also considered the two-factor interaction (sex, AQI). This model was chosen to account for repeated measurements from each subject and the large number of weeks with zero falls. We used Akaike information criterion to select the best model. Results: Fall frequency was positively associated with peak AQI ($p < 0.0001$; Fig. 1). 354 falls were reported by 145 subjects (47% of 308 subjects), with 259 falls reported by 107 women (48%) and 95 falls reported by 38 men (45%). A ten unit increase in peak AQI was associated with an estimated 44% increase in falls per participant. We are currently determining how other factors relate to this association (e.g., weather, BMI, physical activity) and will report those outcomes at the conference. While this study does not demonstrate causation, there are physiological mechanisms that suggest a causal relation. Inhalation or ingestion of pollutants induces systemic inflammatory responses in balance-related systems: neurological, cognitive, and/or cardiovascular structures [1]. Since we did not observe a sex by AQI interaction ($p = 0.83$), sex-based differences in falls cannot be explained by sex-based responses to transient peaks in AQI for young adults.Conclusions: Fall frequency is positively associated with transient peaks in AQI for both sexes. If replicated, this finding could aid clinicians and policymakers in making informed decisions regarding patient care and public safety, especially as the effects of climate change increase.Acknowledgements & Funding: No external funding.References1. Calderón-Garcidueñas et al (2020) Environ Res doi: 10.1016/j.envres.2020.110087 2. Cho et al (2021) PLoS One doi: 10.1371/journal.pone.0250360

P01-K-92 - Individual or combined model? slip and trip related fall-risk prediction for healthy older adults

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Background: The increasing susceptibility to falls with age poses a significant global health risk, leading to severe medical complications and rising healthcare costs. Task-specific training programs aimed at specific types of falls have been proven to be effective for fall prevention. However, the effects of this training fail to be generalized to other types of perturbations. To efficiently allocate individuals to appropriate fall-prevention strategies, accurate and timely fall-risk prognosis is essential. Therefore, developing reliable prediction methods for the early identification of at-risk individuals is critical to reducing fall-related injuries and associated healthcare costs.Method: This study aimed to predict balance outcomes in both slip and trip trials conducted in laboratory environments using gait characteristics, clinical measures, and demographics. These data were collected from 298 community-dwelling older adults who experienced regular walking, gait-slip, and gait-trip in a large research project (NCT03199729). This dataset was used to develop six types of models to predict slip-induced balance loss (LOB-slip), trip-induced balance loss (LOB-trip), combined slip-trip balance loss (LOB-all), slip-induced fall (Fall-slip), trip-induced fall (Fall-trip), and combined slip-trip fall (Fall-all). Five machine learning classifiers [Linear support vector machine classifier (SVC), AdaBoost classifier (ADC), Random Forest classifier (RFC), and Quadratic Discriminant analysis (QDA), Deep Neural Network (DNN)] were selected to train the prediction models. A repeated measures ANOVA was conducted to compare the differences in AUC across different models and different types of balance outcomes, based on varying numbers of features. The model with the highest area under curve (AUC) value, was defined as the best model for each case.Results: Repeated measures ANOVA indicated that the performance of models was significantly affected by the number of features ($F = 304.3$, $p < 0.001$). Models with 10 or more features demonstrated better performance, with AUC values ranging from 0.72 to 0.9 and overall accuracy between 66.3% and 87.5% at the default cutoff. Among the classifiers, the Deep Neural Network (DNN) demonstrated superior performance compared to traditional machine learning models (SVC, ADC, RFC, and QDA), highlighting its effectiveness in predicting balance outcomes. Among different balance outcomes, slip-related fall risk could be predicted with the highest AUC (0.9 for LOB, and 0.89 for fall), followed by trip-related fall risk (0.87 for LOB, and 0.84 for fall), with combined-slip-trip fall risk demonstrating the lowest AUC (0.81 for LOB, and 0.8 for fall). This indicates that individual models for single-type balance outcome prediction might be more effective than combined models for fall-risk diagnosis. Conclusion: This study developed fall-risk prediction models for slip and trip perturbations in healthy older adults, utilizing their gait characteristics, demographics, and clinical measures. The most effective models demonstrated an accuracy of over 76% for predicting balance outcomes following trip perturbations and over 85% for slip perturbations. These models effectively identify individuals at high risk of perturbation-induced LOBs and falls, enabling targeted fall-prevention training, which could lead to a significant reduction in the incidence of falls and fall-related injuries. Future research should focus on validating the robustness of these models across different populations and real-world scenarios.

P01-K-93 - The United Kingdom slip resistance group

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Background and Aim. The United Kingdom Slip Resistance Group (UKSRG) was formed around 38 years ago by a small group of people interested in slipping and slipping accidents. Today there are more than 70 members including several overseas members. The aim of the Group is to raise the profile of the subject and to advance the understanding of the factors that contribute to slipping accidents.Methods. The Group has members from a wide range of backgrounds. Several members are active in British (BSI) European (CEN) and International (ISO) Standard committees including: test methods, resilient flooring, ceramic tile, occupational and safety footwear, and stairs. The Group meets 3 times a year and members can attend in person or virtually. There are smaller working groups that meet to develop new material and to ensure that current guidance is kept up to date.Results. For many years the Group published Guidelines for the use of the pendulum slip resistance test, the preferred method of test in the UK, and one of the tests in the European Standard EN 16165: 2021. It still does so, but more recently has also produced guidance on stairs, cleaning (a key control in the maintenance of the slip resistance properties of many flooring materials), and occupational and safety footwear. A current area of interest is the development of an accelerated wear test which may be helpful in understanding the durability of (wet) slip resistance. Accelerated wear is a topic currently being discussed in a number of standards committees. Conclusions. The Group continues to develop and is actively working to broaden its membership. Networking and discussing its current and future work with colleagues at the International Society of Posture & Gait Control World Congress 2025 is a great opportunity, which may lead to 'productive interactions' . *Corresponding author S. Thorpe, email: thorpes1867@gmail.com. The work of the Group is funded by member subscriptions.

P01-L-94 - Wearable technology to characterize and treat mild traumatic brain injury subtypes: Biofeedback-based precision rehabilitation (subtype protocol)

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BACKGROUND AND AIM: Rehabilitation of persistent imbalance in people with mild traumatic brain injury (mTBI) is challenging, and responsiveness to rehabilitation is often suboptimal. We recently developed a wearable system that provides objective real-time information on the quality of head, trunk, and lumbar movement during standing and walking rehabilitation tasks. In consideration of mTBI subtypes, those demonstrating vestibular and/or oculomotor (V/O) deficits are likely best suited for physical therapy. However, it is difficult to identify these individuals as V/O symptoms are often under-represented in global mTBI symptom rating scales. Objective measures of V/O deficits are needed to identify individuals that will benefit from rehabilitation and to assess potential movement functions both in laboratory and daily living. The SuBTyPE protocol aims to 1) assess if a wearable sensor-based multidimensional biofeedback system could enhance multimodal rehabilitation, 2) examine responsiveness to rehabilitation depending on the severity of V/O deficits, 3) characterize the impact of V/O deficits on gait and turn characteristics during 7-days of unsupervised daily living. METHODS: We will recruit 100 civilians with persistent V/O symptoms from 3 weeks to 1 year following mTBI. Participants will be randomized into standard care rehabilitation (SC) or SC with augmented biofeedback from wearable sensors. Both groups will receive a 6-week rehabilitation program (2x/week). Each session will be 60-minutes long and include oculomotor, gaze stabilization, visual motion sensitivity, static balance, balance perturbation, and dynamic balance exercises. All participants will be tested prior to and upon completing the rehabilitation program. Subjective, clinical, and instrumented measures of balance, gait, turning, and V/O functions will be used to evaluate efficacy of SC compared to SC with biofeedback, stratified by the severity of V/O deficits. A subset of 50 participants with mTBI and 40 healthy active-duty military service members will be asked to wear inertial sensors for 7 days to quantify daily living gait and turns. Collected data will be used to establish normative daily living mobility data from military service members and to examine if severity of V/O deficits following mTBI impacts daily mobility. RESULTS: We have 11 individuals enrolled in the study to date, and 7 participants have finished the study. We anticipate having interim analysis regarding feasibility and preliminary findings by the time of the conference. CONCLUSION: Our novel intervention could improve rehabilitation efficacy by providing real-time biofeedback during multimodal rehabilitation. This work will also help determine whether individuals with high V/O deficits will show greater responsiveness to rehabilitation and worse quality of mobility during daily life, than those with low V/O deficits.

P01-L-95 - Targeted rehabilitation approaches for balance and gait improvement in patients with partial spinal cord injury

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BACKGROUNDSpinal cord injury (SCI) is a life-altering event that affects motor, sensory, and autonomic functions, resulting in significant physical limitations [1]. SCI severely affects an individual's ability to walk/gait [2]. The extent and nature of gait impairment in individuals with SCI can vary greatly depending on the level (cervical, thoracic, lumbar)

and severity (complete or incomplete) of the injury. Instrumented gait analysis plays a crucial role to objectively evaluating the changes in spatiotemporal, kinematics, and electromyography during gait and ultimately helps in evaluating the effectiveness of different rehabilitation strategies, tracking progress over time, and guiding clinical decision-making for patients with partial SCI.AIM & Research QuestionHow 3D gait analysis inform and guide targeted rehabilitation strategies to optimize gait mechanics and enhance functional outcomes in patients with partial spinal cord injury?METHODSThis clinical prospective study after written informed consent included 10 subjects with partial SCI and 10 healthy controls. Balance, Spatio-temporal, kinematics (500 Hz), & EMG parameters were evaluated for healthy controls and 6 weeks postoperatively for SCI patients using instrumented 3D gait analysis (SMART DX-7000, BTS Bioengineering, Milan Italy). Full body marker protocol was used to capture the data. Joint centers were identified by anthropometric data and regression equations. Student T-test was performed to find significant differences between SCI patients and healthy controls.RESULTS AND DISCUSSIONIn comparison to healthy controls the significant decrease in weight load ($p \leq 0.001$), (Gait speed (69%, $p \leq 0.001$), cadence (38%, $p \leq 0.01$), step length (Rt 54 %, Lt 38% $p \geq 0.01$), stride length (48%, $p \leq 0.01$), GPS ($p \leq 0.001$), GDI ($p \leq 0.001$), were observed in SCI patients. In SCI patients Vs healthy controls significant increase in trunk tilt range (250 Vs 70, $p \leq 0.01$), Pelvis tilt range (280 Vs 100, $p \leq 0.05$), and a decrease in ankle plantarflexion range (80 Vs 160, $p \leq 0.001$), Knee flexion range (420 Vs 640, $p \leq 0.05$), hip extension range (00 Vs 120, $p \leq 0.01$), peak EMG activity of erector spinae ($p \leq 0.05$), tibialis anterior, ($p \leq 0.05$), bicep femoris ($p \leq 0.05$), rectus femoris ($p \leq 0.05$) were observed. Kinematic and EMG results suggested designing rehabilitation strategies and exercise programs to decrease pelvis tilt range, increase in ankle plantarflexion, peak knee flexion angles, hip extension, and targeted muscle strengthening exercises to improve muscle activation pattern and balance.CONCLUSIONSOur study indicates that patients with partial SCI demonstrate significant deviations from normative balance and gait patterns. These findings emphasize the critical need for targeted rehabilitation strategies. By developing personalized and targeted therapy programs, rehabilitation professionals can assist SCI patients in regaining their independence and mobility, which may help lessen the long-term impact of gait dysfunction on the daily activities of patients with partial spinal cord injury.ACKNOWLEDGEMENT: The authors are thankful to DIA-COE, IIT Delhi, and DRDO (Grant no. DFTM/03/3203/P/37/JATC-BRAIN-CIAMI-05/011/D[R&D]) for financial support.REFERENCES[1] Wyndaele, M et al, Spinal Cord, 2006, 44(9), 529.[2] Del Valle AED, et al, J Clin Med, 2023 Nov 21;12(23):7208.

P01-L-96 - Evaluation of daily living gait sensitively detects changes in gait speed in patients with symptomatic knee osteoarthritis

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Background and aimPatients with knee osteoarthritis (KOA) often experience a decline in physical function due to knee pain. Lateral wedge insole (LWI) is one of the conservative treatments which reduces knee pain and improve physical function. Gait speed is an indicator of physical function and crucial factor influencing life expectancy. Therefore, accurately evaluating changes in the gait speed after intervention is essential for detecting the effect of treatment. Although previous studies have evaluated the gait speed under laboratory (Lab) condition, the evaluation in controlled condition may be insufficient to detect the effects of treatment because of detachment from daily living. Wearable sensor can capture the gait speed throughout daily living, which could detect a more sensitive changes in the physical function. This study aimed to compare the changes in the gait speed under the Lab and daily living (Daily) conditions after LWI use.MethodsNineteen patients with KOA (females: 9, age: 64.2 ± 12.3 years) were recruited in this study. They were prescribed LWI and instructed to wear it during daily living. Under the Lab condition, they were asked to walk at comfortable speed. The gait speed was evaluated by a three-dimensional motion analysis system. Under the Daily condition, gait speed was evaluated by acceleration data obtained from an accelerometry worn on the patient's waist for one week. Based on a histogram of all gait speed values in each patient during daily living, typical (percentile 50, median), high (percentile 90) and low (percentile 10) value were determined. The knee pain and physical dysfunction were evaluated using the knee injury and osteoarthritis outcome score (KOOS) questionnaire. These evaluations were conducted at two time-points: the LWI prescribed (baseline) and three months later (post). Moreover, the correlation between changes in the gait speed and changes in KOOS were evaluated.ResultsAfter intervention, the improvement of KOOS pain was observed (baseline: 54.5 ± 15.0%, post: 68.9 ± 15.9%, p = 0.01). Under the Lab condition, there was no change in the gait speed (baseline: 0.81 ± 0.22 m/s, post: 0.85 ± 0.19 m/s, p = 0.37); however, under the Daily condition, typical and low value of gait speed significantly increased (typical; baseline: 0.86 ± 0.12 m/s, post: 0.90 ± 0.13 m/s, p = 0.04, low; baseline: 0.66 ± 0.11 m/s, post: 0.73 ± 0.12 m/s, p = 0.001). Additionally, the change in KOOS pain significantly correlated with only change in low value of gait speed under the Daily condition (r = 0.49, p = 0.048).ConclusionsThe daily living evaluation detected the change in the gait speed after LWI use and could provide insight into association between changes in the physical function and KOA symptoms.

P01-L-97 - Effects of the posterior pelvic tilt sitting posture on thoracic morphology and respiratory function

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[BACKGROUND AND AIM]Posterior pelvic tilt sitting (PPTS) posture is recognized as a mal-performance posture. PPTS is suggested to be strongly associated with respiratory function. Although the respiratory function is dependent on the thoracic motion, PPTS is not extensively analyzed concerning the thoracic morphological changes. Therefore, to reveal the role of PPTS on thoracic morphology and respiratory function, we investigated how differences in pelvic angle in the PPTS affect the thoracic morphology, simultaneously with the respiratory function.[METHODS] The participants were 18 healthy young males. This study was approved by the ethics committee of Tokyo Medical University in accordance with the Declaration of Helsinki revised October 2013 (approval no. T2019-0248). We positioned the pelvis at 0°, 10°, 20°, and 30° of posterior tilt, following which the thoracic expansion volume ratio, thoracic spine tilt angle, and respiratory function were measured. We calculated the thoracic volume and thoracic spine tilt angle by measuring the displacement of reflective markers attached to the thoracic area using the Vicon MX 3D-analysis system. Respiratory function was measured by spirometry. The resulting measurement items included forced vital capacity, forced expiratory volume in 1 second, and peak flow rate.[RESULTS]The expansion volume ratio decreased significantly in response to 10°, 20°, 30° PPTS at the mid-thorax and 30° PPTS at the lowest thorax. The upper thoracic spine level showed a change in anterior tilt at 10°, 20°, 30° PPTS, whereas the lower thoracic spine level showed a change in posterior tilt at 30° PPTS. Respiratory function was significantly lower at 30° PPTS than at 0° PPTS. A positive correlation between thoracic expansion volume ratio and respiratory function was found at 30° PPTS.[CONCLUSIONS]These results showed that the areas of decreased thoracic expansion volume ratio were different according to the degree of PPTS. In particular, the posterior tilt of the lower thoracic level, a characteristic of 30° PPTS, may decrease the thoracic expansion volume ratio at the lowest thorax, resulting in a decrease in respiratory function.[ACKNOWLEDGEMENTS AND FUNDING]We gratefully acknowledge the work of past and present members of our laboratory.

P01-M-98 - Simulation of anticipatory postural adjustment of ankle torque in response to trunk disturbance using optimal feedback control theory

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BACKGROUNF AND AIM: When performing voluntary movements, whole body muscles must be appropriately controlled. Todorov and Jordan (2002) proposed the optimal feedback control (OFC) theory which approaches motor control as a result of optimization under the principle of cost minimization. Tanis et al. (2023) demonstrated that OFC theory can predict anticipatory postural adjustment (APA) by simulating arm-raising movements. We simulated postural control activities based on the OFC theory for the task of maintaining quiet standing against unimodal and bimodal perturbations.METHODS: We created a two-link, two-joint model consisting of lower limb and trunk segments (Figure 1). Body parameters such as segment mass, length, and moment of inertia were set based on Winter (2009). We formulated the equation of motion for the system and derived a linear state equation represented by first-order differential equation. We introduced a state estimation equation using a Kalman filter. In OFC theory, motor commands are expressed as the product of estimated state and control gain, with control gain determined to minimize the total cost, which is the sum of state cost and motor cost (Todorov, 2005). We simulated the ankle torque required to maintain quiet standing posture against forward perturbations applied to the upper body segment.In this study, we simulated postural control against unimodal and bimodal perturbations. The unimodal perturbation was a triangular wave with a peak value of 50 N and a period of 600 ms, while the bimodal perturbation consisted of two consecutive triangular waves with peak values of 50 N and periods of 300 ms each. Note that both perturbations had the same impulse of 15 N·s. We analyzed the characteristics of the simulated optimal ankle torque waveforms, as well as the latency and amplitude of the anticipatory components preceding the perturbations.RESULTS: For the unimodal perturbation condition, the simulated optimal ankle torque was also unimodal. Similarly, for the bimodal perturbation, a bimodal waveform was simulated for the ankle torque, which transitioned from the first peak value to the second peak value without returning to 0 Nm. For both perturbations, changes in ankle torque preceding the onset of external force were obtained, revealing that OFC theory predicts APA. While the APA latency was comparable between the two conditions, the APA amplitude was larger in the bimodal perturbation condition.CONCLUSIONS: Based on OFC theory, we simulated ankle torque for maintaining quiet standing against predictable perturbations. Changes in ankle torque preceding the perturbations were predicted, suggesting that APA can be understood as part of optimal control.ACKNOWLEDGEMENTS AND FUNDING: This work was supported by JSPS KAKENHI Grant-in-Aid, Grant

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P01-M-99 - Slow dynamics of human balance control

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BACKGROUND AND AIM: When standing on a tilting support surface, humans' sway behaviour at frequencies below 0.1 Hz indicates the contribution of a slow feedback component. We suggest that this behaviour may reflect a self-calibration mechanism of the balance control system, constantly referencing orientation estimates based on kinematic sensory cues to a reference based on force cues. However, attempts to identify the nature of this mechanism have been limited by insufficient experimental trial durations and small sample sizes. This study aimed to assess the properties of the mechanism that reduces body sway at very low frequencies in upright standing and further confirm its dependence on force cues. METHODS: Body sway responses to short- and long-duration support surface tilts were measured and interpreted using balance control models. Four feedback control model variants, with different mechanisms to account for the slow dynamics, were derived from the literature and fit to experimental data. In addition to comparing different mechanisms, we tested how estimates of the

slow component are affected by the length of stimulus periods. RESULTS: Sway responses to short- and long-duration surface tilts were best reproduced by model variants containing a positive force feedback mechanism. However, the properties of this mechanism were difficult to estimate despite using long-duration trials. CONCLUSIONS: Our results suggest that humans use integrated force afferents from the feet and legs in a slow, positive feedback mechanism during standing to remain upright. This mechanism functionally reduces the effort required to stand and aligns with the notion of self-calibration, correcting kinematic sensory reconstructions of body orientation in space. Estimates of the properties of this mechanism were highly variable, which may offer valuable insights into individual differences in self-calibration.

P01-N-100 - Characterizing how different subtypes of freezers performed on the new clinician reported outcome for freezing of gait

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Background and Aim: Freezing of gait (FOG) is a complex and heterogenous motor symptom of Parkinson's Disease (PD) that negatively impacts quality of life. Assessment and quantification of FOG is challenging due to its episodic and unpredictable nature. Research has shown evidence of subtypes of Freezers using the Characterising FOG (C-FOG) questionnaire, which clusters situations that are more troublesome for provoking FOG in each patient. Using this tool, Freezers can be classified as Asymmetric-Motor (AM), Anxiety (AX), and Sensory-Attention (SA) subtypes, based on the triggers that make their FOG worse. These subtypes may be helpful for personalizing both the assessment and treatment of FOG. Recently, the International Consortium of FOG developed a novel clinician reported outcome (ClinRO) aimed at standardizing clinical assessment of FOG severity. The tool comprises of several timed walking tests designed to provoke FOG, to be rated by a trained assessor. The aim of this preliminary study was to characterize how different subtypes of FOG scored on the ClinRO. This could be used to inform the ongoing development of the ClinRO.Methods: From the ongoing study funded by MJFF, 13 of 105 participants (11M, Age (70.3±7.43), MDS-UPDRS-III (45.0±10.2), MoCA (23.8±3.53), PAS (15.3±7.14)) have come through the study and completed the C-FOG to determine their predominant subtype. FOG severity was rated as the total score on the 8 different walking trials of the ClinRO. Results: 7 freezers (54%) were classified as the AM subtype, 3 freezers (23%) were classified as the AX subtype and 2 patients (15%) were classified as the SA subtype, and one freezer had a mix of AM/SA subtypes. The severity of FOG assessed by the ClinRO was distributed fairly evenly across the different subtypes. For example, when ranked, the highest FOG severity scores came from both AM and AX

freezers, which was similar when ranked by the lowest FOG severity scores, which revealed both AM and AX freezer subtypes. Individual performance on the ClinRO, revealed that the AM- freezers consistently froze more within the turning tasks, compared to the other tasks. In contrast, AX-freezers were less consistent as a group, such that FOG was spread across a variety of tasks assessed during the ClinRO. Those within the SA subtype generally showed more freezing across all tasks, particularly dual-task trials. Notably, all subtypes of freezers showed freezing during turning and shuffling tasks, whereas single-task walking and carrying tasks less consistently provoked FOG across the cohort. Conclusion: Preliminary results suggest that freezing was observed in turning and shuffling tasks across all patients. Carrying, and single-task walking tasks were less effective at provoking freezing in AM and AX subtypes compared to SA subtype. This work is ongoing and must be conducted with a larger sample size to inform future refinement of the ClinRO test battery.

P01-N-102 - Beyond the leaderboard: Evaluating the robustness of deep learning models for detecting freezing of gait

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Background and aim: Freezing of gait is a common, debilitating problem that affects many but not all patients with PD. The lack of a widely applicable, objective method to quantify FOG obstructs research and treatment. In recent years, wearable sensors and automatic FOG detection algorithms have demonstrated increasingly promising results. After organizing a global machine learning contest (A Salomon, Nature Comm. 2024) to speed up the development of acceleration-based FOG detection algorithms, we applied the winning models to a new dataset to test their robustness. Robust wearable-based methods are valuable for FOG detection under different conditions, and could be the key to real-world assessment. Methods: Subjects were videotaped while performing a FOG-provoking test protocol. Two experts reviewed and annotated the videos using the ELAN annotation tool. The subjects wore a body-fixed sensor that contains a 3D accelerometer on their lower back. 12 patients with PD and FOG were included in the analysis (age: 74.0 ± 5.7 yrs, sex: 10 men, disease duration: 9.8 ± 3.1 yrs, NFOGq score: 19.0 ± 4.7, MoCA: 24.3 ± 3.2, MDS-UPDRS part III: 37.3 ± 10.1). Data and annotations preprocessing and performance analyses were done in Python 3.9. Model inference was done on the Kaggle platform. After inference, non-gait segments were filtered out. Standard evaluation metrics and intraclass correlations (ICC) of the % time frozen (%TF), number of episodes, and total FOG duration of each FOG trigger were computed. The threshold for the standard metrics was selected based on Euclidean distance from the point (1,1) on the precision-recall (PR) curve. Results: 39.4 min of annotated recordings were processed. After removing non-gait segments, 30.3 min remained. Figure 1A shows PR curves and ROC curves. The top F1-score, accuracy, precision, and specificity for FOG detection regardless of trigger were achieved with the 3rd place model (see figure 1B) while the 5th place model had the best recall score (although recall didn't drop for 3rd place compared to the contest result). The drop in performance (figure 1B) for the top two models could suggest a "leaderboard probing" approach that optimizes performance on the contest dataset but compromises robustness. The top ICC2(2,1) results were achieved (with a significant gap from the other models) by the 3rd place model, with ICC=0.79 (p<0.001) for %TF, ICC=0.66 (p=0.002) for the number of FOG episodes, and ICC=0.95 (p<0.001) for the total FOG duration. Conclusions: While there was a drop in performance for some of the winning models, the performance of the third place model suggests that it is robust and generalizable. If the goal is to detect FOG duration or %TF, a current standard, the ICC values are sufficient and similar to or better than that seen when comparing two raters. Still, there is room for improvement if the goal is to automatically detect FOG trigger subtypes or accurately count individual FOG episodes.

P01-N-103 - Are digital mobility outcomes sensitive to the biologic staging system of Parkinson’s disease?

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BACKGROUND AND AIM: Parkinson’s disease (PD) is marked by a continuous progression, with no current treatment to slow or halt the disease course. Although being a continuum, discrete stages are required to build a research framework to enable an earlier and accurate diagnosis, as well as advancing therapeutic development across all disease stages. To meet these needs, an integrated biological and clinical system for PD was introduced by Simuni et al., enabling definition of discrete stages based on biomarkers alone (prodromal phase) and incorporating clinical signs and functional impairment (symptomatic phase) [1]. Digital mobility outcomes (DMOs), such as walking speed, are sensitive to subtle motor signs and reflective of functional impairment, and hold promise as quantitative biomarkers to assess progression across Simuni’s stages. Two approaches are feasible for collection of DMOs: laboratory and real-world. The optimal approach is not clear. To date, only Dam et al. developed biologic and clinical criteria to implement Simuni’s staging system [2]. No study has explored DMOs application within biologic staging system for PD yet. The aim of this work was to investigate whether DMOs can differentiate between Simuni’s stages. METHODS: 77 people with PD recruited from the ICICLE-GAIT study (age: 69.1±9.9 years; Unified Parkinson’s Disease Rating Scale-II (UPDRS-II): 13.2±5.1; UPDRS-III: 35.5±11.9) were assessed in the laboratory during a 2-minute continuous walk: data were collected using GAITRite and a wearable device (AX3) positioned on the lower back [3,4]. Participants also wore the AX3 continuously for 7 days (real-world assessment). Participants were grouped according to Simuni’s stages 3 (slight, n=40 GAITRite, n=35 AX3 lab, n=31 AX3 real-world) and 4 (mild, n=36 GAITRite, n=28 AX3 lab, n=31 AX3 real-world), following

Dam's criterion (stage 3: 3≤UPDRS-II≤13, stage 4: 14≤UPDRS-II≤26). Microstructural DMOs related to pace, rhythm, variability, asymmetry, and postural control of gait were quantified from the lab-based and real-world assessments [5]; macrostructural DMOs, related to volume, variability, walking pattern, were also derived from real-world data. ANOVA controlling for age, gender, and BMI was used to detect differences in DMOs (p<0.05) between stages 3 and 4. RESULTS: In the lab, pace, rhythm, and variability domains were significantly different between stages 3 and 4 (Figure 1). GAITRite data showed significant differences in pace, rhythm, variability, and postural control domains. In the real-world significant differences were only found for the macrostructural domain of volume. CONCLUSION: These preliminary findings demonstrate that both lab-based and real-world DMOs are sensitive to distinguish between Simuni's biologic stages 3 and 4 demonstrating their potential utility as outcome measures in disease-modifying trials, and for patient stratification. References: 1.Simuni et al., LNe, 20242.Dam et al., NPJ PDis, 20243.Yarnall et al., AAN, 20134.Del Din et al., JNER, 20165.Lord et al., MD, 2013

P01-N-104 - Characterizing the time of day and year of falls in people with probable Parkinson's disease

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Background and aim: Temporal aspects of falls is a key element of fall circumstances that is not well characterized in people with Parkinson's disease (PD), particularly in those later in life. Therefore, the purpose of the current manuscript is to characterize the timing (across day and year) of falls in people with probable PD compared to non-PD peers. Methods: Swedish registries were used to identify 441 people with one or more prospectively registered falls over the course of approximately 2.5 years. Of these participants, 30 were prescribed dopamine or dopamine derivatives, suggesting presence of PD. Chi-squared tests and Generalized Estimating Equations were used to assess the time of day and year of falls in people with probable PD (n=30) and non-PD (n=401) accounting for covariates (age, gender, number of medications). Results: Swedish residents with probable PD fell less often in the evening than the day (p=0.015, OR=0.61). Across the whole sample, female participants also tended to fall less frequently at night than during the day (p=0.032, OR=0.73). People with probable PD also tended to fall more frequently in the spring months than other seasons (x2 = 32.1, p<0.001). Conclusions: The finding that people with probable PD exhibit more falls during the day than night is consistent with previous work and extends knowledge to show a similar result in older, more frail people with PD. Characterizing the temporal nature of falls in people with PD can provide additional context to other fall circumstances, thus improving our ability to treat and predict falls in this group.

P01-N-105 - Prefrontal cortex activity, but not gait parameters, differentiates fallers from non-fallers in Parkinson's disease

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BACKGROUND AND AIM: Falls are a frequent and significant problem in people with Parkinson's disease (PD). Impairments in gait parameters caused by PD are associated with a higher risk of falls. Additionally, changes in prefrontal cortex (PFC) activity during walking may indicate an increased risk of falls in healthy older adults. However, there is limited information in the literature about PFC activity during walking in people with PD who are fallers versus non-fallers. Therefore, this study aimed to examine PFC activity during walking between people with PD classified as non-fallers and recurrent fallers.METHODS: Participants with mild-to-moderate PD were classified as either non-fallers (those who reported zero or one fall in the past 12 months; n= 34; age= 69.0±6.7 years) or recurrent fallers (those with two or more falls in the same period; n= 18; age= 69.2±7.2 years). Participants walked at a self-selected speed around a 26.8 m circuit for 30 seconds under two conditions (five trials per condition): single-task walking and dual-task walking (walking while performing a digit vigilance task). A mobile functional near-infrared spectroscopy (fNIRS) system (OctaMon, Artinis Medical System, Netherlands) and an electronic sensor carpet (GAITRite® system, CIR Systems Inc., Clifton, NJ, USA) were used to analyze PFC activation and gait parameters, respectively. Relative concentrations of oxygenated hemoglobin (HbO_2) and deoxygenated hemoglobin (HHb) in the PFC were measured. Gait parameters, including the mean of step length, velocity, duration, and swing time were calculated. A two-way ANOVA was performed to compare differences between groups and conditions, this last one was treated as repeated measures. RESULTS: A main effect of group showed that recurrent fallers exhibited higher PFC activity compared to non-fallers, regardless of the walking condition ($F_{1,50}= 5.225$, $p=0.027$). In addition, a main effect of condition revealed that participants increased PFC activity ($F_{1,50}= 11.759$, $p=0.001$), and step duration ($F_{1,50}= 13.077$, $p=0.001$); and decreased step length ($F_{1,50}= 48.335$, $p<0.001$), step velocity ($F_{1,50}= 58.402$, $p<0.001$) and swing time percentage ($F_{1,50}= 23.579$, $p<0.001$) during dual-task walking compared to single-task walking (Figure 1). CONCLUSIONS: Recurrent fallers increased PFC activity during walking, possibly to allocate additional cognitive resources for gait performance. These results are consistent with compensatory reallocation models, suggesting that increased PFC activation in people with PD at higher risk of falls helps maintain task performance at near-normal levels. ACKNOWLEDGEMENTS AND FUNDING: Funding received from the São Paulo Research Foundation (FAPESP # 2023/14143-0).

P01-N-106 - Increased excitability of cortical projections to ankle flexors and extensors in Parkinson's disease

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Background and AimImpaired postural control is common in people with Parkinson's disease (PD) and a major contributor to falls and morbidity. Ankle muscles play a critical role in providing vertical support of the body against gravity and generating power and toe clearance during gait. Ankle strength and power generation during gait is decreased in people with PD, suggesting there are disturbances in descending drive to these muscles. Currently, little is known about the function of cortical projections to the primary ankle muscles in people with PD. The excitability of fast-conducting corticospinal and slower conducting polysynaptic (putative corticoreticulospinal) pathways can be tested using transcranial magnetic stimulation (TMS) by disentangling the early and later components of the motor evoked potential (MEP). This study compared the excitability of cortical projections to the ankle flexor and extensors between people with PD and age matched controls. MethodsSingle pulse TMS over the leg region of the primary motor cortex examined the excitability of cortical projections to the ankle dorsi- (tibialis anterior, TA) and plantar flexors (soleus, SOL, lateral, GL and medial gastrocnemius, GM) in 14 people with PD (off medication) and 14 controls. MEPs were obtained during isometric plantar or dorsiflexion (10% of maximal voluntary contraction) with TMS intensities ranging from 80-150% of active motor threshold. MEPs were quantified using the area under the curve for both the early (onset - 8msec) and late (8 - 25msec) components of the response. ResultsLinear mixed effects analyses showed a significant group x task interaction effect ($p < 0.023$) for both the early and late components of the MEP in SOL and GL muscles. Both components of the MEP were significantly larger in the PD group compared to controls ($p < 0.03$) during plantar, but not dorsiflexion. The late component of the TA MEP was significantly larger than the early component in the PD group during plantar ($p = 0.025$) but not dorsiflexion. In both groups, the MEPs were significantly larger in the TA during plantar- vs. dorsiflexion and larger in SOL during active dorsi- vs. plantarflexion ($p < 0.005$). Conversely, MEPs were significantly larger in the GM and GL during active plantar-vs. dorsiflexion ($p < 0.001$). ConclusionThese findings demonstrate that the excitability of corticofugal projections to ankle muscles during isometric plantar, but not dorsiflexion, is increased in people with PD. Enhanced excitability of corticospinal and putative reticulospinal pathways may reflect an adaptive or compensatory mechanism to actively maintain postural stability. Alternatively, these changes may reflect disturbances in reflex pathways and/or the intrinsic excitability of spinal motoneurons.These results demonstrate that the function of corticofugal pathways is abnormal in those with PD. These changes may be important contributors to postural instability, falls and decreased mobility.

P01-N-107 - Developing a digital framework for continuous monitoring of rest-activity and sleep in inpatients with Parkinson's and delirium

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Background/AimsDelirium is a serious acute neuropsychiatric syndrome characterised by altered levels of consciousness, impaired cognition and inattention and is associated with poor outcomes. Patients with Parkinson's disease (PD) are at an increased risk of delirium [1]. However, delirium may be missed due to overlapping symptoms. Wearable devices can provide objective activity and sleep measures [2] and may facilitate identifying and monitoring delirium inpatients. However, identifying which digital measures to use is unclear. This study aimed to determine differences in digital rest-activity measures in PD inpatients with and without delirium and to propose a digital framework to aid clinical interpretation.MethodsInpatients with PD who were admitted to hospitals in Newcastle-upon-Tyne, wore an Axivity Ax6 wrist-worn device for up to seven days in parallel to daily delirium assessments based on the DSM-5 criteria. Recorded sensor signals were processed using open-source software (GGIR) [3] to provide 70 separate rest-activity and sleep measures averaged over the admission period. Measures showing differences between cases with and without delirium ($p>.05$) were entered into a Principal Component Analysis (PCA). ResultsDigital measures were derived for 54 participant admissions (36-delirium, 18-without). Seventeen separate digital-measures were significantly different in participants with delirium compared to those without. The PCA identified four components: daytime activity, daytime rest, sleep fragmentation and 24-hour rhythm (Figure 1). Delirium was associated with disrupted rest-activity patterns with increased daytime rest periods and increased wake duration at night.ConclusionWe identified digital measures that are significantly different in PD inpatients with delirium compared to those without. The digital framework aids clinical interpretation and provides a foundation to explore the delirium profile across the admission period. The framework could facilitate the monitoring of inpatient recovery and establish common objective endpoints in future clinical trials.REFERENCES:[1] Gerakios et al, 2024, Age Ageing, Mar 1;53(3):afae046.[2] Bate et al, 2023, Sensors, 23(10), 4881[3] van Hees VT, 2015, PLOS ONE, 10(11), p. e0142533.

P01-N-108 - Turning performance in neurodegenerative disease: Classification and longitudinal assessment

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Background and aimNeurodegenerative diseases and ageing are associated with turning impairments, which contribute to functional disability, reduced quality of life, and increased risk of falling [1]. Turning outcomes have the potential to serve as digital biomarkers for diagnosis and monitoring of disease progression. Therefore, a wearable-based analysis of turning performance was conducted to i) differentiate individuals affected by neurodegenerative diseases from healthy adults and ii) assess longitudinal changes over a 3-year period.MethodsA comprehensive dataset (ICICLE-GAIT [2], GAITDEM [3], and InCHIANTI [4]) was analyzed. Turning digital mobility outcomes (DMOs) were extracted by analyzing inertial data recorded using a single wearable device on the lower back [5], during 180° turns in structured in-lab motor tasks (10-meter walk in ICICLE-GAIT and GAITDEM; Timed Up and Go in InCHIANTI). To distinguish between dementia subtypes and healthy adults, 148 participants were included: 81 healthy older adults (OA, 72.0±7.8 y/o), 34 with Alzheimer's disease (AD, 76.8±6.5 y/o), and 33 with Lewy Body Disease (LBD, 76.1±6.5 y/o). Classification (HC vs AD, HC vs LBD, AD vs LBD y/o) was performed using ROC curves and machine learning models (e.g., Support Vector Machine, K-Nearest Neighbour algorithms) using DMOs, demographic, and clinical data. For longitudinal analysis, 47 healthy adults from ICICLE-GAIT (OAICICLE, 70.8±6.8 y/o), 63 from InCHIANTI (OAINCHIANTI, 79.0±6.7 y/o), and 26 with Parkinson's disease (PD, 68.8±8.3 y/o) were included. Linear Mixed Effect models evaluated changes in turning oscillations, measured by the root mean square angular velocity in the vertical (VT) and anteroposterior (AP) directions.ResultsROC curves showed high classification accuracy (AUC: HC vs AD = 0.87; HC vs LBD = 0.91; AD vs LBD = 0.82). Machine learning models achieved F1 scores above 80% (HC vs AD = 90.0%; HC vs LBD = 81.8%; AD vs LBD = 85.7%). PD patients showed increased AP oscillations ($p<0.01$), possibly reflecting a compensatory turning strategy. Individuals affected by PD and OAICICLE participants showed a significant decline in both VT and AP oscillations ($p<0.01$), resulting in reduced motor coordination and impaired stability. In contrast, OAINCHIANTI participants showed no significant changes.ConclusionsWearable technologies might enable continuous monitoring and early detection of neurodegenerative diseases, offering insights into disease progression. Turning DMOs show promise for evidencing neurodegenerative diseases, and for being sensitive to changes over time.References[1] H. Stolze et al., Movement Disorders, 2025.[2] Lord S., et al., Movement Disorders, 2013.[3] Mc Ardle R., et al., Alzheimer's & Dementia, 2019.[4] Ferrucci, L., et al., Journal of the American Geriatrics Society, 2000.[5] Rehman, R.Z.U., et al., Sensors, 2020.

P01-N-109 - Enhancing reactive stepping performance in Parkinson's disease through action observation with motor simulation

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Background and Aim Reactive stepping responses play a crucial role in recovering from loss of balance, but are notably impaired in individuals with Parkinson's Disease (PD), contributing to elevated fall risk. Perturbation-based training has shown promise for improving reactive stepping responses, but is labor-intensive and reliant on costly equipment, limiting accessibility. Action Observation with Motor Simulation (AOMS) of reactive stepping presents a potential alternative as a more feasible and scalable training approach. This study aims to evaluate whether a single session of AOMS training enhances reactive stepping responses in individuals with PD.Methods Twenty individuals with PD (Hoehn and Yahr stage 2 and 3) underwent a sequence of ten backward treadmill-induced perturbations at 1.5 and 2.5 m/s^2 (five at each intensity) in random order. One year later, they were reassessed using the exact same perturbation sequence. Ten participants underwent AOMS training prior to the perturbations. The AOMS training consisted of 30 trials, where the participants observed and simulated backward reactive stepping movements as demonstrated by a virtual humanoid avatar, whose balance was perturbed by a large bird colliding from the front (Figures 1A and B). The other ten participants, serving as a control group, underwent the repeated perturbation protocol without additional preparation. Step quality was quantified as the leg angle relative to the vertical at the moment of first stepping-foot contact (Figure 1C). The primary outcome was the within-participant difference in leg angle of each trial between the initial and follow-up measurements, where positive differences correspond to improvement and negative differences to a decline in reactive step quality at follow-up.Results In all trials, the AOMS group had on average higher leg angle differences than the control group, with a mean 2.06° ± 5.73 improvement in the AOMS group versus a -0.06° ± 6.52 decrement in the control group ($t(185.6) = -2.4$, $p = 0.019$). The difference was most pronounced in the first trial, with the AOMS group demonstrating a 4.71° ± 10.14 improvement in step quality compared to their initial measurement, while the control group showed a -3.51° ± 3.46 decrement (post-hoc t-test, $t(16) = -2.3$, $p = 0.035$).Conclusions The single-session AOMS training shows potential for enhancing reactive step quality in individuals with PD. Notably, the significant improvement in the first trial response is particularly promising, as it best resembles real-life unexpected falls [1]. These findings indicate that AOMS may be a promising approach for home-based training to enhance reactive stepping and reduce fall risk in individuals with PD.Funding: Interreg NWE (ScaleUp4Rehab; NWE0100082)[1] Barajas, J. S., & Peterson, D. S. (2018). First-trial protective step performance before and after short-term perturbation practice in people with Parkinson's disease. Journal of Neurology, 265(5), 1138–1144.

P01-N-110 - Motor-sensory integration during postural control after sport related concussions

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Background: Neural compensation may constitute a mechanism to uphold cognition and behavior during pathological situations. We investigated the hypothesis that athletes with ongoing symptoms after sport-related concussions (SRC) may be characterized by neural upregulation within the motor-sensory cortex to counteract postural deficits. Methods: 66 athletes (27 ± 13 years; 50 men, 16 women) participated in the study. 22 concussed athletes reported high post-concussion symptoms (PCS; symptomatic group) and 22 concussed athletes reported low PCS (symptomatic group). 22 healthy non-concussed athletes served as a control group. Postural control was assessed by a pressure distribution measuring plate during four balance conditions with eyes closed and/or eyes open whilst either standing on a stable or an unstable surface. Brain oxygenation was collected during postural control tasks by functional Near InfraRed Spectroscopy (fNIRS) above motor-sensory cortices of both hemispheres. Results: Postural stability was decreased in symptomatic athletes when compared to control athletes overall conditions as well as during unstable surface conditions. Symptomatic athletes were characterized by increased brain activation when compared to asymptomatic athletes overall balance conditions. When contrasting unstable versus stable surface conditions for each group symptomatic athletes (but not any other group) showed increased activation in the left precentral gyrus (PCG), left supramarginal gyrus (SMG), and the superior parietal lobe (SPL) of either hemisphere. The contrast of closed eyes versus open eyes showed minor brain activation in symptomatic athletes but increased activation in the asymptomatic and control groups. Conclusion: Athletes with persisting symptoms after sport-related concussions (SRC) are not effectively controlling posture within motor-sensory brain regions. The results therefore indicate that potential compensatory neuronal mechanisms in concussed and symptomatic athletes cannot countervail for post-concussion balance deficits.

P01-N-111 - Impact of muscle weakness and joint contracture in lower limb on walking impairments in people with Multiple Sclerosis

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Background and aim: There are limited data linking weakness in specific lower limb muscle groups and walking impairment in people with multiple sclerosis (MS). Our study aims to establish the impact of lower limb muscle weakness on gait characteristics in people with MS, to ultimately inform the design of interventions to improve mobility. Methods: Our sample so far comprises 49 people with MS (27 women, mean (SD) age: 49.7 (10.5) years) and 33 healthy controls (17 women, mean (SD) age: 38.1 (11) years). Strength is measured in the hip and knee flexors and extensors, hip abductors and adductors and ankle plantar- and dorsi-flexors. Lower limb kinematics during walking at self-selected speed are recorded with a motion capture system.Results: Preliminary

findings show that compared with healthy controls and after controlling for age, participants with MS display weakness in all lower limb muscle groups, except for knee flexors and extensors. People with MS have slower speed, display reduced range of motion at the hip, knee and ankle joints during walking, as well as a decrease in hip extension during stance and decrease knee flexion during swing. A multiple linear regression model show that knee joint range of motion, presence of an ankle joint contracture and hip extensor strength are significant and independent predictors of usual walking speed in our sample of people with MS. Conclusions: Our findings will contribute to inform best practice guidance on training programs to improve walking and mobility in people with MS.Acknowledgements and Funding: Multiple Sclerosis Research Australia Project Grant

P01-N-112 - Physical activity and sedentary behavior monitoring in people with Parkinson's disease and fatigue

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Background and aims: Decreased intrinsic motivation and difficulty in sustained attention for locomotor control are linked to walking difficulties experienced by people with Parkinson's disease (PwPD) and fatigue. This suggests that fatigue leads to gait changes that could potentially be markers of fatigue in PD. Nevertheless, no gait outcome has yet been identified as a biomechanical marker of fatigue in PD. This discrepancy could arise from the Hawthorne effect and the increased motivation to do well when taking part in research studies, especially in research labs or hospital environments. This underlines the need for more ecological and unsupervised studies. Another related explanation is that current standardized gait assessments might not be sensitive enough to capture the behavioral aspect of fatigue beyond walking kinematics. Monitoring of physical activity (PA) and sedentary behavior (SB) does capture motivational fluctuations in rest-activity time, levels, and patterns. Given the motivational constraints ascribed to the pathophysiology of fatigue, objective measures of PA and SB could provide more insights about the influence of fatigue on walking behavior. A recent systematic review on the topic (Maetzler et al. Digit Biomark. 2024) does in fact advocate for more ecological and digital performance-based studies to better understand the influence of fatigue on walking behavior and daily activity. The purpose of this study was thus to i) determine the link between fatigue, PA and SB time, levels, in PD and ii) determine the frequencies and patterns of rest-activity behaviors during wake hours. Methods: Fatigue was measured with the multidimensional fatigue inventory (MFI >48). We recruited 23 PwPD (11 with fatigue) and no major depression or anxiety (HADS <11), and no mild cognitive impairment (MOCA >25). To objectively measure physical activity level, rest-activity patterns, and sleep quality, we provided each participant with two activity monitors

(Actigraph) to wear in their usual environment for 5 consecutive days; one during the day (over the left waist) and one at night (on the wrist) In addition, all participants received logbooks to indicate device wear times, bedtime, and awakening(s). They also filled diaries commenting on their experience of fatigue, sleep quality, activities, and other perceived emotions (ecological momentary assessment). Results: Analysis of Actigraph data and subjective data is ongoing. We hypothesize that i) fatigue in PD will be linked to decreased physical activity and increased sedentary behavior time and levels during the day ii) people with PD and fatigue will show relatively less frequent and more consolidated both activity and sedentary bouts during wake hours. Conclusion: Our results will help identify whether PA and SB monitoring could be markers of fatigue in Parkinson's disease. This will inform the development of behavioral interventions to mitigate the influence of fatigue on walking performance in PD. Acknowledgement and funding: This study was funded by Parkinson Canada.

P01-N-113 - Enhancing patient- and clinician-reported outcome measures for freezing of gait in Parkinson's disease through patient engagement

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Background and Aims: Freezing of gait (FOG) in Parkinson's disease (PD) continues to be a major challenge for people with PD, caregivers, clinicians, and researchers alike. Limited treatment options reflect a paucity of research demonstrating efficacious therapeutics partly due to the lack of standardized Clinician Reported Outcomes (ClinRO) or Patient Reported Outcomes (PRO) to appropriately quantify changes in FOG severity. To meet this need, a working group of the International Consortium of FOG (ICFOG) was formed to develop a FOG ClinRO and PRO. Here we describe the development process and patient engagement that shaped the development of these new tools that are currently being validated. Methods: Consensus and recommendations were obtained through an iterative process involving multiple stakeholders, including people with FOG. Phase 1 involved assembling and discussing strengths and limitations of the currently available clinical assessment tools and consulting the regulatory roadmap of fit-for-purpose, for clinical outcome assessments (COAs). From there, the working group proceeded to draft the novel FOG ClinRO (6 items) and PRO (8 items) instruments. Phase 2 involved pilot testing our draft version on 20 participants with FOG and collecting caregiver unstructured feedback. We also assembled an international patient advisory committee (PAC) consisting of 6 people with PD with lived experiences and 2 caregivers who took part in five 1-hour virtual, structured consultation sessions. Upon integrating comments and feedback from 50 expert clinicians, researchers and the PAC, Phase 3 was initiated to validate the ClinRO and PRO and is currently underwayResults: The initial ClinRO was composed of 6 timed gait tests and the initial PRO had 8 items evaluating the impact of FOG on physical, social and emotional contexts in daily life. Based on the experiential knowledge from the PAC, the ClinRO expanded to 8 tests and the PRO expanded to 16 items. Additionally, the PAC revised the PRO Likert scale, reworded the FOG lay definition, and provided several examples to include in each PRO item that related to daily situations that FOG makes more difficult. The PAC also revised the dual-task procedure in the ClinRO, as well as specified guarding instructions, and adjusted the grading scale for scoring FOG severity. The validation testing is now in process, recruiting 105 individuals with PD and FOG and 35 individuals with PD without FOG across 7 international sites (sponsored by Michael J Fox Foundation).Conclusion: Taken together, multi-stakeholder perspectives, particularly persons with lived experiences, provided several insights into how to define FOG, how it meaningfully impacts daily life, how to maximally provoke FOG in clinical settings, and how to measure its severity, while also highlighting the importance of the caregiver perspective. These insights have been instrumental in guiding this ongoing ClinRO and PRO development research.

P01-N-114 - Understanding the relationship of static and dynamic balance measures in ataxic stance and gait at different disease stages

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BACKGROUND AND AIM: Ataxic gait is typically characterized by an unstable, stumbling gait, increased step width, and high gait variability. The characteristic high variability is thought to result from the complex interaction between cerebellar-induced deficits in balance control and multi-joint coordination, the compensatory strategies used, and inaccurate postural adjustments to the apparent loss of balance. The interplay and relative importance of these individual factors and their development over the course of the disease are not fully understood. Clarifying their relationship during disease progression would allow both efficient neurorehabilitation and the development of disease-phase sensitive performance markers for clinical trials. Here, we aimed to investigate the role of ataxia-specific balance dysfunction in static (stance) and dynamic (gait) conditions, particularly in very early and pre-symptomatic disease stages (i.e., mutation carriers without clinical manifestation). METHODS: We assessed static and dynamic balance of subjects with degenerative cerebellar ataxia at baseline and 1-year follow-up using three body-worn inertial sensors. Stance conditions included natural stance and feet together stance with eyes opened and eyes closed. As a measure of static balance performance we used the sway path length (SPL) based on the hip sensor. Walking was performed in laboratory settings, i.e., supervised straight walking of a 60m corridor at preferred speed, and unsupervised in real life. The compound measure of spatial step variability (SPcmp), which integrates step length variability and lateral step deviation, served as a measure of ataxia-specific gait variability. RESULTS: Cross-sectional analysis of symptomatic ataxia patients (n = 44, SARA = 10.1) revealed correlations between SPL during natural stance and SPcmp during walking, with increasing effects moving from laboratory ($r = 0.36$, $p < 0.0001$) to real-life conditions ($r = 0.51$, $p < 0.0001$). For the group of pre-ataxic mutations carriers (n = 33, SARA = 0.7) we saw a strong trend for the relation of gait variability and sway in a stance task with increased complexity (i.e., feet together, eyes closed) ($r = 0.25$, $p = 0.06$). The relation was particularly evident longitudinally when 1-year changes in stance sway and gait variability were correlated ($r = 0.44$, $p = 0.01$). CONCLUSIONS: We were able to identify specific influences of the static balance mechanism on gait in pre-symptomatic mutation carriers, suggesting that alterations in balance control mechanisms already play a verifiable role in pre-symptomatic and very early disease stages, whereas cerebellar-induced deficits in balance control and multi-joint coordination and compensatory strategies such as slowing down may have a greater influence in later disease stages. This highlights the importance of static stance testing and related balance exercises in rehabilitation, particularly in pre-symptomatic and early disease stages.

P01-N-115 - Real-world digital mobility outcomes in single and recurrent fallers with Parkinson's disease

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Background and Aim: Falls are prevalent in people with Parkinson's disease (PD) – up to 90% fall once and 65% fall multiple times over 12-months[1]. Recurrent fallers (RF) are older than single fallers (SF), however many other outcomes (ie. cognition, disease severity, lab-based gait speed and stance time variability) are similar[2]. Monitoring mobility in the real-world provides an ecologically valid evaluation of function that is meaningful to patients[3] and may be useful in understanding fall risk and fall frequency. This study evaluated differences in real-world digital mobility outcomes (DMOs), functional and clinical outcomes across non-fallers (NF) and fallers (SF and RF). Methods: 600 people with PD were recruited across 5 sites internationally [Mobilise-D Clinical Validation Study; www.mobilise-d.eu]. Participants were categorised as NF (0 falls), SF (1 fall) or RF (≥2 falls) based on 12-months self-report fall history. Demographic, functional (6 minute walk, Timed get up and Go, Mini best) and clinical outcomes (fear of falling, cognition; MOCA, Levodopa Equivalent Daily Dose (LEDD), MDS-UPDRS subscores, Hoehn & Yahr, freezer status) were collected. A single wearable device was worn on the lower back for 7 days[4]. 24 DMOs were extracted covering activity (amount, pattern), pace, rhythm and bout-to-bout (B-B) variability. Between-group differences were evaluated (Kruskal Wallis with post hoc tests (Bonferroni correction)).Results: Of the 531 participants with DMO data, 343 (65%) were NF, 82 (15%) were SF, and 106 (20%) were RF. RF were significantly older than NF (p=0.046). The proportion of freezers was highest in the RF group (n=45,43%) compared to NF (n=45,13%) and SF (n=12,15%). The proportion reporting fall-related injuries was similar in SF (n=37,45%) and RF (n=50,47%).Many functional and clinical outcomes were significantly different between NF and fallers. In comparison to SF, RF had a significantly higher fear of falling, increased LEDD and higher MDS-UPDRS IV score (evaluating motor complications).Compared to NF, fallers walked significantly slower (pace; Figure 1). SF walked with reduced stride length B-B variability compared to NF (p<0.05). Whereas, RF walked with reduced walking speed B-B variability and increased cadence B-B variability compared to NF (p<0.05). No DMOs were significantly different between SF and RF.Conclusions: Clinical and functional outcomes were significantly different between NF and fallers and should be accounted for in future analyses. Fallers walked slower overall, however gait variability differences were selective to faller classification. Further research investigating how components of real-world gait variability progress with disease severity and evolve in fall naïve cohorts are required. These findings have implications for clinical trial design, participant selection and fall prevention.[1] Allen 2013 PMID:23533953 [2] Lord 2017 PMID:28948348 [3] Delgado-Ortiz 2023 PMID:36729471 [4] Kirk 2024 PMID:38243008.

P01-N-116 - Ai-moka: A pilot study on AI-based wearable telemonitoring to explore gait, balance, and cognitive load in daily activities

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Background and Aim: People with neurological conditions, such as multiple sclerosis (MS), face challenges in Activities of Daily Living (ADLs) demanding motor and cognitive effort. This study aimed to develop and evaluate AI-Moka, a telemonitoring system integrating wearable sensors and Artificial Intelligence (AI) algorithms to assess mobility and cognitive load during coffee preparation. This pilot study focused on healthy individuals to explore AI-MOKa usability and extract preliminary metrics for future comparisons with MS populations. Methods: Four healthy participants (4 males, age=38.0±16.4) completed a coffee preparation task while wearing Tobii Pro Glasses 3 to capture video of the surrounding environment and monitor pupil activity, and Sensing Tex insoles to measure plantar pressure distribution. The task was conducted in a kitchen where room areas were identified using QR codes. AI-driven algorithms processed the data to automatically identify working areas, task phases and object interactions, and to extract metrics related to gait (step number), balance (left vs. right foot weight distribution), and cognitive load (pupil diameter variations). Usability was assessed using participant questionnaires. Results: AI-Moka successfully identified distinct working areas (blue line in the figure, one representative subject). Participants primarily remained in the coffee preparation area, including the support surface, sink and hob (Coffee Area). Specific tasks were mapped to areas such as the shelf, stock, and drawer, where participants retrieved tools (cups, coffee, sugar, spoons) according to their individual planning. Image processing identified objects and delineated task phases (e.g., moka preparation, coffee brewing, and serving). Preliminary metrics extracted included: total number of steps (159.0±60.3, yellow footprints in the figure), steps during the serving phase (13.8±8.8, blue footprints), weight distribution on left vs. right foot (red line), number of balance alternations in the Coffee Area (66.3±45.7) and its rate (10.6±.6.9 alternations/minute). Further, pupil diameter variations (dotted lines) indicated cognitive effort, which increased during moka manipulation and coffee serving.Participants rated the system as comfortable (4.1±0.8/5), non-intrusive (5.0±0.0)/5), and highly usable (4.8±0.5/5), emphasizing its strong ecological validity. Conclusions: This pilot study demonstrated the feasibility of AI-Moka for simultaneous correlation of gait, posture and cognitive load during ADLs in real-world settings. The system effectively captured relevant motor and cognitive parameters across different areas and task phases, characterizing individual performance independently of task sequence. These findings lay the groundwork for applying AI-Moka in neurological populations such as MS. Future work will focus on expanding sample size, addressing technical limitations, and validating the system in clinical populations.

P01-N-117 - Transcranial magnetic stimulation evoked potentials used to assess pain and motor-symptoms in persons with Parkinson's disease: A protocol

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Background and aimParkinson's disease is a devastating disease leading to motor symptoms such as tremor, rigidity, and dystonia. However, non-motor symptoms, such as pain, are often overlooked. People with Parkinson's disease frequently suffers from debilitating pain which makes their daily life challenging. Brain neuromodulation is a non-invasive way to alleviate some of the non-motor symptoms that persons with Parkinson's disease experience. Repetitive Transcranial Magnetic Stimulation (rTMS) of a cortical region is a new technique that has shown promising results in alleviating pain in patients with chronic pain. Additionally, there has been promising results in persons with Parkinson's disease improving both motor symptoms (measured using e.g., timed Up-and-Go scores or Freezing of Gait scores) and non-motor symptoms using rTMS. However the mechanisms by which rTMS work is yet to be fully understood. By assessing the pertubational electroencephalographic (EEG) responses triggered by TMS, known as

TMS-EEG, measures of brain connectivity can be better understood.MethodsPersons with Parkinson's disease will be recruited and compared to a cohort of healthy participants without pain. All participants undergo a range of questionnaires about pain and wellbeing (e.g., HADS, McGill, EQ-5D). Specifically for the persons with Parkinson's disease, the motor part of UDRPS, and the (modified) Hoehn-Yahr scale will also be applied. Additionally, the persons with Parkinson's disease will have their gait ability assessed with the TUG. Transcranial magnetic stimulation evoked potentials (TEPs) will be recorded from all participants during TMS-EEG recordings, targeting their primary motor cortex (M1). From the TEPs, natural frequency, power in the alpha frequency, and connectivity measures (e.g., weighted phase lag index; WPLI) will be computed and finally compared to normative data from healthy participants. The aim is to recruit 30 persons with Parkinson's disease. The study will commence in January 2025 and will continue for two years. The main hypothesis is that the groups will present distinct TEPs characteristics, and that these differences might be related to pain type and motor symptoms (UDPRS motor score and time to complete the TUG) for persons with Parkinson's disease.ResultsWe expect to find differences in the connectivity measures (WPLI) around M1. The expectation is that persons with Parkinson's disease will have lower connectivity with surrounding brain areas than normative, healthy participants. The results of a small subset of the intended number of persons with Parkinson's disease will be presented at the conference.ConclusionTMS-EEG is a promising tool for assessing natural frequency and connectivity of the diseased and healthy brain. In this study we aim to be able to classify patients with Parkinson's disease depending on their non-motor symptoms, specifically pain, and relate them to the severity of motor symptoms.

P01-N-118 - Test-retest reliability of IMU-based turning in place outcomes in people with Parkinson's disease and freezing of gait

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BACKGROUND AND AIM: Turning difficulties have an enormous impact on daily mobility and independence of people with Parkinson's disease (PwPD). These deficits are likely due to the complex interaction between interlimb coordination, stepping asymmetry, and high dynamic balance requirements. PwPD typically perform slower, more variable and jerky turns and turning on the spot frequently provokes freezing of gait (FOG) episodes. Consequently, there is a growing interest for designing interventions that target turning performance in PwPD. However, the test-retest reliability of turning outcomes are yet to be evaluated. Therefore, this study aimed to investigate the test-retest reliability of inertial measurement unit (IMU)-based turning outcomes in PwPD evaluated during a one-minute alternating turning in place (TIP) task on two separate occasions. METHODS:A total of 26 PwPD will be included. The current abstract, however, is based on data from 18 PwPD with self-reported daily FOG (age 62.94±7.06; disease duration

11.56±4.82) who completed the study and performed the TIP task at home on two separate days, four weeks apart, without an intervention. The TIP was performed ON medication both in single-task (ST) and dual-task (DT) conditions. The auditory Stroop task was used as the DT. During the TIP, participants wore five IMUs, placed on the lower back and bilateral feet and shins, sampling at 128 Hz. Turning outcomes included the average and coefficient of variation (CV) of turning speed, mediolateral jerkiness, and the number of turns. FOG was assessed using the anterior-posterior FOG index extracted from the sensor data. Test-retest reliability was evaluated with intraclass correlation coefficients (ICC) for absolute agreement.RESULTS:During DT, test-retest reliability was good for average turning speed (ICC=0.76) and the number of turns (ICC=0.72). There was moderate agreement for average jerkiness (ICC=0.56), jerkiness CV (ICC=0.59), and the FOG index (ICC=0.59) and poor agreement for turning speed CV (ICC=0.44). Reliability was lower for ST turning, with moderate to good reliability for average turning speed (ICC=0.68), number of turns (ICC=0.59), and average jerkiness (ICC=0.59) and a poor reliability for turning speed CV (ICC=0.13;), jerkiness CV (ICC=0.15) and the FOG index (ICC=0.12). For all outcomes, the confidence intervals of the ICCs were wide, reflecting large intra-subject variability (Table 1).CONCLUSIONS:DT turning performance can be reliably assessed in PwPD and FOG, and may be used as an outcome in intervention studies. For ST turning, turning speed, number of turns and jerkiness have acceptable reliability for use as an outcome. Minimal detectable changes will be calculated next. It should also be noted that these are preliminary results that might change upon inclusion of the total study population.

P01-N-119 - The effects of physical exercise on motor complications in Parkinson's disease: A systematic review and meta-analysis

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Background and aim. Levodopa remains the most effective pharmacological treatment for Parkinson's disease (PD) symptoms. However, long-term dopaminergic treatment often leads to motor fluctuations and levodopa-induced dyskinesia (LID), significantly affecting quality of life by contributing to disability, increased fall risk and impaired gait and balance. While physical exercise is well-established for managing PD symptoms through its neuroprotective and neurorestorative properties, its specific role in addressing motor fluctuations and LID symptoms remains unclear. This systematic review and meta-analysis aim to (a) investigate whether physical exercise improves motor complications in people with PD and (b) identify specific exercise modalities effective in addressing these symptoms. Methods. This study was registered in PROSPERO (CRD42024562505). Searches were conducted in Pubmed, Embase, Scopus, Web of Science, and Scielo databases. Inclusion criteria were randomised

controlled trials (RCT) involving physical exercise intervention assessing motor complications pre-and post-intervention. Screening and data extraction were performed independently by two authors, with conflicts resolved by a third author. Risk of bias was assessed using the Physiotherapy Evidence Database scale. Data were synthesised for meta-analysis. Results. Nineteen studies were included, of which twelve had a low risk of bias. Participant numbers ranged from 18 to 125. Interventions included aerobic training (n=6), strength training (n=2), stretching (n=3), mixed training (n=12), aquatic ai chi (n=1), tango (n=1) and exergaming (n=1). All the studies assessed motor complications using the Unified Parkinson's Disease Rating Scale part IV (UPDRS-IV) or its modified version (MDS-UPDRS IV). Only one study reported significant improvements in motor complications post-intervention, while others reported no significant differences. However, most interventions did not target LID or motor fluctuations directly. The planned meta-analysis will offer additional insights into the pooled effects of exercise interventions. Conclusions. Although only one study demonstrated improvements in motor complications, it is essential to highlight that none of the studies targeted people with LID or motor fluctuations as primary outcomes, nor did they use specialised assessment scales tailored to these symptoms. This underscores the critical need for further RCTs to address this gap. Future research should prioritise populations with LID and motor fluctuation, use tailored outcome measures and explore the potential benefits of different exercise modalities. The forthcoming meta-analysis will provide a more comprehensive understanding of the role of physical exercise in managing motor complications, potentially informing clinical practice and guiding future interventions. Acknowledgements and funding. University International Postgraduate Award (UIPA) from the University of New South Wales.

P01-N-120 - Freezing of gait and fear of falling in patients with Parkinson's disease: A cerebral blood flow imaging analysis

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Background and aim: Freezing of gait (FOG) and fear of falling significantly affect the quality of life in patients with Parkinson's disease (PD), but management and underlying mechanisms of each symptom remains elusive. Whether FOG and fear of falling shares common central mechanisms or independent functional responsible regions, are clinically relevant, in terms of planning therapeutic strategies. Considering that fear of falling may cause FOG and vice versa, it may be possible to investigate the responsible brain regions in the same PD group. Therefore, aim of this study was to explore the functional responsible brain region of FOG symptoms and fear of falling in patients with PD by utilizing brain perfusion imaging.Methods: From January 2018 to November 2024, 105 patients with PD, fulfilled the clinically established Movement Disorder Society

criteria for PD (mean age 68.2 years, mean disease duration 8.0 years), were evaluated with FOG questionnaire (FOG-Q), Modified Falls Efficacy Scale (MFES), and 123I-iodoamphetamine single photon emission computed tomography. The PD group scoring 0 on the FOG-Q question 3 (question on the frequency of FOG) was defined as PD without FOG (n = 28), the PD group with scores ranging from 1 to 4 were classified as PD with FOG (n = 77). Group comparison of perfusion images between two groups were performed by SPM12 running on MATLAB R2024a, using 2-sample t-test and global normalization method. Age, sex, camera type was incorporated into the model as nuisance covariates. The statistical peak threshold of $p < 0.001$, and a cluster threshold of $p < 0.05$, both uncorrected for multiple comparisons. Spherical volumes of interest (VOIs) with 8 mm radius were defined from the significant peak coordinates derived from the initial voxel-based group comparisons. Individual regional cerebral blood flow (CBF) was calculated as counts in the VOI divided by the global mean. Correlations between regional CBF in the bilateral VOIs and MFES or FOGQ scores were investigated using Spearman's rank correlation.Results: FOG-Q score and MFES score were correlated (Rs=-0.70, $p < 0.05$). Compared to PD without FOG group, PD with FOG group showed higher CBF level in the left temporal pole to the left insular cortex (Z = 4.05, cluster size = 1484 voxels). In contrast, high MFES PD group and low MFES PD group did not show significant difference. MFES scores showed correlation only with left insula CBF (Rs=-0.19), whereas FOGQ scores showed correlation with bilateral insula (left: Rs=0.27, right: Rs=0.21) and temporal pole (left: Rs=0.30, right: Rs=0.20) CBFs (all $p < 0.05$).Conclusion: Increased activation in the left temporal lobe and the left insula were associated with FOG symptoms, while the left insula may be ascribed by the fear of falling in patients with PD.

P01-N-121 - Daily walking outcomes as a motor prodromal marker of Parkinson's disease incidence – a UK biobank study

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Background and aim: Parkinson's disease (PD) is marked by the presence of motor and non-motor symptoms, the latter being most often observed years before clinical diagnosis, called the prodromal phase of PD. Parkinson's clinical diagnosis is marked by the manifestation of motor symptoms, including bradykinesia, tremor and rigidity. With the advancement of wrist-worn accelerometry, widely incorporated into smartwatches, these devices can potentially monitor another PD motor symptom, gait disorders, including its manifestations in prodromal PD phases. Thus, this study determined whether (i) validated digital gait biomarkers derived from wrist-worn sensor data could predict incident PD and (ii) we could identify outcomes to differentiate those individuals yet to be diagnosed with PD from healthy subjects.Methods: A population-based longitudinal cohort study was conducted with 73,413 participants aged 65 and older

recruited from the UK Biobank study. Participants were people diagnosed with PD at baseline (n=119), healthy subjects (n=72,980) and healthy subjects that presented with incidental PD between (i) 0 to 40 months (n=78); (ii) 41 to 60 months (n=78); (iii) 61 to 80 months (n=77); (iv) 81 to 119 months (n=81) after the beginning of the study. At baseline, participants were assessed on several outcomes using wrist-worn accelerometers for up to seven days, and 18 digital gait biomarker outcomes were used. One-way ANOVAs with Bonferroni-adjusted post hoc were used to determine between-group differences. The association between each digital gait biomarker and incident PD was examined with univariable Cox regression, including age and sex as covariates. Results: We identified a distinct motor prodrome of PD that can be detected using digital gait biomarkers up to 60 months before the clinical diagnosis of PD ($p<0.05$). This motor prodrome is characterised by digital gait biomarkers, including a lower average number of daily steps, slower average gait speed, increased step and stride regularity and reduced arm swing. Interestingly, some of these motor abnormalities during gait, particularly changes in arm swing, can be observed up to 119 months before clinical onset ($p<0.05$). Irrespective of the time of incidental PD, 5 outcomes were used to discriminate those with incidental PD and healthy subjects, including reduced numbers of steps per day, slower maximum speed, poorer step regularity, more bouts of walking in 60 seconds and having the hand static, mimicking a texting or phone call. Conclusions: This study confirms the existence of a distinct motor prodrome in idiopathic PD and demonstrates the potential of digital gait biomarkers in identifying individuals at risk long before clinical diagnosis. Future research combining motor and non-motor prodromal markers could help usher in a new era of early intervention and disease-modifying therapies for PD.Acknowledgments: This study was conducted using the UK Biobank Resource, Application Number 56109.

P01-N-122 - Real-world digital mobility outcomes evolution between patients with Parkinson's disease with and without freezing of gait and converters to freezing of gait

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Background and aim: Freezing of gait (FOG) is one of the most disabling motor symptoms in Parkinson's disease (PD). PD+FOG have slower gait speed, shorter strides and more variable step times in the clinic, compared to PD-FOG. Yet, little is known how daily-life mobility outcomes (DMO) differ between these groups and how DMO progress over time, especially in those who convert to PD+FOG (CONV). Here, we compared the one-year DMO evolution between PD+FOG, PD-FOG and CONV as part of the Mobilise-D PD cohort.Methods: A cohort of 600 people with PD were recruited across 5 sites internationally [Mobilise-D Clinical Validation Study; www.mobilise-d.eu]. Participants were categorized as: PD+FOG if they reported to experience FOG (NFOGQ ≥1) consistently at baseline (T1), 6 month (T2) and 12 month (T3) timepoints; PD-FOG if they consistently reported not to experience FOG; CONV if they developed FOG after T1 and continued to report it at T3. Those who inconsistently reported FOG were excluded from this analysis. A single wearable device was worn on the lower back for 7 consecutive days at all timepoints. DMOs were extracted covering gait quality and gait volume. Linear mixed models with Tukey corrected post-hoc tests were used to compare groups over time on DMOs and clinical scale (MDS-UPDRS3).Results: Of the 531 participants with valid DMO data, 507 (71%) were PD-FOG, 82 (15%) were PD+FOG, 50 (9%) were CONV. 24 (5%) were excluded for inconsistent FOG. Age (66±9 yrs; p=0.23) and gender (65% male; p=0.27) were similar across the groups.Gait speed (GS) and stride length (SL) was lower in PD+FOG (GS: 0.70m/s; SL: 91cm) and CONV (GS: 0.70m/s; SL: 92cm) than in PD-FOG (GS: 0.74m/s; SL: 96cm; p<0.001) and declined in all groups over one year (ΔGS: -0.01m/s; ΔSL: -1.3cm; p<0.001), no group x time interaction. However, a sub-analysis only considering >30sec. walking bouts found a significant group x time interaction (p<0.05) with CONV decreasing their max GS (Δ -0.06m/s) over one year whereas PD+FOG and PD-FOG did not.Step counts were similar at T1 (~8200 steps/day) and remained stable in PD-FOG and PD+FOG while CONV had 1800 steps/day less after one year (group x time p<0.001). The same patterns were seen for walking duration and number of walking bouts.MDS-UPDRS3 was higher in PD+FOG and CONV (29 pts) than PD-FOG (25 pts; p=0.31) at baseline but deteriorated more in PD+FOG (Δ+6 pts; p<0.01) and CONV (Δ+7 pts; p<0.01) compared to PD-FOG (Δ+1 pts; p=0.64).Conclusion: Real-world gait quality is more affected in freezers and in converters when compared to non-freezers. Notably, gait volume remains stable in established freezers and non-freezers, whereas converters present a clear decline over one year. Future analysis covering a longer timespan needs to determine whether the decline of gait quality and volume is a consistent feature of the transition to FOG and why gait volume is maintained in freezers, despite their poor gait quality.Acknowledgements: This work was supported by the Mobilise-D project that has received funding from the Innovative Medicines Initiative 2 Joint Undertaking (JU) under grant agreement No. 820820.

P01-N-123 - Split-belt gait adaptation in people with a functional neurological movement disorder

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BACKGROUND AND AIMPatients with functional neurological movement disorders (FND) present with neurological symptoms without physiological or structural cause. FNDs are common and disabling and thought to result from dysfunction in the sensorimotor control circuitry comparing feedforward and feedback models. In FND it is hypothesized that feedforward signals in planning and preparation of movement are overweighed under the influence of previous expectation, attention and emotion. Feedback signals are subsequently insufficiently used to update feedforward models, resulting in neurological symptoms and signs1. Here, we aimed to assess this hypothesis by comparing adaptation speed to split-belt walking2 between patients with FND and controls. We hypothesized that adaptation of step length asymmetry (SLA) to split-belt walking would be slower in FND patients compared to controls.METHODSWe included 12 FND patients as diagnosed by a movement disorders specialist and controls. All FND patients suffered from functional tremor in the arms. Participants walked on an instrumented split-belt treadmill at 2 min 1.0 m s-1 tied-belt (fast baseline), 2 min 0.5 m s-1 tied-belt (slow baseline), 7 min 1.0:0.5 m s-1 split-belt (adaptation), 4 min 0.5 m s-1 tied-belt (washout). SLA was calculated from 2D center of pressure (m) data and defined as the difference between left and right step length divided by the sum of both step lengths. We performed singular spectrum analysis to identify global adaptation trends in SLA3 and calculated adaptation time (s) as the point at which participants reached 90% of their total adaptation volume. We performed an independent t-test to compare adaptation time between FND and control (α=0.05).RESULTSFrom the 12 FND patients 3 were not able to complete the study because treadmill walking was too difficult. In 9 FND patients we were able to perform the study and controls were age- and sex-matched. Patients with FND and healthy controls showed similar SLA at fast and slow baseline (Figure 1). Patients with FND adapted their SLA to split-belt walking significantly faster (126.7 s ±122.5) compared to healthy controls (268.2 s ±86.5; t=-2.8300, p=0.012). Visual inspection of Figure 1 indicates that patients with FND showed reduced after-effects compared to healthy controls.CONCLUSIONSContrary to our hypothesis, patients with FND adapted faster to split-belt walking than age-matched healthy controls, which indicates faster task-switching between tied- and split-belt walking in the FND group. Based on these results, we hypothesize that FND patients focus on normalizing their step lengths towards a symmetric gait pattern more than healthy controls. Future research could assess whether (hyper)focus on task execution affects movement in FND patients.REFERENCESHallett et al., 2022. Lancet NeurolBuurke et al., 2018. J Exp BiolSwart et al., 2022. Biomed Signal Process Control

P01-O-124 - Preoperative characterization of Sarcoma patients through an ecological wearable sensor-based protocol

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Background and AimSarcomas are rare malignant tumors affecting bones and soft tissues, mainly in the lower limbs, leading to alterations in the motor performance[1].

Heterogeneity in tumor size, growth rate, and localization[2] can further impact patient's motor abilities, making the motor assessment objectivation even more crucial, as it usually relies on subjective questionnaires[3], or it is even completely absent. The aim of this study is, therefore, to understand if and how the tumor presence and size affect gait and functional abilities in the preoperative phase of sarcoma patients through an objective evaluation protocol based on wearable inertial sensors (IMUs). MethodsFifteen osteosarcoma (OS) and 29 soft tissue sarcoma patients (ST), and 21 healthy controls (CG) performed a 2-minute walking test (2MWT), a Timed Up and Go (TUG), and 60s posturography while wearing a full-body protocol of 15 IMUs (OPAL, APDM Inc., 128Hz). Spatiotemporal gait parameters, TUG duration and trunk kinematics, turn parameters, and sway parameters were assessed. Tumor volume was calculated using MRI and approximating the tumor mass as an ellipsoid. Data were analyzed using SPSS with repeated measures ANOVA or Kruskal-Wallis test for group differences, and Spearman correlation for tumor volume and gait parameters.Fifteen osteosarcoma (OS) and 29 soft tissue sarcoma patients (ST), and 21 healthy controls (CG) performed a 2-minute walking test (2MWT), a Timed Up and Go (TUG), and 60s posturography while wearing a full-body protocol of 15 IMUs (OPAL, APDM Inc., 128Hz). Spatiotemporal gait parameters, TUG duration and trunk kinematics, turn parameters, and sway parameters were assessed. Tumor volume was calculated using MRI and approximating the tumor mass as an ellipsoid. Data were analyzed using SPSS with repeated measures ANOVA or Kruskal-Wallis test for group differences, and Spearman correlation for tumor volume and gait parameters.ResultsResults are reported in the Table.Gait. OS group showed significant gait alterations in stance and swing phases, displaying a higher stance and a lower swing phase, compared to CG, as well as a prolonged double support on both affected and unaffected side. Conversely, ST group did not show significant differences in gait parameters compared to OS and CG, except for stride length of the healthy limb.TUG. Both OS and ST displayed significantly higher turn duration, and the overall task duration showed a significant difference in the ST group.Posturography. No differences were observed among groups.Tumor size. Tumor size did not correlate with any parameters. ConclusionBone sarcomas appear to affect gait performance more than soft tissue sarcomas, possibly due to the impairment of weight-bearing structures, which may lead to reduced stability and, in some cases, pain. However, it should be noted that the heterogeneity, and consequent high variability of the patients, may have influenced results, limiting detection of significant differences in other groups.The increased turn duration phase suggests difficulties in performing complex tasks such as curvilinear walking, which requires greater motor control, highlighting the importance of multi-directional tasks in preoperative evaluations.Sarcoma lesions do not seem to affect balance control, and tumor size does not influence gait parameters, suggesting lesion size is not the primary factor affecting gait.IMU-based evaluations identify preoperative functional impairments in sarcoma patients, providing objective measurements to guide tailored rehabilitation treatments and monitor postoperative recovery. References[1]

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P01-O-125 - Effects of cognitive task difficulty on postural control during dual-task performance in individuals with chronic ankle instability

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BACKGROUND AND AIM: Postural control impairments in individuals with chronic ankle instability (CAI) have been widely discussed. Although several studies have examined changes in postural control during dual-task performance in individuals with CAI, it remains unclear whether CAI-specific alterations in postural control exist. This study aimed to investigate the effects of cognitive task difficulty on postural control during dual-task performance in individuals with CAI. METHODS: A total of 11 healthy individuals (age: 24.1 ± 2.5 years; height: 166.4 ± 7.5 cm; weight: 59.3 ± 8.8 kg) and 11 individuals with CAI (age: 24.5 ± 2.1 years; height: 164.2 ± 8.1 cm; weight: 53.9 ± 8.8 kg) participated in this study. Participants performed single-limb balance tasks on a foam pad (Balance-pad Airex, Airex AG, Switzerland) placed over a force plate with their eyes open, while simultaneously engaging in visuospatial cognitive task, specifically the Manikin test. The Manikin test was modified with three levels of difficulty (easy, moderate, and difficult) by manipulating images with varying degrees of rotation in the transverse and frontal planes. Each participant completed 30-second trials of the single-limb balance task under four experimental conditions: no cognitive task, easy cognitive task, moderate cognitive task, and difficult cognitive task. During the dual-task trials, participants were instructed to prioritize the cognitive task. The conditions were presented in a randomized order and repeated three times. Postural sway was measured using a force plate (Kyowa Electronic Instrument Co., Ltd., Japan) at a sampling rate of 1000 Hz. Center of pressure (COP) parameters, including COP amplitude, COP area, and COP velocity were calculated. Statistical analyses were performed using a two-way (Group × Condition) ANOVA with a split-plot factorial design. Post-hoc tests were conducted using Shaffer's modified t-test. A significance level was set at $p < 0.05$. RESULTS: A significant Group × Condition interaction was identified for COP area, while no significant main effects were observed for either Group or Condition. Post-hoc analysis revealed that COP area was significantly larger in CAI subjects than in healthy subjects under the difficult cognitive task condition. For COP velocity, a significant main effect of Group was observed, with COP velocity being higher in CAI subjects compared

to healthy subjects. No significant main effects of Group or Condition, nor a Group × Condition interaction, were found for COP amplitude. CONCLUSIONS: This study demonstrates specific alterations in postural control during dual-task performance in individuals with CAI. The impact of postural control on the difficulty of cognitive tasks during dual-task performance may differ between healthy individuals and those with CAI. Further research is warranted to explore the effects of cognitive load on postural control during dual-task performance in individuals with CAI.

P01-O-126 - Effects of hip arthroscopy on gait, functional performance, and patient-reported outcomes in military service members

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Effects of Hip Arthroscopy on Gait, Functional Performance, and Patient-Reported Outcomes in Military Service MembersTy Cardinale1*, Andrew Plows1, Patrick Desrosiers1, Trevor Kingsbury1, Brian Barlow1 1Naval Medical Center San Diego, San Diego, CA, USA*Corresponding author's email: tycardinale@gmail.comBackground and Aim: Femoroacetabular impingement syndrome (FAIS) involves various morphological patterns and symptoms, often associated with labral tears and an increased risk of osteoarthritis. Military service members (SMs) face a higher risk of FAIS-related pathomechanics due to the physical demands of their roles [1, 2].Arthroscopic surgery, aimed at improving function and relieving symptoms by restoring the femoral head-neck offset, is a common treatment, but its effectiveness remains inconclusive. Research shows that FAIS patients may have altered movement strategies, such as reduced squat depth and gait changes, yet the impact of arthroscopy on gait and higher-level movements, particularly in military populations, remains unclear. This study examines the effects of hip arthroscopy on gait biomechanics and demanding movements in military SMs, comparing results to existing literature.Methods: Eleven service members (SMs) undergoing hip arthroscopy at a Military Treatment Facility were assessed pre-surgery and 9 months post-operatively. Assessments included gait analysis, three maximal countermovement jumps (CMJs), and five bodyweight squats on dual force plates. Gait variables included temporospatial parameters and sagittal hip kinematics, while CMJ jump height and squat depth were analyzed. Patients also completed the PROMIS Pain Interference (v1.1) and Physical Function (v2.0) scales. Results: No significant differences were observed in temporospatial parameters between pre- and post-surgical groups during gait analysis. However, post-surgery, the mean stride length on the affected side increased (1.38 m to 1.40 m), and stance time decreased (0.61 s to 0.58 s), potentially reflecting improved confidence in the surgical limb. Sagittal plane gait kinematics also showed no significant changes, with peak anterior and posterior pelvic tilt remaining within 1 degree and peak hip flexion and extension within 2 degrees of pre-operative values.Post-operatively, participants showed reduced mean squat depth (38.9 cm to 33.9 cm) and mean jump height (9.2 in to 8.2

in).Self-reported outcomes revealed a significant reduction in pain interference post-surgery (64.1 to 60.3, p = 0.04). Additionally, there was a clinically meaningful improvement in physical function scores (38.9 to 42.2), though this change was not statistically significant.Conclusion: This study demonstrates improved patient-reported outcomes following hip arthroscopy, with reduced pain interference and better patient reported physical function, highlighting the surgery's positive impact on recovery. Objective measures of basic functionality, such as gait, showed minimal changes consistent with prior literature, where significant improvements are not typically expected.In contrast, slight declines in performance during higher-level activities, such as squats and countermovement jumps, may hold implications for military populations reliant on peak physical performance. While these differences are small, long-term monitoring is crucial to assess recovery and address residual deficits.The small sample size limits the generalizability of these findings, emphasizing the need for larger studies to better understand surgical outcomes and their impact on functional performance.References:[1] Dutton et al., 2017[2] Thomas et al., 2017Disclaimer: The views expressed herein do not necessarily reflect those of the Department of the Navy, Department of Defense, DHA or the U.S. Government.

P01-P-127 - Lower limb sensorimotor function explains a greater proportion of balance impairment in people with COPD compared to people without COPD

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Background and aim Chronic obstructive pulmonary disease (COPD) is characterised by breathlessness but balance impairment is becoming increasingly recognised. The reasons underpinning balance impairment in people with COPD are largely unknown. We aimed to quantify the relationship between balance and lower limb sensorimotor function in people with COPD and compare this to people without COPD. Methods People with COPD and those without (controls) were recruited from pulmonary rehabilitation waiting lists and public advertisements respectively. Differences between-groups were calculated for balance, sensorimotor function, strength and body composition. A multivariable linear regression was run to predict balance performance (Balance Evaluation Systems Test (BESTest) total score(%)) from measures of sensorimotor function (H-reflex latency of the femoral nerve(ms)), plantar flexor maximum voluntary contraction (MVC)(Nm), involuntary activation of the quadriceps(%MVC) and sensitivity threshold of the sole of the dominant foot(v)). Results 40 participants were recruited and 38 (19 COPD, 19 controls) included. COPD: 47% male, mean(SD) age(y) 69 (6.65), BMI 28.33 (7.81), FEV1(l) 1.45 (0.61), FEV1/FVC(%) 54.47 (15.51). Controls: 58% male, mean(SD) age(y) 67 (7.47), BMI 26.49 (4.4)1, FEV1(l) 2.89

(0.94), FEV1/FVC(%) 76.37 (4.78). There were significant between-group differences in (mean difference (95% CIs)) BESTest total score(%) -22.81 (-30.23 to -15.39) effect size (ES)=-2.06, H-reflex latency(ms) 2.88 (0.43 to 5.32) ES=0.79, plantar flexor MVC(Nm) -22.53 (-40.20 to -4.87) ES=-0.85, quadriceps MVC(Nm) -53.38 (-88.30 to -18.47) ES -1.01 and max grip strength(kg) -8.92 (-16.95 to -0.97) ES -0.73 in favour of controls. All other differences were non-significant. 56% of the variance in balance can be explained by lower limb sensorimotor function in COPD ($F(4,13)=4.12, p=0.02$) compared to 46% in controls ($F(4,12)=2.56$, $p=0.09$). Plantar flexor MVC(Nm) beta (β)=0.45, H-reflex latency(ms) β=-0.63 and involuntary activation(%MVC) β=0.47 contributed to the prediction model in people with COPD (all $p<0.05$) while only plantar flexor MVC(Nm) β=0.63 added to the prediction in controls ($p=0.30$). Conclusion People with COPD appear to have worse balance. Plantar flexor strength seems to be an important predictor of balance in both groups, whilst sensorimotor function, specifically stretch reflex response time and involuntary activation, only appears to be important in those with COPD. Findings offer a focus for future balance training tailored to the needs of this population.

P01-P-128 - Effect of additional somatosensory information on gait trajectory deviated by neck muscle vibration

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Background and aimHuman subjects form a body scheme for successful locomotion, perceiving real-time body position in space and limb posture. Neck proprioception is crucial for developing the body scheme during locomotion and provides spatial orientation and information of location. When neck proprioception is disturbed by neck muscle vibration during dynamic tasks, the body deviates and rotates toward the side opposite the vibration due to body scheme distortion.Additional somatosensory input from the external environment via haptic cues may address these abnormalities. The anchor system (AS) provides spatial orientation feedback relative to the ground during dynamic tasks, enhancing body scheme formation and performance. However, it is unclear if AS benefits extend to disrupted neck proprioception. Therefore, this study aimed to investigate the effect of AS on locomotor trajectory deviation induced by neck proprioception perturbation through muscle vibration during tasks like stepping in place (STIP) and gait. MethodsThirteen healthy young adults (9 males, 4 females; age 22.9 ± 1.0 years) participated. They performed STIP for 35 seconds and walked 7 meters with eyes closed in the Gait task. Each task was conducted under four conditions: normal (N), vibration (V), anchor (AN), and anchor + vibration (ANV).In V and ANV conditions, 80 Hz vibration was continuously applied to the left sternocleidomastoid (SCM) using a vibration speaker fixed with surgical tape. The AS consisted of cables with 125 g lead weights that remained taut and in contact with the ground during tasks.Reflective markers on the bilateral acromion, posterior superior iliac spine (PSIS), and heel were tracked using a Vicon MX system (Vicon Motion Systems, UK). The trunk position was the midpoint of the PSIS markers, and trunk rotation was the angle between the frontal plane and the shoulder axis, with positive values indicating rightward rotation.The average for each condition was analyzed. Normality was assessed using the Shapiro-Wilk test. Repeated measures ANOVA compared conditions, with Sequential Bonferroni corrections for post hoc tests, and significance set at $p < 0.05$. ResultsIn the STIP task, anteroposterior (AP) deviation was significantly larger in N and V than in AN and ANV conditions. Mediolateral (ML) deviation was significantly larger in V compared to the other three conditions. Body rotation was also significantly greater in V compared to the other conditions.In the gait task, deviation and body rotation were significantly larger in V compared to the other three conditions. ConclusionThis study examined the effect of AS on dynamic tasks disrupted by neck muscle vibration. Vibration caused the body to rotate and deviate toward the opposite side, but AS suppressed this effect. These findings suggest that adding somatosensory input via AS effectively mitigates disruptions caused by neck muscle vibration during dynamic tasks.

P01-R-129 - Anticipatory cortical modulation under varying balance demands

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Background & Aim: Initiating gait from quiet stance requires foot-sole cutaneous receptors to provide essential feedforward information to the cortex, with the cortex modulating this input to inform anticipatory postural adjustments (APAs) to prepare to step. Yet, how cortical preparation scales with variation in balance demands is unknown. The amplitude of the Contingent Negative Variation (CNV), recorded with electroencephalography (EEG), is a negative potential between warning and go cues which indexes motor preparation, whereas Somatosensory Evoked Potentials (SEPs) quantifies somatosensory processing. Thus, the aim of this project was to probe preparatory sensorimotor mechanisms in tasks with escalating postural challenge. We hypothesized that cortical planning of tasks with greater postural complexity would evoke larger CNVs and SEPs.Methods: Participants performed three conditions: two step-initiation variants, straight and diagonal stepping, plus a quiet-standing control condition. In the stepping conditions, an auditory direction cue identified the step-initiation variant, followed 2s by a go cue to trigger movement. All steps were executed with the right foot.EEG was collected through the experiment. For SEPs, a separate set of trials delivered continuous 2Hz electrical pulses at 120% of perceptual threshold to the stance (left) foot sole during the three tasks.The 2s between the direction and go cues isolated the CNV which was averaged across trials to quantify CNV amplitude. The CNV data was then source localized using eLORETA. For SEPs, the four stimuli that fell within the 2s motor preparation window of each stepping condition and the quite standing block were segmented and averaged. Analyzing CNVs and SEPs separately enabled

independent evaluation of motor preparation and the effect of gains in cutaneous somatosensory information.Results:Data were recorded from 31 participants (17 males and 14 females) with the mean age of 23.71 (SD = 4.95) years. The CNV was significantly more negative at the fronto-central and parietal electrodes during diagonal versus straight stepping preparation ($p < .05$). Source localization attributed this enhancement primarily to parietal and premotor/frontal cortices. SEP analysis showed larger peak-to-peak amplitude during motor preparation of stepping tasks compared with quiet standing ($p < .05$), and a larger amplitude in diagonal than straight stepping preparation ($p < .05$).Conclusion: The more negative CNV over frontal and parietal sites during diagonal stepping vs straight stepping highlights modulation of top-down motor control based on task complexity. CNV and SEP analysis together show amplified somatosensory processing with intensified motor preparation, revealing a unified sensorimotor strategy that up-regulates both cortical anticipation and cutaneous feedback as postural demands rise. These findings identify complementary neural targets with potential for balance-oriented rehabilitation approaches and brain computer interfaces.Acknowledgement and Funding: This research was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC). The author thanks Dr. Sue Peters and Sean Lai for their help throughout the project.

P01-R-130 - Effect of movement speed on athlete decision making

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Background: Navigating a dynamically changing environment requires one to accurately perceive possibilities for action based on the affordances of the environment and their own action capabilities. Training improves athletes' perceptions of their action capabilities and their knowledge of where their action boundaries lie. Athletes perform differently based on the type of task, which may be due to the context-specific nature of their trained knowledge of their action capabilities. The current study aimed to determine whether athletes perform closer to their action boundaries in a context in which they are trained by comparing performance on a closing-gap aperture-crossing task while walking and running. We expected athletes' crossing decisions to be different based on their type of locomotion. Methods: 13 strategic field sport athletes (female=3; 20.43±1.65yrs) were immersed in a virtual environment (VE) using an HTC Vive Pro2 head mounted display (HMD). Participants approached a set of doors from a distance of 6.5m. The initial aperture of the doors was 4m and when the participants were 3m from the doors, they began to close at a rate ranging from 0.6-1.2m/s*participant's preferred walking speed. There were 2 locomotion types organized into 2 blocks: 1) walking; and 2) running. Participants were instructed to approach and pass through the closing aperture if they deemed it passable without acceleration or shoulder rotation, otherwise they were instructed to stop. The HMD recorded the participants' head position in space at 90Hz, the position at slowdown (i.e., <2SD of approach speed) was calculated to determine

each participant's critical point (i.e., switch point from passible to impassible) and their distance from the doors when the passability decision was made. Results: A significant main effect of door closing speed [$p<.001$, $\eta p2=.824$] and type of locomotion for position at slowdown [$p<.001$, $\eta p2=.851$] was observed. The critical point for door closing speeds deemed passable versus impassable when walking was 0.92m/s*walking speed and when running was 0.99m/s*walking speed. There was a significant interaction between locomotion type and door closing speed for position at slowdown [$p=.002$, $\eta p2=.251$] where participants slowed down significantly closer to the doors when running than when walking for door closing speeds deemed impassable (Figure 1).Conclusions: Findings indicate that athletes may have a better understanding of their action capabilities allowing them to act closer to their action boundaries (pass through smaller apertures and slow down closer to doors) within a sport-specific context (running).Acknowledgements and Funding: Natural Sciences and Engineering Research Council (NSERC).

P01-R-131 - Examining the effects of movement perception during balance tasks

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BACKGROUND AND AIM: Neural and behavioural components are crucial in perceiving one's movement to maintain balance [1-2]. Cortical responses have been shown to be critical in the control of upright stance, mediated by the perception of one's self-motion [3-5]. Previous work has shown individuals are able to accurately perceive their movement specifically during dynamic balance tasks [6]; however, the perception of movement during upright stance and its influence on balance behaviour remains unclear. Therefore, this study aims to examine the effects of movement perception on objective and subjective postural responses during static and dynamic balance tasks. METHODS: Young adults stood upright for 70s during 2 visual conditions (eyes open; EO, and eyes closed; EC), 2 balance tasks (static and dynamic), and 2 perception tasks (tracking and non-tracking) for a total of 8 conditions. For the dynamic balance task, participants stood on a support surface that pseudorandomly tilted in the mediolateral (ML) direction (± 2°, below 0.5 Hz). For the tracking task, participants tracked their ML trunk position using a handheld device. Cortical activity (64 channel electroencephalography; EEG), muscle activity (electromyography; EMG), and kinematics (3D motion capture) were analyzed. Following each trial, perceived stability, perceived total movement, balance confidence, movement self-consciousness and conscious motor processing were measured. RESULTS: Preliminary results (6 participants) indicate the average coherence between trunk and tracked displacement across trials was 0.72, demonstrating that the tracking task was performed sufficiently. No differences in objective postural and perceived responses were observed when comparing tracking to non-tracking conditions. However, there were differences in subjective measures, specifically balance confidence which decreased during tracking

conditions. In addition, there were no effects of vision on postural or perceived measures. However, dynamic stance increased postural (EEG, EMG, kinematic) and perceived responses (tracking, subjective perceived total movement), while decreasing balance confidence and perceived stability compared to static stance. CONCLUSIONS: Perceiving movement during balance tasks had no effect on objective postural responses yet affected some subjective responses. Therefore, measures of perceived movement can be included in fall risk assessments without altering balance behaviour. These findings have implications for examining individuals with increased fall risk; however, further work is needed to advance our understanding of perceived movement during upright stance. ACKNOWLEDGEMENTS AND FUNDING: Funded by VISTA, NSERC, CFI.
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P01-R-132 - Exploring the cortical involvement in sensorimotor integration during early stages of independent walking

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Background and AimThe control of human locomotion is governed by a combination of congenital and emerging muscle synergies. Congenital synergies, likely mediated by spinal circuits, are present at birth. In contrast, emerging synergies involve cortical contributions and develop with independent walking. This study explores the role of sensorimotor integration and cortical contributions in shaping locomotor synergies during early walking. By manipulating sensory input through varying levels of body weight support (BWS), we examined its effects on cortico-synergy coherence in toddlers at two stages of gait development: the onset of independent walking (within days of their first steps) and six months after gaining walking independent experience.MethodsWe recruited 23 typically developing toddlers and recorded brain and muscle activity while they walked on an instrumented treadmill. Whole-head EEG (32-channel) and 24 bipolar EMGs electrodes were used to record activity in the trunk and lower extremities. Two sensory loading conditions were analyzed: low and high levels of BWS. Muscle synergies were extracted using non-negative matrix factorization, and cortico-synergy coherence was evaluated across BWS-levels and development stages using mixed-design ANOVAs.ResultsOf the 23 toddlers recruited (34 sessions recorded), only sessions with at least 15 strides in both BWS conditions were included, resulting in 14 sessions from 12 toddlers. Four muscle synergies were consistently identified across all conditions, reconstructing the original EMG signals with 92-94% accuracy. The two emerging synergies showed significant coherence with sensorimotor cortical activity during the double support phase. High BWS significantly reduced cortico-synergy coherence in

toddlers at walking onset but had minimal impact after six months of walking experience. ConclusionsOur findings indicate that gravitational loading affects cortical contributions to locomotor control during early stages of walking development. These results underscore the role of sensory information in shaping emerging muscle synergies and highlight its importance in the maturation of independent walking. Acknowledgements and FundingWe extend our gratitude to all participating children and their parents for their dedicated time and effort, and to Dr. Annike Bekius for her assistance during the experimental phase. This project has received funding from the Dutch Organization for Scientific Research (NWO) VIDI-grant "FirSTeps" (#016.156.346) and the European Research Council (ERC) under the European Union's Horizon 2020 Research and Innovation program "Learn2Walk"-grant (#715945), both awarded to Nadia Dominici.

P01-S-133 - Gait adaptability in chronic low back pain: Reduced complexity during aperture passing

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Background and Aim. Chronic non-specific low back pain (cNSLBP) is a leading cause of disability worldwide, with limited pathological explanations. It impacts locomotion (kinematics and dynamics) and influences adaptive behavior; individuals with cNSLBP tend to adopt riskier strategies when passing through openings, which may be a means of minimising shoulder rotations [1]. Movement variability complexity, assessed via Sample Entropy (SEn) as an index of time-series irregularity, offers insights into adaptive capacities, relevant to conditions like cNSLBP with reduced complexity [2]. The aim of this study was to compare gait adjustments and behavioral complexity between individuals with cNSLBP and healthy participants when approaching horizontal openings. Methods. Fifteen asymptomatic adults (AA) and fourteen individuals with cNSLBP completed a walking protocol along a 14-meter path. The protocol consisted of 3 randomized blocks of 19 trials, with apertures ranging from 0.9 to 1.8 times the participants' shoulder width, designed to induce trials that either required or did not require shoulder adaptive rotations. Movements were recorded using the Qualisys motion capture system. The changes in behavioral complexity related to the change of aperture width were quantified using SEn, where lower entropy indicates greater regularity and reduced complexity [3]. The analysis period covered the 2 seconds preceding the crossing of the opening [3]. Results. The results indicated that in the AA group, SEn increased as the aperture ratio increased. Similarly, the cNSLBP group also showed an increase in SEn with wider apertures, but the rate of increase was significantly lower compared to the AA group. This suggests that individuals with cNSLBP may struggle to increase movement complexity or degrees of freedom [4], resulting in less adaptable, more constrained movements even when facing wider apertures. Conclusions. The

findings support that cNSLBP affects adaptive locomotor behavior, as movement complexity increases with the widening of the aperture, although this increase is less pronounced in cNSLBP participants. These results align with existing literature, which has demonstrated that individuals with low back pain tend to exhibit lower movement variability and complexity compared to those without pain. This suggests that their movements are more stereotyped and less varied [5]. This reduced complexity may partially explain why their navigation strategies tend to be riskier. Future research is to explore different phases of the adaptive aperture crossing task, including the stable walking period [3] and the approach phase [1]. Acknowledgements and funding. Rennes 2 University, Rennes, France. [1] Bilhaut et al., 2023, Gait and Posture. [2] Gizzi et al., 2019, European Journal of Pain. [3] Muroi et al., 2023, Journal of Motor Behavior. [4] Kodama et al., 2022, Journal of Motor Behavior.[5] Laird et al., 2014, BMC Musculoskeletal Disorders.

P01-S-134 - Hybrid machine learning with particle swarm optimization for step length estimation in healthy adults

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Background and AimStep length is a critical gait characteristic to better understanding functional mobility as well as fall risk. Instrumented approaches to quantify step length typically rely on inertial measurement units (IMUs) positioned on the lower back near the body's centre of mass (CoM). Step length is derived from IMU data by applying the inverted pendulum model taken from biomechanical principles to track the CoM. Although reasonable approximations for step length can be quantified large errors exist as the inverted pendulum approach is erroneous with changes in walking speed or deviations from a linear path. This study aimed to develop and optimize a hybrid machine learning model to predict step length more accurately across different walking conditions.MethodsThirty/30 young healthy subjects (YHS) (15M:14F:1NB, 29.4 ± 5.6 years, 77.2 ± 15.5 kg, 171.0 ± 9.3 cm) and 30 older healthy subjects (OHS) (9M:21F, 61.3 ± 8.8 years, 72.5 ± 14.3 kg, 165.4 ± 10.2 cm). Each participant walked at normal and fast speeds. IMU data were collected (100Hz, ±8g) using a smartphone located on the lower back, and reference data were obtained from foot-mounted Opal APDM. Initial and final contact events were estimated using continuous wavelet transform-based algorithm on filtered accelerometer data. Fifty/50 features were extracted from each step, including time-domain metrics and frequency-domain features derived from Fast Fourier Transform (FFT). A multilayer perceptron (MLP) was trained to extract deep features, combined with particle swarm optimisation (PSO) selected features trained on Optuna optimized XGBoost model. The train-test split ensured group-aware separation, with 42 participants for training and 18 for testing. The inverted pendulum model was also implemented as a comparative lower back method for step length estimation. Analysis combined data from normal and fast trials across YHS and OHS to evaluate overall model

performance in diverse walking conditions, rather than subgroup-specific variations.ResultsThe hybrid model was initially trained on all 50 features (i.e., without PSO-selected and MLP-based feature extraction) and achieved a root mean square error (RMSE) of 6.76cm when compared to step length data from the reference wearable worn on the feet. In comparison the inverted pendulum model had an RMSE of 6.50cm. Accordingly, the hybrid model was then trained using PSO-selected (n=19) and MLP-extracted features achieving an RMSE of 3.96 cm.DiscussionThe proposed hybrid (PSO+MLP) model outperformed the traditional inverted pendulum model in predicting step length across normal and fast walking. The optimized model demonstrated superior accuracy, highlighting the need to move beyond biomechanical models toward feature-optimized, machine learning-based approaches for more accurate step length estimation. Limitations include testing in a controlled environment with healthy participants, which restricts its generalizability. Additionally, the reference wearables measure stride lengths, requiring step lengths to be estimated as half of each stride, a simplification that may impact model accuracy.ConclusionsThe proposed model more accurately estimates step length across normal and fast walking conditions than the inverted pendulum approach. Future work is ongoing to extend the application to people with Parkinson's disease.Acknowledgements and FundingThe authors would like to thank all who volunteered for the study. This research is co-funded by a grant from National Institute of Health Research (NIHR) Applied Research Collaboration (ARC) North East and North Cumbria (NENC). This research is also co-funded by the Faculty of Environment and Engineering at Northumbria University.

P01-S-135 - Standardizing the usage of head movements in gait stability assessment through augmented reality

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Background and aimEveryday activities, such as crossing the street and grocery shopping, often necessitate head movements. They challenge the human balance system by creating a dual-task condition during locomotion. Although common, the precise impact of head movements on gait stability remains unclear due to the lack of standardized experimental setups. This study aims to evaluate if head movements induced by augmented reality (AR) is a valid method in gait stability assessment in healthy individuals. It investigates the hardware impact, the task performance accuracy, and whether an AR-HMD setup elicits more reproducible and standardized head movements compared to the traditional auditory cueing method, mapped by variance in head kinematics.MethodsIn a cross-sectional study involving 25 healthy adults (10 male/15 female; age 23.28±2.65 years; body mass index 23.20±2.65), participants underwent a 3D-motion capture gait stability protocol. They walked a 10-meter overground walkway under three different conditions: 1) head turn with auditory cue only,

2) head turn with auditory cue while wearing the AR-HMD (AR cue not activated), 3) head turn with AR cue by the AR-HMD (Hololens 2, Microsoft Inc.). Head kinematics (angles and angular velocity) during horizontal and vertical cued head movements were captured (Vicon Motion Systems Ltd.). Eye tracking data was collected by the AR-HMD. Statistical analyses were conducted using linear mixed models in RStudio to assess hardware impact and statistical parametric mapping ANOVA in MATLAB (MathWorks Inc.) to analyse variability in head kinematics between conditions. Task performance accuracy was calculated as a ratio of head and eye directional coordinates respectively to the hologram.ResultsAll participants completed at least 42 walking trials. A significant difference was found in angular head velocity ($p<0.001$), but not in head angles ($p=0.700$) between conditions 1 and 2, suggesting an effect of hardware solely on angular head velocity. Task performance accuracy was high with values of 99.5±0.8% (eyes) and 98.8±1.6% (head). Standard deviations (SD) for head angles were lower in AR (condition 3) compared to the no-AR conditions (1 and 2), although not significant ($p>0.05$). For angular head velocity, SDs were significantly lower in AR (condition 3) compared to condition 1 ($p=0.017$) and 2 ($p=0.041$). Head kinematic patterns in the three conditions can be consulted in the attached statistical parametric mapping figures.ConclusionsIn conclusion, an AR-HMD setup elicits more reproducible head movements shown by lower variance in head kinematics with excellent task performance accuracy. This offers a proof of concept for the usage of AR elicited head movements as a method in gait stability assessment in healthy individuals.

P01-S-136 - Implementing self-selected gait speed in virtual reality for research – fully immersive head mounted device versus semi-immersive large screen-based device

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Background: The use of large-scale virtual reality (VR) systems in combination with self-paced treadmill (SP-TM) enables gait research that simulates everyday conditions. However, such large-scale systems are relatively expensive and thus, rare. The objective of the present study was to validate a newly developed method that enables walking on SP-TM while using Head Mount Display (HMD). Methods: Seventeen young healthy participants (mean age [±SD] 31.6 ± 6.54 years; 9 females) walked for 303 seconds on a SP-TM under three different conditions, randomly presented: (1) Without any visual flow; (2) with a visual flow synchronized with their walking speed presented on large screen (51''); (3) wearing HMD synchronized with their walking speed. (HTC-VIVE, Taiwan). Likert questionnaires were introduced to assess the level of subjective reassurance and comfort while walking in the different trials (seven questions, score = 35- Maximal reassurance, Score=5- minimal reassurance). Gait speed profiles (V) were fitted to the function of where X is the distance passed and a is the estimation of the asymptotic steady state velocity value. From the point where the participant reached 95% of the estimated walking speed, we also calculated the mean value of gait speed (GS) and the coefficient of variation (GS-CV= 100*SD/GS). Results: Sixteen participants completed all three experimental trials, and their subjective evaluation of the HMD-SP TM walking was comparable to the large screen-based VR system SP TM walking (24.7±5.7 vs. 27.9 ± 3.8, p=0.078). Figure 1 depicts GS data from one participant. GS was significantly lower in the HMD-SP TM condition as compared to the large screen condition (1.02 ± 0.14 m/s vs., 1.23 ± 0.22 m/s, respectively, p=0.022) and significantly lower than the no visual flow condition (1.25±0.23 m/s, p=0.019). GS did not differ significantly between the no visual flow and the large screen walking conditions (p=0.49). GS-CV was significantly higher in the HMD-SP TM condition as compared to the large screen condition (14.4 ± 12.3 % vs. 4.5 ± 1.9%, respectively, p=0.010) and significantly higher than the no visual flow condition (5,2 ±1.5 %, p=0.037). GS-CV did not differ significantly between the no visual flow and the large screen walking conditions (p=0.20).Conclusions: This study suggests that walking in self-pace mode while wearing HMD is feasible in terms of the user comfort and acceptance. Gait performances as reflected by GS and GS-CV fall short from meeting the values of walking in the large screen and the 'no visual flow' conditions. Future studies should address whether this problem can be overcome by training before the introduction of rehabilitation treatments on such platform

P01-S-137 - IMU-based pelvic rotation detection: Insights from machine learning and rom analysis

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Background and AimThe integration of wearables and machine learning (ML) has advanced human activity recognition (HAR), allowing robust detection of the common activities of daily life such as sitting, standing, and walking. While excelling in HAR is essential for daily health monitoring, current solutions often overlook subtle but clinically significant movements like pelvic rotation (PR), which plays an important role in posture control and is essential for low back pain (LBP) prevention. This study explores using wearable IMUs and ML to classify and analyze PR in different directions and ranges of motion (RoM). MethodsMotion data were collected from 39 sedentary participants (21 females, 18 males), including 5h23m31s of valid recordings sampled at 60Hz using Xsens, an IMU-based Motion Capture System. Participants performed sitting, standing, walking, 5-time sit-to-stand-to-sit (5TSTS), and anterior and posterior PR during sitting and standing. Data were proceeded into 159510 windows (0.5s length, 0.1s stride). Six classical ML classifiers were applied to classify PR across tasks. To complement the ML analysis, PR RoM was extracted from the “Ergonomic Joint Angles ZXY-Vertical_Pelvis Flexion/Extension” feature. For each repetition, the difference between anterior and posterior PR was computed by peak detection, with maximum values extracted as the RoM per posture and subject. ResultsXGBoost, the best-performing classifier, achieved a class-specific F1 score of 0.965 for PR in binary classification (PR vs. the other

activities), demonstrating the effectiveness of the approach. When extended to 3 classes (anterior PR, posterior PR, and other activities), the class-specific F1 scores of 0.823 for anterior PR and 0.793 for posterior PR. This reduction highlights the added complexity of differentiating between PR directions. We also observed a significant directional difference. During sitting, the maximum absolute angle of anterior PR from the neutral (vertical) position was 18.0° ± 8.3° vs. 13.5° ± 4.5° for posterior PR ($p = 0.004$); during standing, the anterior was 17.5° ± 5.8° compared to the posterior at 10.3° ± 3.8° ($p < 0.001$). The larger anterior angles resulted in a greater number of windows classified as being in anterior postures, regardless of the actual direction of PR, making identifying anterior PR relatively easier than posterior PR. Additionally, RoM (max anterior to max posterior) between sitting (30.0° ± 9.7°) and standing (24.1° ± 6.8°) revealed considerable variability across participants.ConclusionsThis study demonstrates the feasibility of IMU-based ML models to recognize PR. The observed directional differences from the vertical orientation provide insights into the biomechanical and anatomical factors influencing PR. These findings pave the way for future work aiming to integrate precise PR detection into prolonged posture monitoring, with promising applications in LBP prevention and personalized daily healthcare solutions.

P01-S-138 - External validation of a deep learning model for freezing of gait detection in Parkinson’s disease

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BACKGROUND AND AIM:Visual inspection of video footage is currently the gold standard for assessing the severity of freezing of gait (FOG) in Parkinson’s disease (PD). However, this method requires significant expertise, time, and effort. While studies have proposed automatic FOG severity assessment methods using deep learning algorithms (DLAs) and wearable sensors such as inertial measurement units (IMUs), these methods have not yet been validated against external, multi-center datasets. This study is the first to externally validate a DLA for automatic FOG severity assessment. METHODS:This study utilized a private dataset from KU Leuven and a public dataset from Stanford University, both featuring IMU data from five sensors placed at the pelvis, both lower legs, and both feet. The KU Leuven dataset comprised four subdatasets (a to d), capturing different tasks, medication states, and IMU sensor configurations: (a) Timed-Up-and-Go and 360-degree turning-in-place tasks (360Turn) recorded with Shimmer 3 sensors (64 Hz) during both ON- and OFF-medication states; (b) and (c) walking tasks with and without 180- and 360-degree turns, recorded using a 3D Vicon motion-capture system (100 Hz) in the OFF-medication state and used to simulate IMU data (32 Hz); and (d) 360Turn tasks recorded with APDM IMUs (128 Hz) during the ON-medication state. The Stanford dataset, collected using APDM IMUs (128 Hz), involved a walking trial comprising two elliptical paths and two figure-of-eight paths around tall barriers during the OFF-medication state.

All IMU signals across both datasets were resampled to 32 Hz for consistency. A state-of-the-art DLA, LTContext, was trained on the KU Leuven dataset and externally validated on the Stanford dataset. Agreement between the DLA's predictions and expert annotations for the percentage of time frozen (%TF) and the number of FOG episodes (#FOG) was assessed using the intraclass correlation coefficient (ICC(2,1)). RESULTS:The KU Leuven dataset consisted of 2388 gait trials with 1951 FOG episodes from 85 patients, while the Stanford dataset comprised 60 gait trials with 211 FOG episodes from 7 patients. The model demonstrated strong agreement with expert annotations for %TF (ICC=0.90, CI= [0.54, 0.98]) and moderately strong agreement for #FOG (ICC=0.65, CI=[-0.17, 0.93]). Figure 1 illustrates examples comparing the model's predictions against expert annotations.CONCLUSIONS:This study demonstrated that a DLA can assess FOG severity across datasets. Further validation is ongoing to evaluate the model on more external datasets with more diverse tasks and cohorts.ACKNOWLEDGEMENTS AND FUNDING:This study was funded, in part, by the KU Leuven Industrial Research Fund (C3/20/109). BF was supported by the Data Sciences Institute at the University of Toronto (under grant DSI-PDFY3R1P13). PY was supported by the KU Leuven – Taiwan scholarship. MG was supported by the Research Foundation Flanders (1SHEK24N).

P01-S-139 - A physics-informed federated learning model to decompose bilateral ground reaction forces and centre of pressure from a single forceplate for gait analysis

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Background and AimMeasuring bilateral ground reaction forces (GRF) and centre of pressure (COP) is essential in gait analysis. This requires stepping sequentially on separate forceplates, which is difficult for those with musculoskeletal disorders and may cause unnatural gait. Recent advances in physics-informed deep learning approaches have shown great potential in decomposing resultant signals from a single forceplate to estimate GRF and COP for each foot during double-limb support. However, AI training typically depends on large, centralised datasets, facing data scarcity and privacy issues. Federated learning (FL) offers decentralised training across datasets from separate institutions while maintaining privacy. This study proposes a physics-informed FL model to decompose bilateral GRF and COP from a single forceplate for gait analysis. MethodsRetrospective gait analysis data from 3,600 trials of three groups (60 healthy young adults, 60 healthy older adults, and 60 children with cerebral palsy), each representing a separate institution (agent), were used. Data were collected for each subject walking along a 10-meter walkway with four forceplates, without intentional foot placement on the plates. A physics-informed residual recurrent neural network (PI-ResRNN) was used for decomposing bilateral GRF and COP from single-forceplate data. Using FL, each agent trained its PI-ResRNN model locally using data from 45 subjects, sending periodically model parameter updates to the central server for aggregation into a unified global model. The Federated Proximal (FedProx) algorithm optimised the global objective function, which combines the average of local objective values from the agents (FedAvg) and a proximal term for each local objective. The global model updates each agent's local model at each iteration, enabling large-scale training while maintaining data privacy. A centralised training approach with pooled data was also conducted for comparisons. Model accuracy was evaluated using data from 15 subjects of each group not involved in model training, giving root-mean-squared error (RMSE, mm) for COP and relative RMSE (rRMSE, %) for GRF. Effects of subject groups and training methods on prediction accuracy were tested using two-way ANOVA ($\alpha = 0.05$). ResultsThe FedProx-trained global model demonstrated accuracy comparable to the centralised model ($p > 0.05$), with mean rRMSEs of 0.3%, 0.4%, and 0.6% for anteroposterior, mediolateral, and vertical GRF, respectively, and a mean RMSE of 3.1 mm for COP. No significant differences in prediction errors were observed between groups ($p > 0.05$). ConclusionsThe FL-based PI-ResRNN model showed accuracies comparable to the centralised model in decomposing bilateral ground reaction forces and centre of pressure. The proposed approach is promising for collaboratively developing large-scale AI models across gait laboratories. Acknowledgements and FundingThe Taiwan National Science and Technology Council.

P01-T-140 - Combined influence of auditory and vestibular cues in navigation tasks: Preliminary results

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Background and AimRecent evidence suggests that auditory cues can enhance postural control in quasistatic tasks. However, little is known about audio-vestibular interactions during more complex tasks such as navigation. Such tasks are often more complex than static postural control due to head movements that can change auditory and vestibular information. However, to date, little is known about the use of auditory cues during navigation tasks when vestibular cues are perturbed. Deepening our understanding of this interaction could potentially benefit the development of rehabilitation methods for individuals with vestibular impairments. Therefore, this study aims to examine the influence of spatial auditory cues on a navigation task while vestibular cues are either unperturbed or perturbed by galvanic vestibular stimulation (GVS). MethodsA preliminary sample of 8 healthy participants has completed the Triangle Completion Task (TCT). Blindfolded participants were guided along the two right sides of a standardized triangle path, schematized on the ground, and asked to return to the starting point along the hypotenuse. A loudspeaker behind the starting point played the International Speech Test Signal at 55dB SPL. The task was performed under the combination of three GVS conditions (No GVS, GVS Anode left, GVS Anode Right) and two auditory conditions (with and without auditory cues). A Vicon system monitored pelvic position and orientation. ResultsPreliminary analysis focused on angular error, which consists of the absolute value of the angle measured for the participants' trajectory compared to the ideal trajectory towards the starting point. Although no significant results were found, there was a tendency for a reduced angular error when auditory stimuli were presented, particularly in both anode right and no GVS conditions. No similar trend was observed in the anode left condition.ConclusionIn conclusion, preliminary results revealed that auditory spatial cues could have a positive influence during the navigation task when the vestibular system is not perturbed, but more interestingly, when this system is perturbed. Moreover, the positive influence of auditory cues during the TCT seems to be more accentuated during an induced right vestibular asymmetry compared to an induced left vestibular asymmetry. However, additional testing is needed to draw definitive conclusions.Acknowledgments and Funding NSERC-RGPIN-2022-04402

P01-T-141 - Frequency-dependent processing of sensory signals to detect abnormal whole-body oscillations

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Background: Humans are mechanically unstable when standing upright, leading to whole-body oscillations likely to arise from sensory and motor noise. Maintaining balance relies on integrating sensory inputs from various systems, which detect whole-body amplitudes and directions. Depending on these body sway characteristics, the balance-correcting responses involve non-perceptual or perceptual detection mechanisms. It remains unclear what body sway characteristics the brain uses to estimate abnormal whole-body motions at the perceptual level. Aim: The current study identified the characteristics of body sway that trigger the perceptual detection of abnormal whole-body motions.Methods: Fifteen healthy participants aged 18–40 participated in this study. Participants stood upright on a force platform with their eyes closed. We delivered vestibular stimuli as sinewaves at frequencies of 0.1, 0.2, 0.5, and 1 Hz to evoke whole-body motion. The sinewaves' amplitude linearly increased for each frequency from 0 to 2 mA within 60 seconds (i.e., the same rate across EVS frequencies). Each frequency condition consisted of 15 trials, with each trial lasting 60 seconds. Participants maintained their heads forward and tilted their nose upward by ~18° to maximize vestibular-evoked balance responses along the frontal plane. We measured participants' head accelerations and ground reaction forces using an accelerometer on the head and the force platform. We instructed participants to press a button when they perceived abnormal whole-body motions, specifically when they felt their body sway was greater than standing upright with their eyes closed. In every five trials, participants assessed their typical whole-body motions with their eyes closed. We asked them to close their eyes and feel their body sways. Features were extracted from both force platform and accelerometer data to analyze the relationship between postural signals and conscious perception. These features included metrics from time and frequency domains and derived parameters capturing signal variability and complexity. Decision tree modeling and logistic regressions were employed to assess the body sways characteristics the brain uses to estimate abnormal whole-body sways.Results: The analysis revealed frequency-dependent patterns in the relationship between body sways and conscious perception. At the lower EVS frequencies (0.1–0.5 Hz), features from ground reaction forces were more associated with participants' conscious detection of whole-body oscillations. In contrast, at the highest EVS frequency (1 Hz), features from head accelerations allowed perceptual detection of abnormal body sways. Conclusion: The shift from ground reaction force to head acceleration features as a function of EVS frequency suggests a change in the sensory cues contributing to a conscious perception of abnormal whole-body motion. These findings align with results from auditory neuroscience, where specific signal features are associated with different perceptual roles, such as the "what" and "where" pathways in sound processing. Processing sensory information triggered by body sway may involve breaking down the signals into components that independently contribute to postural stability and conscious awareness of movement. The current results suggest that frequency-specific processing could be a key principle in how the brain converts sensory signals into meaningful perceptual and motor responses.

P01-T-142 - Real-world head kinematics in persons with persistent postural-perceptual dizziness (PPPD).

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Background. Persistent postural-perceptual dizziness syndrome (PPPD) is a chronic vestibular disorder, characterized by non-rotatory vertigo or dizziness lasting over three months and worsened by dynamic visual environments. Following an acute vestibular pathology, an increase in visual reliance and altered postural and gait strategies have been proposed as the most plausible pathological mechanism to develop PPPD. Observations from previous studies suggest that frequency characteristics of head kinematics could be more affected than temporal features by the maladaptive processes proposed in patients with chronic dizziness (not PPPD). Given that persons with PPPD most often complain of symptoms worsening in dynamic visual environments (e.g., supermarkets), the aim of this study was to characterize head kinematics in 2 ecological environments: a grocery store (trigger for symptoms in PPPD) and a quiet school hallway (lower visual stimuli). Methods. Fifteen adults (8 PPPD; 7 controls) were recruited and matched for age, sex, weight, and height. Participants walked for ~5 min while doing a visual search task in 2 ecological environments (grocery and quiet hallway). They wore 4

inertial measurement units (IMU: head, sternum, and one on each foot) that recorded 3D linear acceleration and angular velocity. We quantified frequency power spectra of the head and trunk using the recorded 3D linear accelerations and angular velocities. We further separated the data into the single and double leg stance phases of locomotion. Results. As they walked in both environments, participants with PPPD exhibited 16% to 57% smaller peak head linear acceleration and angular velocity compared to controls. In the frequency domain, these smaller peak head kinematics were reflected as 57% to 71% decreases in the power at frequencies below 5 Hz (i.e. low frequencies). This resulted in a larger proportion of high frequency (>5 Hz) for the head in space angular velocity, especially in the roll and pitch axes during the single-leg stance. Similar to the observed head in space kinematics, participants with PPPD showed 43% to 56% decreases in head on trunk roll angular velocity power below 5 Hz in both environments compared to controls. Conclusions. Participants with PPPD reduced their peak head in space and head on trunk kinematics (particularly for low frequency components) in both environments. These smaller head kinematics may minimize their symptoms align with static postural studies demonstrating a stiffening of posture in PPPD compared to controls. The well-known “supermarket” effect in PPPD could be characterized by a different gait strategy that reflect in head kinematic by reducing angular velocity and by increasing HF in roll. We hope the present results will eventually lead to the development of individualized intervention to improve quality of life and rehabilitation procedures.

P01-T-143 - Differences in axis specific recovery between vestibulo-ocular reflexes (VOR) and vestibulo-spinal reflexes (VSR) after an acute unilateral peripheral vestibular deficit (AUPVD)

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Background: Typically, aUPVD patients have balance deficits lasting several weeks. Changes in VOR and VSR deficits about each rotation axis need to be quantified to judge a patient’s improved balance capacities over time. Clinically, usually only yaw VOR and pitch VSR tests serve this purpose. The question thus arises, which, if any, yaw VOR tests are related to the unstable pitch and roll balance control in aUPVD patients. To answer this question, we examined changes in and correlations between axis specific video head impulse tests (vHIT), yaw body rotation tests (ROT), caloric tests of the horizontal VOR, and compared the results with stance and gait tests. That is, we examined if the effect of peripheral recovery and central compensation is similar for VORs and VSRs, specifically for vHIT and balance control responses in 3D.Methods: As described in ref 1-4, vHIT was performed with short ca. 200º/s head turns in each canal plane, rotating chair (ROT) with triangular yaw profiles of acceleration 20º/s2 and 5º/s2 and caloric tests with bithermal (44 and 30°C) water irrigation. To measure balance control during 14 stance and gait tasks, gyroscopes mounted at lumbar 1-3 recorded the angular velocity of the lower trunk in the roll, pitch and yaw directions. To measure recovery, patients were examined at onset of aUPVD, 3, 6 and 12 weeks later. Changes in mean VSR and VOR measures at the 4 time points were modelled with exponential decays.Results: VOR, stance and gait tests results were pathological at onset but improved to normal by 12 weeks. vHIT yaw results for the deficit side were better correlated with caloric tests (R=0.8 p<0.01) than those of ROT tests. vHIT yaw VOR response gain asymmetries (mean 32.3±10.4) were greater than roll asymmetries (mean 14.2±9.9, p<0.05) but correlated (p=0.04). Pitch gain asymmetries were less (mean 5.6±9.2). Several gait roll balance measures were significantly correlated with VOR roll asymmetries: for example, walking 8 tandem steps (R=0.51), walking while pitching the head up and down (R=0.59), walking eyes closed (R=0.45). Similar results emerged for yaw, but no correlations were found with VOR pitch asymmetries. Yaw and pitch Balance Control Indexes (BCIs) were significantly (p≤0.004) greater (88 and 30%, respectively) than roll BCIs.Conclusions: This is the first report to directly link deficits in balance control with deficits in the roll plane of VOR control. Gait not stance correlations were found possibly because head roll velocity during gait is similar to that imposed during vHIT responses. Futhermore, the sensory mechanisms underlying aUPVD pitch plane balance instability despite a minor effect on posterior canal responses [5], and therefore on pitch plane asymmetry, remains unresolvedRef 1. Otol & Neurootol, 2013, 980-989; 2. JVR 2015, 205-231; 3. Otol & Neurotol 2020, 41, 952-960; 4.Brain Sciences 2024,14,664; 5. Otol Neurotol; 2005, 26, 489-494

P01-T-144 - Objective characteristics of nystagmus of Roll Test and Dix-Hallpike Test in benign paroxysmal positional vertigo

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Objective To analyze the objective characteristics of Roll Test and Dix-Hallpike Test in patients with benign paroxysmal positional vertigo (BPPV) explore the underlying mechanisms of induced nystagmus, and evaluate the clinical utility of positional testing. Methods Induced nystagmus during the Roll Test and Dix-Hallpike Test was recorded using video-nystagmography (VNG). The direction, intensity, and temporal characteristics of nystagmus were compared between the different BPPV subtypes. Results Vertically upward nystagmus was induced by hanging in PSC-Can Dix-Hallpike Test,and the nystagmus reverse and turn weaker by sit.The intensity turning to lesion side by hanging and sit were (30.3±14.1)°/s and (12.6±7.5)°/s, the difference is statistically significant (t=20.153,P＜0.05).Howecer, no nystagmus was induced in PSC-Can Roll Test. Horizontal nystagmus in the same direction with turning were induced in HSC-Can Roll Test.The intensity turning to lesion side and normal side were (42.0±18.0)°/s、(20.3±8.7)°/s, the difference is statistically significant (t=12.731,P＜0.05). Furthermore, 57 patients' horizontal nystagmus were induced in HSC-Can Dix-Hallpike Test. Conclusion Dix-Hallpike Test not only can be used to diagnose PSC-Can, but also induce nystagmus in HSC-Can. Roll Test only has significance in diagnosing HSC-Can. It is suggest starting with Dix-Hallpike Test , and execute Roll Test if the horizontal nystagmus was induced , to avoid more uncomfortable stimulation to patients .The application of VNG is an objective guideline for BPPV diagnose.

P01-T-145 - The impact of locomotion speed on gaze stabilization and dynamic visual acuity

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Background and aimGaze stability during locomotion is primarily maintained by the vestibulo-ocular reflex (VOR). In patients with chronic vestibular loss, impaired gaze stabilisation results in oscillopsia and reduced visual acuity. However, the interplay between head-eye coordination and dynamic visual acuity during gait remains insufficiently understood, both in healthy subjects and in patients with vestibular hypofunction. This study aimed to systematically investigate the relationship between head-eye coordination and dynamic visual acuity during locomotion at different speeds in healthy subjects.MethodsEye and head movements were recorded in healthy subjects using video-oculography and a camera-based motion tracking system during locomotion on a treadmill at varying speeds (0.4, 0.8, 1.2, 1.6, 2.0, and 2.4 m/s). Simultaneously, dynamic visual acuity was measured on a screen placed 2 m in front of the subjects using an adaptive visual acuity test. The VOR was characterised by its gain and phase relationship for both angular and linear head-eye movements in the horizontal (yaw) and vertical (pitch) planes. Angular VOR was analysed directly, while the linear VOR was calculated based on lateral head displacement during walking. The relationships between eye, head, and VOR parameters and dynamic visual acuity (DVA) were examined using repeated measures correlation (Rmcorr).ResultsHead-eye coordination during locomotion was significantly linked to walking speed. In the horizontal plane, a compensatory angular VOR dominated across all speeds, while linear gaze stabilisation remained generally insufficient and highly variable. In the vertical plane, the angular VOR shifted from a compensatory mode at slower speeds to an anti-compensatory mode at higher speeds. This shift optimally compensates for prominent vertical head movements during fast walking and running ($p < 0.01$). Gaze stability in both planes and DVA decreased as walking speed increased. All aspects of head-eye coordination were significantly related to speed-dependent changes in DVA ($p < 0.01$), with the strongest correlation observed to vertical VOR.ConclusionsThis study provides the first systematic understanding of the interaction between gaze stabilisation and dynamic visual acuity during locomotion in healthy individuals. These findings will form the basis for future investigations into gaze stabilisation deficits in patients with chronic vestibular loss and assessing therapeutic interventions, such as vestibular neuromodulation, to enhance VOR function.Acknowledgements and FundingThis research was funded by the German Federal Ministry for Education and Science, grant number 13GW0490B.

P01-T-146 - Gait and mobility remain impaired after repositioning maneuver in older adults with Benign Paroxysmal Positioning Vertigo

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Background and aim: Benign Paroxysmal Positioning Vertigo (BPPV) is a common vestibular disorder in older adults, causing vertigo provoked by head movements(Von Brevern et al.2006). Treatment with repositioning maneuvers can resolve symptoms, but its effect on gait and mobility parameters has rarely been studies in older adults(Bhattacharyya et al.2017a). This study aimed to investigate the treatment-effect of repositioning maneuvers on spatiotemporal gait and mobility parameters in older adults with BPPV(oaBPPV), and compare them to matched controls. Methods: Twenty-five community-dwelling older adults (≥65 years old) diagnosed with BPPV (mean age 73.2(4.9)) were recruited at the hospital and compared to twenty-two matched controls (mean age 73.5(4.5)). OaBPPV were treated with repositioning maneuvers until nystagmus disappeared. Gait assessments were repeated pre-, 1 month, 3 months and 6 months post-treatment. Controls completed the same protocol, without the treatment for BPPV. Gait assessment included the instrumented Timed Up and Go (iTUG), Timed Up and Go with dual-task (iTUG dual-task) and 10-meter walk test with and without head turns (i10MWT and i10MWHT, respectively), using APDM-sensors(Horak et al.2009). Significance level was set at $\alpha=0.05$ and p-values were adjusted for multiple testing. Results: Pre-treatment, oaBPPV had a significantly slower gait speed and shorter stride length compared to controls during both i10MWT and i10MWHT ($p<0.001$ and $p<0.001$, and $p=0.002$ and $p<0.001$, respectively). During i10MWT, oaBPPV also had a significantly longer double support time ($p<0.001$) and a trend towards a slower cadence ($p=0.04$). No significant effects of repositioning maneuvers were found on i10MWT. During i10MWHT, gait speed ($p=0.004$), cadence ($p=0.01$), stride length ($p=0.001$), stride length SD ($p=0.009$), double support time ($p=0.004$) and gait cycle duration ($p=0.007$) significantly improved but remained different from controls. OaBPPV also needed significantly more time to complete the iTUG ($p=0.001$) and iTUG dual-task ($p=0.001$) and had a trend towards a slower turn duration during both tests ($p=0.01$ and $p=0.003$, respectively) compared to controls. Sit-to-stand time and stand-to-sit time did not differ between groups. Repositioning maneuvers significantly improved total duration of the iTUG ($p=0.02$) and the turn duration during iTUG ($p=0.02$) and iTUG dual-task ($p=0.01$). However, total duration remained longer compared to controls after repositioning maneuvers during both iTUGs, whilst turn durations were equal to those of controls after treatment. Conclusion: Spatiotemporal gait and mobility parameters are significantly impaired in oaBPPV. Treatment with repositioning maneuvers improves parameters that involve head turning. However, only turn duration of iTUGs normalized after treatment,

whilst other spatiotemporal parameters remained worse than controls. Additional rehabilitation might be necessary to recover persistent deficits in gait performance.

P01-T-147 - Assessments of subjective visual gravity and spontaneous Nystagmus in patients with Vestibular Neuritis

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Background and aimThis study aimed to assess the correlation between the spontaneous nystagmus (SN) and the subjective visual vertical/horizontal (SVV/SVH) among patients with vestibular neuritis (VN) at the different head positions.MethodsVN patients (19 superior VN and 1 entire VN) with spontaneous horizontal nystagmus visited the Department of Otolaryngology Head and Neck Surgery of Shanghai Sixth People's Hospital were recruited in the VN group, including 15 males and 5 females, from 2021 to 2023. We evaluated the SVV/SVH in both healthy subjects and patients with VN. These evaluations were performed in 5 different head positions: upright, 45° tilt to the left, 90° tilt to the left, 45° tilt to the right, and 90° tilt to the right. Additionally, the intensity of SN, as measured by slow-phase velocity, was recorded.ResultsIn patients with VN, a significant correlation was observed between SN and SVV/SVH in an upright position. The intensity of SN was higher when the head was tilted 90° toward the affected side compared to other positions. The SVV/SVH displayed an ipsiversive shift, when the head was tilted toward both the lesion and unaffected sides, exhibiting a contraversive direction. Furthermore, the changes in position-induced SN were consistent with the displacements of SVV and SVH caused by head tilt.ConclusionsThe presence of SN in patients with VN was observed to vary across different head position. These variations could potentially be attributed to the diverse activation patterns of the mechanical properties of otolith organs that are induced by head tilts. Acknowledgements and fundingThe authors would like to thank all the subjects for supporting the work. This study was supported by the National Natural Science Foundation of China (Grant Nos. 82330034, 82271163, 82020108008) .

P01-T-150 - The graded treatment strategy of vestibular rehabilitation for patients with intractable dizziness caused by peripheral vestibulopathy

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BACKGROUND and AIMVestibular balance rehabilitation therapy is effective for the treatment of balance problems. However, some patients with uncompensated unilateral vestibular hypofunction have a long-term history of a persistent severe problem in their posture and mobility intractable to any treatment. We examined whether graded vestibular balance rehabilitation decreases dizziness and balance problems and increases safety and independence in patients with chronic balance disorders after a

unilateral vestibular loss.METHODS87 subjects with persisted chronic dizziness and postural imbalance due to unilateral vestibular loss determined by significant unilateral caloric canal paresis received the stepwise vestibular rehabilitation therapy. The treatment program in this study comprised vestibular balance rehabilitation of vestibular adaptation training (Step 1) to promote the central vestibular adaptation process, sensory reweighing training (Step 2) to alter vestibular, visual, and somatosensory input, and vestibular substitution training (Step 3) to use the sensory substitution system with human (brain)–machine interface which substitutes diminished vestibular input by transmitting information from the patient's head to the tongue at our clinic. The clinical trials were performed to investigate the effectiveness of a stepwise multimodal approach in order from Step 1 to 3 for chronic balance disorder in subjects with unilateral vestibular loss caused by decompensation. Some interventions for rehabilitation were selected and customized for each patient in accordance with the level of their compensation for postural control and their sensory dependence. RESULTSImprovements in the balance performance were noted in 56 (64.4%) of the 87 subjects with intractable dizziness as examined in the Step 1 training. The remaining 31 subjects (35.6%) indicated failure in the Step 1 training. However, 14 of these 31 subjects (45.2%) showed improvements after the Step 2 training. All subjects with no improvement in the Step 1 and Step 2 training programs showed pronounced improvements after the Step 3 training. CONCLUSIONSOur results cumulatively suggest that the programmatic stepwise multimodal approach for vestibular rehabilitation provides beneficial effects for persistent balance disorder caused by vestibular decompensation.

P01-U-148 - How obstacle contrast and height affect foot placement variability in adults with normal and impaired vision

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Background and aimThe contrast and height of an obstacle can impact obstacle crossing in adults with normal and impaired vision. Understanding how these visual characteristics affect gait during obstacle approach is important to prevent tripping. This ongoing study aimed to determine if obstacle contrast impacts foot placement variability in the 3 steps before stepping over an obstacle in adults with normal and impaired vision (VI). This abstract compares preliminary findings for one adult with VI to a group of adults with normal vision. MethodsTwenty adults with normal vision, (11 older, mean 68+- 5 yrs; 9 younger, mean 21 +- 2 yrs), and 1 adult with VI (77 yrs) walked along a 6-meter, black carpeted walkway and stepped over a single obstacle positioned 4 m from the start. The obstacle varied in height (1 cm, 19 cm) and contrast (6% and 90% Michelson contrast). Ten trials for each of the 4 conditions were completed in a random order. Lower limb kinematics were recorded. Binocular visual acuity (VA), contrast sensitivity (CS), and visual field (VF) were measured. Foot placement variability was quantified by standard deviation of the toe position from the obstacle during stance phase for the 3 steps prior

CTRL F to search document for key words and author names etc.

to crossing the obstacle. Linear mixed-effect models assessed the impact of step position, age group, obstacle height, and obstacle contrast on foot placement variability. Independent t-tests were used to compare vision variables between age groups. ResultsVA was similar in both age groups with normal vision (p=0.17), though CS was better in the younger than older adults (p=0.001) as was VF (p=0.003). VA and CS for the adult with VI were outside the range of the normal vision group but VF was not. No main or interaction effects for foot placement variability were observed for age in the adults with normal vision, so the age groups were collapsed. In the normal vision group, foot placement variability increased with farther step position (p<0.001) and decreasing obstacle height (p=0.017). There was no effect of obstacle contrast (p=0.12). The adult with VI had a mean foot placement variability 6.8 times higher than the normal vision group mean for the short low contrast obstacle at step -1; at step -2 it was 3.8 times higher and at step -3 it was 3.0 times higher (see Figure 1). ConclusionsObstacle contrast did not impact foot placement variability before crossing an obstacle in adults with normal vision. However, an adult with VI had greater foot placement variability for the short low contrast obstacle at all step positions. The adult with VI likely could not see the small low contrast obstacle well enough to consistently place their foot as they approached the obstacle, though this appeared to be less of an issue for the tall low contrast obstacle. This suggests that both height and contrast affect the conspicuity of hazards for adults with VI. Data collection of adults with VI is ongoing to further explore this finding.

P01-U-149 - Effects of useful field of view on postural control during a quiet stance

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BACKGROUND AND AIM: Visual information is used to recognize spatial relationships and self-posture orientation in postural control. In particular, the range within the visual field where humans can instantly store and process information is called the useful field of view (UFOV), which is changed by cognitive load and motor behavior. Our previous study showed that reduction of the peripheral visual field causes postural instability. However, the association between the UFOV and postural stability is unclear. Therefore, this study aimed to investigate the impact of changes in the UFOV on postural control using a cognitive task.METHODS: Twenty healthy young adults participated in this study. Participants were instructed to maintain a quiet stance on a force plate under three levels of difficulty for cognitive tasks: Control, Easy, and Difficult. Cognitive tasks were presented at the center of the screen at eye level, and simultaneously, visual stimuli were presented at one of nine possible locations (0°, 20°, 30°, 40°, and 50° viewing angle on either side) at eye level for measuring the UFOV. The 95% confidence area of the center of pressure (COP) in the horizontal plane (Sway area), the mean velocity and the sample entropy (SampEn) of the COP in the anteroposterior (AP) and mediolateral (ML) directions were measured for postural control, and the reaction time to the visual stimulus was measured to assess the UFOV. In addition, the cognitive task cost (CC) by subtracting the

value under the Control condition from that under the Difficult condition for reaction time to visual stimuli at the largest viewing angle and postural stability measurements were calculated.RESULTS: A significant main effect of viewing angle, but not cognitive condition, was observed for the reaction time. Participants showed a significantly delayed response at the largest (50°) viewing angle. In addition, a significant difference in the mean velocity and SampEn in the ML direction, but not in the Sway area, was found among the cognitive conditions. A pos-hoc analysis demonstrated that both mean velocity and SampEn significantly decreased under the Difficult condition compared to the Control condition. Furthermore, the Spearman rank correlation test revealed a significant negative correlation between the DC of reaction time and that of SampEn in the ML direction.CONCLUTIONS: Our findings suggest that participants maintained their UFOV under the cognitive load, but the cognitive load decreased regularity in postural control, resulting in a reduction of postural adjustments. Moreover, those whose UFOV decreased due to cognitive loads showed increased regularity in postural control. These findings may indicate that a reduction of the UFOV causes automatic postural strategy while reducing redundant responses.ACKNOWLEDGEMENTS AND FUNDING:This study was supported by Grant-Aid for Early-Career Scientists (20K19371, 24K20491, NH) from the Japan Society for the Promotion of Science.

Poster session 2

P02-A-01 - A method for accurate step detection from IMU data recorded from smartphones worn in multiple body locations

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Background and aimSmartphone-based assessment of motor capacity by means of inertial sensor data recorded during the execution of structured motor tasks has gained popularity for the longitudinal monitoring of patients with neurological diseases [1,2]. In daily-life unsupervised conditions, phone handling becomes a critical factor to control for. In gait applications, for example, patients might find it preferable to place their phones in a pocket, even when instructed to use a provided belt [1,2]. This leads to a need for algorithms capable of correctly identifying and segment steps under a variety of conditions. The aim of this paper is to present an innovative approach to step detection based on a frequency-adaptive, iterative time-variant quantification (FAIR-Q), specifically designed to cope with multiple phone locations. MethodsSeventy-four healthy volunteers (42 females, age range: 21 - 77) performed multiple repetitions of a 30-second walk task, during which inertial sensor data were simultaneously collected by a reference system (Awinda, Xsens) and two smartphones, one worn in a waist-belt and the other one in a front pocket. All data were resampled at 50Hz and signals from the different devices were synchronized using an autocorrelation approach between the gravity vectors. The ground truth steps were detected according to the foot contacts provided by the reference system. The FAIR-Q method detected the steps from the vertical acceleration of the smartphones, by dynamically selecting the predominant motion-related frequencies, and by performing an iterative filtering process to optimize the signal-to-noise ratio. The algorithm performance was evaluated against the ground truth in terms of percentage of correctly detected steps per trial and relevant bias and limits of agreement, and in terms of mean absolute error (MAE) in the foot contact timing. Performance was compared to that from a state-of-the-art step detection method (Continuous Wavelet Transform, CWT [3]), previously proven to be highly accurate when applied to data collected from lower back sensors.ResultsOut of 400 test executions, 385 (96.25%) met prespecified technical verification criteria for signal quality. Table 1 shows the performance of the two algorithms for both belt and pocket data. The FAIR-Q algorithm appeared to be superior to CWT in step counting and more accurate in foot contact detection.ConclusionsThe CWT method, which was previously proven to be accurate for data collected with a sensor on the lower back, did not lead to equally good results when applied to signals collected from the front of the trunk or in a pocket. Conversely, the FAIR-Q algorithm appears to be highly accurate in both conditions. Ongoing work is exploring accuracy of FAIR-Q in other body locations and in pathological

gait.References[1] Scaramozza et al., doi: 10.3233/JND-240004; [2] Bracho-Arteaga et al. doi:10.2196/60673; [3] McCamley et al., doi:10.1016/j.gaitpost.2012.02.019

P02-A-02 - Recovery of real-world gait 1 and 2 years after total knee arthroplasty

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BACKGROUND AND AIMEnd-stage knee osteoarthritis (OA) has a major impact on daily life walking, primarily due to pain, making improved walking a key goal for individuals undergoing total knee arthroplasty (TKA). In fact, implant manufacturers claim that TKA enables an active lifestyle comparable to that of healthy peers. Although a previous study from our group [1] revealed that gait post-TKA improves towards the level of healthy peers, these assessments were limited to single, snapshot evaluations that may not reflect real-world gait. In this study, we quantified recovery of real-world gait two years after TKA, and compared gait metrics one year post-TKA with those of healthy peers. METHODSThirty-two individuals with end-stage knee OA undergoing TKA (20 women, 65 ± 9 years) and thirty-two sex- and age-matched healthy peers were included in this study. Real-world gait data was collected pre-TKA, 1 and 2 years post-TKA, and once for healthy peers. Gait data were collected during 5-7 subsequent days at each time point using inertial sensors placed on both feet and the lower back. From sensor data, stride velocity and stride time were calculated per stride [2]. Per individual and per time point, a frequency distribution of gait speed and stride time was constructed, from which the dominant peak or median was used for analysis. The mean number of strides per hour was used to quantify walking activity. Changes in gait metrics from pre- to 1 year post-TKA and 1 to 2 years post-TKA were assessed using linear mixed models. Gait metrics of the TKA group at 1 year were compared to healthy peers using independent samples t-tests.RESULTSImprovements from pre-operative to 1 year after TKA were observed in gait speed (+0.10 m/s, 95%CI: 0.04, 0.15) and stride time (-0.03 s, 95%CI: -0.06, -0.01). Also, walking activity increased from pre- to 1 year post-TKA (+73 strides per hour, 95%CI: 19, 128; Figure 1). None of the outcomes changed significantly from 1 to 2 years post-TKA. One year after TKA, gait speed of the patient group was lower than of the healthy peers (-0.09 m/s, 95%CI: -0.18, -0.01). Stride time and the number of strides per hour did not differ significantly from healthy controls at 1 year post-TKA.CONCLUSIONSOur study indicates that TKA had a positive, albeit modest, effect on real-world gait quality and quantity after 1 year, with no further improvement from 1 to 2 years post-surgery. Notably, gait speed at one year post-TKA remained below that of healthy peers, which may indicate that there is room for improvement for the TKA group. These findings provide valuable information for patients and clinicians, and can help to set realistic expectations regarding post-TKA recovery of walking.REFERENCES[1] Boekesteijn et al. 2022; PeerJ; DOI: 10.7717/peerj.14054[2] Shah et al. 2020; J Parkinsons Dis; DOI: 10.3233/JPD-201914

P02-A-03 - Wearable measures of sleep and sedentary behaviour in neurodegenerative conditions: A systematic review

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Background and aimSleep disturbances and reduced physical activity are common in neurodegenerative conditions such as Parkinson's disease (PD), Lewy body dementia (LBD) including Parkinson's disease dementia (PDD) and dementia with Lewy bodies (DLB), and idiopathic rapid eye movement (REM) sleep behaviour disorder (iRBD). Sleep and reduced activity are associated with poorer quality of life and patient outcomes, such as daytime somnolence, frailty, and mortality. Monitoring these symptoms is crucial for understanding disease progression and clinical management. Wearable devices offer a non-invasive way to track sleep, circadian rhythms (the 24-hour sleep-wake cycle) (CR), and sedentary behaviour (SB) in ecologically valid, real-world environments. This systematic review aimed to identify the protocols used and the digital outcome measures extracted to monitor sleep, CR, and SB, in people with PD, LBD, and iRBD.MethodsDatabases (Web of Science, Scopus, EMBASE, APA Psychinfo, PubMed, CINHAL, and IEEEXplore) were searched between 1993 and 2024 to identify studies investigating sleep, SB, and CR using wearable devices in people with PD, DLB, and iRBD. Two reviewers screened all articles independently to include peer-reviewed quantitative studies published in English and exclude conference abstracts, reviews and animal studies. Design and quality were evaluated; population features, wearable devices, placement of the devices, and reported metrics were extracted for review synthesis.ResultsOf 5424 records screened, 81 studies met the inclusion criteria. The majority of studies included PD participants (n=72, 85%) followed by iRBD (n=5, 6%), LBD (n=4, 5%), PDD (n=3, 4%), and DLB (n=1, 1%). Fifty-four publications studied sleep, 38 SB, and 9 CR. There was substantial heterogeneity in devices and protocols including 40 different wearable devices, 20 different durations of data collection, and 10 different device placement sites. The most common placement of wearable devices was the wrist (n=53, 65.4%). The most commonly used duration was 7 days (n=35, 43%) followed by 14 days (n=15, 18.5%). Device wear duration ranged from 1 night to 15 days. Ninety-one different digital outcome measures were identified; 44% assessed sleep, 30% SB and 26% CR. The majority of digital outcome measures characterised the duration, frequency, and timing of sleep/activity (71%), rather than pattern or variability (16%).ConclusionsThis review highlighted the heterogeneity of procedures used to objectively assess sleep, SB, and CR in terms of the devices and protocols used. Despite a number of studies using wearable devices to measure sleep/activity in PD, there is a paucity of studies in iRBD and LBD, particularly DLB. Future research is needed to assess if different neurodegenerative conditions have distinctive sleep, CR, and SB profiles. This would be useful for identifying emerging symptoms and patient stratification.

P02-B-04 - Verbal memory practice effects are associated with responsiveness to reactive balance training in Parkinson's disease

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Background and Aim: Practice effects represent a psychometric phenomenon observed when individuals demonstrate improved performance on cognitive tests after repeated exposure to the same or similar test materials, distinct from a true change in a patient's ability. These improvements can occur naturally, reflecting the learning and adaptation through repeated testing, and may serve as indicators of cognitive plasticity and predictors of motor learning. Despite their potential significance, these effects remain underexplored in individuals with Parkinson's Disease (PD), a population characterized by cognitive and motor impairments. This study quantified practice effects in PD and investigated their relationship with outcomes of reactive balance training to identify predictors of rehabilitation responsiveness. Methods: Thirty-five individuals with idiopathic PD at risk for falls participated in an 18-week protocol. Cognitive assessments, including verbal episodic memory (California Verbal Learning Test; CVLT-II) and processing speed (Symbol Digit Modality Test; SDMT), were conducted at two baseline visits separated by two weeks (B1 and B2) to evaluate practice effects. Reactive stepping metrics, such as anterior-posterior margin of stability (AP MOS), step length, and latency, were assessed during the same baseline visits (B1 and B2), immediately after a two-week reactive balance training program (P1), and two months post-training for retention (P2). The two-week training program, conducted between B2 and P1, involved repeated support-surface perturbations designed to improve reactive balance. Two-week cognitive practice effects were quantified as the change in CVLT-II and SDMT scores between B1 and B2. Relationships between cognitive practice effects and improvements in reactive stepping were analyzed for immediate (B2-P1) and retained (B2-P2) outcomes. Results: Significant practice effects were observed for CVLT-II delayed recall (mean improvement: 2.54, $p < 0.001$, $d = 0.74$) and total recall (mean improvement: 9.68, $p < 0.001$, $d = 0.72$), but not for SDMT ($p = 0.21$). Greater practice effects in CVLT-II delayed recall correlated strongly with immediate improvements in AP MOS ($r = 0.64$, $p < 0.001$) and moderately with step length ($r = 0.39$, $p = 0.04$) following training. No significant associations were noted between cognitive practice effects and retained improvements at P2. Practice effects in verbal episodic memory may be robust predictors of short-term responsiveness to reactive balance training in individuals with PD. Conclusions: These findings highlight the importance of incorporating cognitive assessments into motor rehabilitation programs to optimize outcomes and effectively target interventions. Future work should explore mechanisms linking practice effects, cognitive plasticity and motor learning in PD. Acknowledgements and Funding: This study was supported by the Michael J. Fox Foundation, Grant #008373.

P02-B-05 - Assessing the impact of perturbation intensity schedule on improvements in reactive balance recovery in young adults: An experimental study

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Background and aim: Recovery from balance perturbations can be trained, which may prevent falls in daily life. Improvements can be specific to the trained tasks, so approaches to improve generalisability are needed. We examined the effect of different perturbation intensity schedules (fixed high intensity [FH], low to high intensity [LH] and variable intensity [VA]) on balance recovery from untrained perturbations. Methods: 36 healthy adults (20-35y) participated. A translating motion platform delivered forward, backward, left and right perturbations. 5 intensity levels were used, defined by the peak platform acceleration. Perturbations were delivered in 5 trial blocks: 1 pre-training test, 3 training blocks of 9 perturbations, and 1 post-training test. Test blocks included 10 perturbations: 4 backwards (3.5 m/s2; untrained task) and 6 (1.0 m/s2) to the left, right, or forwards (2 per direction). Training included perturbations in forward, left and right directions. The FH schedule included level 5 intensity for all; LH had increasing intensity levels from 1 to 5; and VA varied the intensity (levels 1 to 5). VA and LH were matched for number of perturbations at each intensity. Outcomes were assessed via 4 force plates, 12-camera marker-based and 8-camera markerless motion capture systems and 4 video cameras. Electrodermal activity (EDA) was recorded and participants rated the training perturbations using the OMNI Perceived Exertion Scale (0-10, extremely easy - extremely hard). Primary outcomes were the number of recovery steps and the proportion of multi-step reactions for the untrained perturbations. Secondary outcomes included multiple centre of mass (CoM)-derived and spatiotemporal parameters. Results:ANCOVA found no significant intensity schedule group difference in number of steps or proportion of multi-step reactions post-training. Overall, participants took fewer steps and multi-step reactions ($p<0.0001$) post-training. We found no group differences in CoM or spatiotemporal variables post-training. Across all groups, only mediolateral margin of stability (ML MoS) significantly increased pre-to-post-training ($p=0.0003$). There was a significant group-by-training block interaction for perceived exertion ($p<0.0001$) with significant declines across training blocks in FH and significant increases in LH. There was no significant group-by-training block interaction for EDA but there was a significant effect of training block ($p=0.017$) with declined across all groups between blocks 1 and 3. Conclusions: Participants improved reactive stepping after untrained perturbations, regardless of the intensity schedule, suggesting that exposure to multiple perturbation directions, rather than intensities, may be more important for improving performance in untrained perturbations. All groups exhibited a similar decrease in EDA post-training, so amount rather than intensity of perturbations may be more important for reducing arousal during training.

P02-B-06 - Motor memory during walking in older adults relies on attentional resources, unlike in younger adults

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BACKGROUND AND AIM: Mobility in community-dwelling older adults requires adaptation of walking patterns when interacting with a new environment and “save” (i.e., remembering) previously learned movements for future encounters, known as locomotor savings. For example, one might learn a specific way to walk on a slippery surface and recall the same pattern the next time they encounter a sign reading “slippery floor”. The neural mechanisms underlying locomotor savings are not fully understood, and the impact of aging on these savings remains inconclusive. Possible neural substrates of locomotor savings include the basal ganglia and cerebellum, whose function is susceptible to age-related declines. Thus, we hypothesize that older adults rely more on attentional resources from the prefrontal cortex (PFC) as a compensation strategy for locomotor savings, and cognitive health impacts this compensation ability. METHODS: We compared attentional control of gait and locomotor savings on young (n=12), older (n=12), and older adults with mild cognitive impairment (MCI). Attentional control of gait was measured by prefrontal cortical activation during dual-task walking. Locomotor savings were quantified by improvements in walking performance after multiple exposures of split-belt walking, where the legs moved at different speeds. RESULTS: We found that older adults with MCI (n=7) required more attentional control for walking than those without MCI (p=0.03), who required more attentional control than young adults (trending, p=0.07). We showed that MCI participants (n=2) had worse locomotor savings than older adults (p=0.067), which was worse than young adults (p=0.005). Lastly, we found that more attentional walking was associated with more locomotor savings in older (rho=0.50,

p=0.02), but not young adults, suggesting that attentional control could

facilitate locomotor savings in older adults but this attentional compensation

is not needed in young adults. Data collection is ongoing to determine this

association in MCI participants. CONCLUSIONS: In summary, older adults exhibit reduced locomotor savings compared to younger adults. Also, unlike young, older adults rely more on attentional resources during challenging walking tasks, such as dual-task walking. Interestingly, older adults who exhibit more attentional walking had more savings, suggesting that older adults might rely on cognitive strategies for recalling motor memories. Ongoing studies are investigating the impact of compromised attentional resources due to mild cognitive impairments on locomotor savings. Understanding the cognitive compensation's role in walking control and adaptability may inform rehabilitation strategies aimed at improving mobility through motor learning principles in older populations. ACKNOWLEDGEMENTS AND FUNDING: Collaborators of this study are Ms. Shuqi Liu, Dr. Andrea Rosso, and Dr. Andrea Weinstein. This work is funded by NIH R01AG089175

P02-B-07 - Overview of effects of motor learning strategies in neurologic and geriatric populations: A systematic mapping review

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Background and aim: Motor learning plays a central role in neurological and geriatric rehabilitation. In clinical practice, however, therapists treat various populations with a great variety of motor problems, rehabilitation needs, and preferences. The wide range of motor learning strategies and increase in evidence can make it difficult to make informed decisions about the use of motor learning strategies in practice. The aim is to provide a broad overview of the current state of research regarding the effects of 7 commonly used motor learning strategies to improve functional tasks within older neurologic and geriatric populations.Methods: A systematic mapping review of randomised controlled trials was conducted regarding the effectiveness of seven motor learning strategies – errorless learning, analogy learning, observational learning, trial-and-error learning, dual-task learning, discovery learning, and movement imagery – within the geriatric and neurological population. PubMed, CINAHL, and Embase databases were searched. The Risk of Bias 2 tool was used to assess bias; additionally, papers underwent screening for sample size justification.Results: Eighty-seven articles were included. Identified articles regarding the effects of the targeted motor learning strategies started around the year 2000 and mainly emerged in 2010. Eight populations were included, for example, Parkinson's and stroke. Included studies were not equally balanced: analogy learning (n=2), errorless learning and trial-and-error learning (n=5), mental practice (n=19), observational learning (n=11), discovery learning (n=0), and dual-tasking (n=50). Overall studies showed a moderate-to-high risk of bias. Four studies were deemed sufficiently reliable to interpret effects. Positive trends regarding the effects were observed for dual-tasking, observational learning, and movement imagery.Conclusions: Findings show a skewed distribution of studies across motor learning interventions, especially toward dual-tasking. Methodological shortcomings make it difficult to draw firm conclusions regarding the effectiveness of motor learning strategies to improve functional studies. Based on observed trends, therapists may consider (to continue) using dual-task learning, observational learning and movement imagery. While waiting for future research, therapists may also consider the other motor learning strategies based on their own experiences and patients' preferences. Future researchers are strongly advised to follow guidelines that aid in maintaining methodological quality. Moreover, alternative designs fitting the complex practice situation should be considered.

P02-B-08 - Effect of visual biofeedback scale on the rambling and trembling components

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BACKGROUND AND AIM: Visual biofeedback (vBF) effectively reduces postural sway by providing real-time information about the center of pressure (COP) displacement. Recent research has shown that scaling the vBF size to a 1:5 ratio—where 1 unit of movement in real life corresponds to 5 units on a computer monitor—further enhances this sway-reducing effect (Michaud et al., 2024). However, the mechanisms underlying this improvement remain unclear. To better understand the effect of v on the COP dynamic, we decomposed the COP displacement into its Rambling and Trembling components as proposed by Zatsiorsky and Duarte (1999, 2000). In this framework, Rambling represents the transitional movement of a reference point representing the equilibrium state, while Trembling corresponds to corrective oscillations around that reference point, ensuring stability. METHODS: Twenty healthy young adults performed 60s trials under four vBF conditions: no vBF, 1:1, 1:5, and 1:10 scaling ratios. Participants were asked to keep their COP within a visual target displayed on a monitor while standing as still as possible with their feet together. The recorded COP signals were decomposed into their Rambling and Trembling component using Zatsiorsky and Duarte (1999, 2000) method. The Rambling signal was generated via spline interpolation on the COP data at moments when the horizontal force was equal to zero. The Trembling component was calculated as the difference between the original COP signal and the Rambling signal. Standard deviations of the Rambling and Trembling components were computed in both the anterior-posterior (AP) and medial-lateral (ML) directions. Additionally, continuous wavelet transforms were used to identify the frequency bands containing 95% of the Rambling signal's power. Linear mixed models were used to compare differences across conditions. RESULTS: Results revealed that the frequency band containing 95% of the Rambling power was larger during vBF conditions. Rambling displacement significantly decreased in both the AP and ML directions when vBF was provided. Conversely, the Trembling displacement showed contrasting results: it decreased in the ML direction but increased in the AP direction, suggesting a directional shift in corrective behavior. In general, the vBF effect plateaued at the 1:5 scaling ratio, as no further improvements were observed at 1:10. CONCLUSIONS: These results indicate that the positive effect of vBF primarily resides in its ability to reduce the slow, possibly exploratory, Rambling component of the COP displacement. At the same time, the Trembling component becomes more prominent in the AP direction, likely reflecting fast, precise corrective movements originating from visual integration of the vBF by the central nervous system (CNS) to maintain the COP within the visual target. The CNS also appears to optimize the use of vBF around the 1:5 and 1:10 ratio.

P02-B-09 - Postural adaptation, sensory reweighting and muscle co-contraction for postural control in people living with Parkinson's disease

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Background: Postural instability is common in people with Parkinson's Disease (PwPD), increasing their risk of injurious falls. Evidence suggests a sensory reweighting deficit in PwPD, along with compensatory muscle co-contraction in response to postural challenges. During balance tasks requiring sensory reweighting, older adults exhibit elevated postural sway and muscle co-contraction, as well as longer perceptual delays, compared with younger adults. Such responses may be exacerbated in PwPD, with implications for fall risk. The aim of this study was to compare postural sway, muscle co-contraction, and perceptual delays between PwPD and healthy age-matched controls during a sensory reweighting balance task.Methods: Eleven PwPD and 16 control participants completed a sensory reweighting protocol: standing without vision on a fixed platform (2-min), which then undergoes a period of body sway-referencing (3-min) before returning to its fixed position (2.5-min). Anteroposterior (AP) path length, co-contraction index (CCI), and perceptual delay were analysed across task phases. Results: PwPD showed a significantly longer time-delay in perceiving when the body sway-referenced platform returned to a fixed position. The perceptual delay (43.40-s) was over double that observed in controls (21.25-s). AP path length and CCI aftereffects were longer in control participants than PwPD. Conclusions: Where conditions require it, PwPD can effectively adjust their reliance on proprioceptive information for postural control. However, the significant delay shown by PwPD in perceiving changes to sensory conditions could be detrimental during everyday sensory transitions, potentially increasing the likelihood of a fall.Acknowledgements and funding: This work was supported by the São Paulo Research Foundation (FAPESP) and Queen's University Belfast SPRINT (São Paulo Researchers in International Collaboration) partnership award.

P02-B-10 - Obstacle crossing: Reducing foot placement variability is associated with reduced toe clearance variability in younger and older adults

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Background and Aims: Appropriate foot placement during approach to an obstacle is related to successfully clearing the obstacle [1,2]. Examination of failed trials (i.e., trips) indicates that some failures result from inappropriate foot placement of the trail foot before the obstacle: When the location of toe-off is objectively different from the preceding trials but the shape and size of the foot trajectory is not different from successful trials (Fig. 1A). This observation highlights a potential strategy to mitigate

trips: a foot target placed before obstacles in the environment to reduce inadvertent shifts in foot placement. A reduction in foot placement variability may lead to reduced toe clearance variability (Fig. 1A vs 1B) and reduced likelihood of obstacle contact. Our aims were to determine (1) if a reduction in foot placement variability – without a change in mean foot placement position – reduces toe clearance variability and (2) the effect of age on the association between foot placement variability and toe clearance variability. Methods: Fourteen younger (24 ± 3 years) and 20 older adults (64 ± 5 years) walked on an 8 m walkway and crossed an obstacle placed in the walkway (obstacle 25% of leg length; ~22 cm). Two conditions were compared: (1) baseline obstacle crossing task and (2) a foot placement target projected at the subject's preferred foot position of the trail foot in front of the obstacle (Fig. 1A). The second condition should reduce foot placement variability while keeping mean foot placement the same. Each condition was performed 20 times. The primary outcome measures were variances in trail foot placement and trail toe clearance. A two-way ANOVA (condition by age) was used.Results: The variance in foot placement was significantly reduced by the target placed at the preferred location of the trail foot before the obstacle ($p < 0.0001$). In addition, the variance in toe clearance was significantly reduced in the condition with the targeted foot placement ($p = 0.01$). No main or interaction effects of age were observed. Conclusion: Targets placed at an appropriate foot placement before an environmental hazard reduced trail foot placement variability. The more consistent foot placement at the start of swing phase was associated with reduced variance of trail toe clearance. Importantly, the lack of significant age interaction suggests both younger and older adults benefit similarly from reduced foot placement variability. These findings emphasize the role of consistent foot placement in minimizing clearance errors and provide new potential interventions to improve obstacle negotiation and reduce fall risk. These interventions include teaching people to appropriately target the trail foot placement before an obstacle.ReferencesChou Draganich, 1998.Heijnen et al., 2012.

P02-B-11 - Effects of known versus unknown load positions during lifting tasks on postural control in healthy adults

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Background: During lifting tasks, individuals encountering predictable perturbations typically generate anticipatory postural adjustments (APA) to maintain stability and minimize potential disturbances to their balance. Before lifting a known load, the body pre-activates specific muscle groups to counteract expected changes in the center of gravity and manage the forces acting on the body. While factors such as load weight, lifting technique, and body mechanics have been extensively studied to understand their influence on balance and performance, the specific impact of altering weight distributions within an object, particularly when individuals are either aware or unaware of the load's imbalance, has not been thoroughly investigated.Aim: To investigate the

effects of lifting an object with known versus unknown unbalanced weight distributions on postural control in healthy volunteers.Methods: We conducted a randomized cross-over study with 16 healthy participants, who were assigned to two conditions: known and unknown load positions. Participants lifted a plastic box with an added mass (5% of body weight) placed in one of five compartments while standing. In the known condition, the load position was disclosed before each trial, with three trials per position. In the unknown condition, the load position was not disclosed, and participants lifted the load in a set sequence (middle, outer-left, middle, outer-right, middle), completing 4–7 trials per position. Testing occurred on two non-consecutive days, with one session per day. Center of pressure (COP) displacements and electromyographic activity from the trunk and thigh muscles were recorded and analyzed during the anticipatory and compensatory phases of postural control. A one-way repeated measures ANOVA was used to compare outcomes between conditions.Results: In the first trial under the unknown condition, participants demonstrated statistically significant less efficient APA ($p < 0.05$) and relied more on compensatory postural adjustments (CPA) compared to those in the known condition. However, participants showed statistically significant improvement in APA ($p < 0.05$) when lifting the load in the same positions, as observed in the final trial of the unknown condition.Conclusion: Young adults exhibited inefficient APA when lifting a load without prior knowledge of its position, which significantly affected their ability to maintain balance. However, with repeated exposure to lifting the load in the same positions, they adapted by refining their motor strategies and improving their APA. This suggests that experience plays a critical role in enhancing postural control, as repeated practice allows individuals to form motor patterns based on learned predictions.Acknowledgements: The authors wish to thank all participants for giving their valuable time to take part in our study. Funding: This work was supported by the Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand

P02-C-12 - Lifetime noise exposure affects age-related gait changes

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BACKGROUND & AIM: Reduced vestibular function increases fall risk (Agrawal et al. 2012). Noise exposure (NE) can lead to otolith damage (Stewart et al. 2020), yet can be overlooked as a source of vestibular deficit and thus fall risk (e.g., Picard et al. 2008; Girard et al. 2014). To date, little is known about the effects of NE on gait. The aim of this study was to investigate how lifetime NE may change gait characteristics across the life span.METHODS: To assess lifetime NE, participants completed the Noise Exposure Structured Interview (NESI, Guest et al. 2018). 25 (9M) participants had low and 22 (16 M) had high (logNESI ≥ 1) lifetime NE. Mobility was assessed using a clinical timed up and go (cTUG). Stride cycles were extracted from straight phases of the instrumented TUG (iTUG, 3 m) and ellipsoid (4 m) walking tasks (Agathos et al. 2023). Movements were recorded using 6 IMUs placed on the back of the head, chest (used to estimate trunk motion), back

(~L4), and 2-3 cm above each ankle, with one IMU placed on the floor for reference (N=17) or with 3 IMUs placed on the head, chest, and right leg as above (N=30). Stride duration, length, and speed were averaged from all available cycles for each participant. Subsequently, all cycles were aligned on cycle start and samples at matching time points were averaged. Peak power/frequency and peak sway times/amplitudes, as well as angular head and trunk velocities/rotation angles (pitch, roll, yaw) and linear accelerations/displacements in mediolateral (ML), anteroposterior (AP) and vertical (Z) directions were extracted from these cycle averages. We also calculated head-trunk delays and anchoring indices. In total, 146 gait features were evaluated as a function of age and NE group (simple model), or also including cTUG times and participant height (full model), using robust linear regression modeling. RESULTS: To look at the effects of NE on age-related gait changes, we selected gait features that showed a significant interaction between age and NE group in one or both models (22 gait features). 9 were trunk-related: pitch angular velocity maximum/range and peak power frequency; yaw angular velocity peak amplitude/time ; peak Z acceleration; pitch and yaw maximum angle; and roll angle extremum time. 8 were head-related: yaw angular velocity range, extremum/timing ; time of min Z linear acceleration; pitch angle peak power frequency; yaw angle range, maximum/timing. 5 were delays between head and trunk in pitch angular velocity, ML and Z linear acceleration, and pitch and roll angle. Only 2 features were better represented by the full model (time of minimum head Z linear acceleration and peak power frequency of the trunk pitch angular velocity). CONCLUSIONS: In those with high NE, affected gait characteristics were similar to older non-exposed individuals at younger ages. Our findings suggest that vestibular changes due to NE may have similar effects on gait as those due to normal aging.ACKNOWLEDGEMENTS AND FUNDING: This study was supported by NIH research grant R00-EY-026994 and The Smith-Kettlewell Eye Research Institute

P02-C-13 - Injuries, causes and activities related to falls are under-reported in prospective studies of older adults: A brief review

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Background and AimInjuries, reduced physical and social activity, the fear of falling again, and increased use of healthcare services make falls among older adults a significant public health issue. Demographic, health and lifestyle predictors of fall and fall-related injuries are well documented. However, pre-fall environments, causes and/or activities prior to falls in older adults are difficult to study. Prospective falls monitoring via diaries, questionnaires and phone calls is considered the standard method to collect falls incidence data in research studies. The aim of this review of the literature was to examine which and how frequently various fall-related outcomes (e.g., injury rate, type and severity, cause, activity preceding the fall, location, time, etc.) are reported in larger (n≥100) prospective studies. MethodsA semi-structured, iterative search process

combining a PubMed search, screening of studies included in published reviews on prospective falls monitoring, and forward and backward citation searching was conducted. Prospective studies with 100 or more participants with falls monitoring were included to generate a representative sample. Data from the falls monitoring process of each article were extracted and categorised. ResultsWe analysed 179 articles including 465,348 older adults (mean age: 74.76±5.50 years, range: 50-105; female: n=340,449) meeting our criteria. We found that 97 prospective studies collected the fall-related data retrospectively. The studies were mostly conducted in the USA (40), Australia (21), Japan (18), China (16), and Netherlands (10), respectively. 161 articles reported overall percentage of people experiencing a fall (31.03%), while 42 and 87 articles defined those experiencing a single fall (24.17%) and recurrent falls (20.79%) during follow-up, respectively. Mean follow up duration of the studies was found approximately 2 years. 10, 22, and 62 articles reported the fall time, fall location and fall-related injuries, respectively. 19 articles reported fractures, with hip fractures being the most frequent (9/19). Only 22 articles reported details related to causes of and/or activities prior to falls. 9 of them reported the most common cause was a slip or trip, and 12 of them reported walking as the most common activity prior to a fall. One study also reported that 88.2% of falls occurred while participants were doing something they often did. ConclusionsPercentages of people experiencing falls are commonly reported and fall-related injuries are reported moderately frequently in prospective studies of fall incidence, whereas outcomes related to time, location, causes and activities prior to fall are scarcely reported. In order to better understand the role that these factors might play in falls, we recommend that more studies include these outcomes in their data collection.

P02-C-14 - Real-world walking bouts were increasingly broken up with age in multi-cohort adults

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Background and aim: With the wider use of digital wearables, more and more research has focused on walking in the real-world. The multi-centre IDEA-FAST project is exploring digital endpoints to objectively assess fatigue in chronic diseases. As such, the ongoing Clinical Observation Study (COS) data includes objective, continuous records of real-world walking from a large population of participants with various conditions, across Europe. This provides a unique opportunity for preliminary exploration of the impacts of age on walking behaviour, an important measure of health.Methods: At present, 922 participants wore an accelerometer on the lower back for up to 31 days (4 visits: 1x10-day and 3x7-day continuous periods) from 18 sites in 9 countries across Europe. A visit was considered valid if ≥12 hours during waking hours (0700 – 2000) for ≥3 days of data were recorded. All participants had at least 1 valid visit. Participant cohorts included Parkinson's Disease (N=337), Huntington's disease (N=56), inflammatory bowel disease (N=221), primary Sjogren's syndrome (N=85), systemic lupus erythematosus (N=80), rheumatoid arthritis (N=70), and healthy individuals (N=73). The participants' walking bouts (WBs) and steps were estimated from the accelerometer data using validated algorithms [1]. The number of WBs and mean daily step count were then calculated for all (>10s) WBs, as well as 3 sub-categories: short (10-30s), moderate (30-60s), and long (>60s) WBs. Regression analysis was used to explore the relationships between age and walking behaviours whilst controlling for cohort, sex, body mass index (BMI), height, country, occupation status, and education.Results: Walking volume was not significantly linked with age. For all, short, moderate, and long WBs, age was not significantly associated with step count (p=.280, .232, .457, .087), total daily walk time (p=.229, .314, .394, .057), or number of WBs (except for long WBs) (p=.776, .243, .418, .036). However, mean WB length significantly decreased with age (p=.010) and when considering the proportion (%) of steps taken in each WB sub-category, age was significantly associated with proportionally more steps in short WBs (p=.002) and fewer steps in long WBs (p=.018), but not with moderate (p=.979), as seen in Figure 1. This is possibly due to the number of WBs, since age was significantly associated with proportionally more short WBs (p<.000) and fewer moderate (p=.001) and long (p<.000) WBs.Conclusions: While age did not have a relationship with walking volume, in these 922 multi-cohort participants, mean WB length decreased with age. Therefore, our preliminary analysis indicates that in these healthy and chronic disease cohorts, walking bouts were increasingly broken up with age, highlighting a decreased capacity for longer periods of activity. Future analysis will explore within-cohort outcomes once the COS is completed.References: [1] McCamley et al Gait Posture 2012.

P02-C-15 - The EXALT cycle ergometer: A technological innovation for the rehabilitation of frail older adults

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Background and aim: Personalized exercise prescription is a cornerstone of preventive and rehabilitative care. However, no commercially available cycle ergometer currently meets the combined requirements of precision, clinical safety, patient and provider acceptability, and affordability for widespread use in healthcare settings. This study aimed to develop and evaluate a clinically integrated cycle ergometer—EXALT—using a "develop with clinical intent" approach, prioritizing real-world usability among frail older adults and healthcare professionals.Methods: An interdisciplinary team co-designed the

EXALT ergometer (Phase 1), followed by usability testing (Phase 2) with frail older adults undergoing hospital-based hemodialysis (n=13) and exercise professionals overseeing the sessions (n=4). Usability and acceptability were assessed using questionnaires based on the Unified Theory of Acceptance and Use of Technology (UTAUT), focusing on performance expectancy, effort expectancy (ease of use), social influence, and facilitating conditions. Data were collected during in-hospital exercise sessions and remotely transferred using OpenTera, a secure, microservice-based framework for telehealth deployment.Results: Phase 1 resulted in a lightweight prototype with accurate power output, a universal hospital bed attachment system, an integrated touchscreen for exercise feedback, and secure remote data access. In Phase 2, 77% of patients and 75% of professionals expressed intent to use the device regularly. However, only 54% of patients found the pedaling comfortable, and 62% considered the device well-adapted. All professionals reported the integrated tablet as non-beneficial. Based on this feedback, a second iteration was developed with a lighter, wireless frame, smoother pedaling, and a detachable tablet (see attached picture). This version was rated acceptable by 100% of participants, though all noted that the pedal and bed attachment system still required improvement. Remote data transfer was successfully achieved in all cases.Conclusions: The EXALT ergometer shows strong potential as a clinically viable, telerehabilitation-enabled tool for personalized exercise in frail populations. Iterative design based on real-world clinical feedback led to substantial improvements in usability. Further refinement of the pedal attachment system is needed before broader clinical implementation.Acknowledgements and funding: We gratefully acknowledge the contributions of the clinical staff and patient participants. This study was supported by the Centre for Aging + Brain Health Innovation and the INTER network.

P02-C-16 - Epidemiology of falls in community-dwelling older adults in Europe: A systematic review and meta-analysis

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Background and Aim: Falls have long been recognized as a common problem among older adults and have been cited in literature since the 1950s. Based on extensive research, ranging from studies on risk factors to investigations into prevention and implementation strategies, one might expect a decline in fall prevalences. However, it is assumed that this may not be the case and with the proportion of older adults worldwide continuing to rise, this issue requires urgent attention. The aim of this review is to explore the epidemiology of falls in Europe over the years, specifically focusing on healthy, community-dwelling individuals, aged 65 years or older.Methods: Articles included in this systematic review and meta-analysis were extracted from PubMed and Web of Science in June 2023. The screening was completed in August 2023 and an update was performed in January 2024. In- and exclusion criteria ensured that the population in the included articles was an correct and accurate representation for all community-dwelling

older adults. All articles were checked for potential bias using the Standard quality assessment criteria and potential outliers were calculated. Data analysis consisting of subgroup analysis and meta regression was performed in R using the "meta" package. Publication bias was assessed using Egger's regression test.Results: Thirty-nine articles were included, comprising a sample of 71549 European, community-dwelling older adults. The average fall prevalence among European older adults was 31% (95% CI 0,26 – 0,36). Meta regression-analysis showed no changes in fall prevalence through the years ,suggesting no change in fall prevalence over time (p=.903). In the subgroup analysis, differences in fall prevalence were seen for gender (p=.0004), country (p<.0001), length of follow-up (p=0.004) and age (p<.0001), but not for study design (p=.244). Conclusion: Despite decades of evidence supporting effective fall prevention, the fall prevalence among community-dwelling older adults in Europe remained unchanged. Future research and discussions should focus on systematically identifying the factors contributing to the persistent fall rates. Additionally, efforts must be made to address these barriers and to ensure the effective implementation of existing knowledge on fall prevention.Acknowledgements and funding: No potential conflict of interest was reported by the author(s). The authors did not receive support from any organization for the submitted work.

P02-C-17 - How do plantar flexor muscle characteristics influence the use of trailing-limb control to maintain stability during walking?

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BACKGROUND AND AIMS: Aging is associated with shifts in body composition, particularly gains in fat mass and loss in muscle mass. Clinically, these changes are observed as obesity and/or sarcopenia, conditions that influence the functional capacity, tissue quality, and activation of muscles. Previous studies have shown that these conditions influence vertical ground reaction forces (vGRF) during gait, which may have implications on the control of mediolateral walking stability, specifically the use of trailing-limb control. In this study, we tested the hypothesis that plantar flexor muscle characteristics, defined as muscle capacity, muscle quality, and muscle activation of the plantar flexors, are related to vGRF output, which subsequently is related to trail-limb contributions of mediolateral stability control. METHODS: 12 typically functioning adults (ages: 56-69 years, 7 females, BMI: 21.0-33.3 kg/m2) have completed this study. A heel-rise test (Calf Raise App v.1.5.1) was conducted to measure muscle capacity as relative total positive work. Muscle ultrasound imaging (Logiq E, Chicago, IL) was used to capture images of the medial and lateral gastrocnemii, with muscle quality assessed through mean muscle echogenicity (ImageJ, Bethesda, MD) from three images. Participants walked on an instrumented, split-belt treadmill (Bertec, Columbus, OH) with EMG of the medial and lateral gastrocnemius heads (Cometa, Bareggio, Italy) recorded to measure peak muscle activation throughout stance, scaled by maximum voluntary contraction. Force-plate data were used to measure relative peak vGRF during push-off. Trail-limb contributions were determined using a force-plate-only approach and were expressed as an average acceleration induced by the trailing limb during double support (Figure 1). The magnitude of trail-limb contributions is influenced by the magnitude of the limb-specific vGRF and its lateral location relative to the COM. Spearman-rank correlations were used to assess the relationships between plantar flexor muscle characteristics, peak vGRF, and mean trail-limb contribution. RESULTS: Lateral gastrocnemius activation and peak vGRF were positively correlated (rs=0.63, p=0.03). No significant correlations were found between the other plantar flexor muscle characteristics and peak vGRF (rs<0.56, p>0.06), or between peak vGRF and trail-limb contributions (rs=0.26, p=0.42). CONCLUSIONS: Individually, the plantar flexor muscle characteristics did not strongly relate to the vGRF of gait, which in turn did not strongly relate to trail-limb contributions. We do not yet know how plantar flexor muscle characteristics may, together, relate to vGRF using a multivariate approach. As opposed to its magnitude, the location of the vGRF relative to the COM may play a more prominent role in determining trail-limb contributions. Future work will include a broader range of body sizes, plantar flexor muscle characteristics, and gait mechanics.

P02-C-18 - Does previewing of walking route lead to safer stepping strategies in community dwelling older adults when dual-tasking?

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BACKGROUND AND AIM - Falls are a leading cause of avoidable injury in older adults, costing the NHS more than £6 million a day. While multitasking and walking, older adults (OA) will walk slower and use maladaptive stepping strategies, such as cross-steps that may increase falls risk. Most studies to date are limited to steady-state straight-line walking, which requires limited to no visual planning, and which is unrepresentative of environments in which falls often occur. Therefore, this study aimed to (i) investigate the impact of dual-tasking when walking complex routes that require gait adaptation, and (ii) assess if such impact can be reduced when OA preview their walking route to improve planning. METHODS - We aim to recruit 45 community-dwelling OA. Preliminary results are reported for 19 (13F & 6M) community-dwelling OA without neurological or musculoskeletal diagnosis (Mean age = 77, range = 64–85). Participants walked different winding paths on an 8-meter-long instrumented walkway under three conditions for 6 trials per condition: Single-task (ST), Dual-task (counting backwards) without previewing their route (DT) and Dual-task with previewing of the route (DTP). For each condition, we recorded walking speed, stepping errors (deviations from the instructed pathway), cross-steps and Dual-Task Cost (DTC).RESULTS - When not allowed to preview, participants walked significantly slower during the dual-task (M=58.2 cm/s, SD=16.1) vs single-task condition (M=79.8 cm/s, SD=13.7; p<.001). When dual-tasking, participants also made

more errors (M=0.9/trial, SD=0.9; p=.001) and more cross-steps (M=0.5/trial, SD=0.4; p=.009) compared to the single-task condition (no errors; M=0.5 cross-steps/trial, SD=0.0). However, when allowed to preview their route prior to dual-tasking, participants walked faster (M=68.3 cm/s, SD=17.1; p=.001) and with fewer errors (M=0.0/trial, SD=0.1; p=.001). Overall, there were lower DTCs during the dual-task-previewing condition (M=21.6, SD=41.9) vs the non-previewing dual-task condition (M= -19.1, SD=35.8; p= 0.001).CONCLUSIONS - Attentional loading in the form of a cognitive dual task during adaptive walking reduces speed and increases the occurrence of high-risk stepping strategies. A simple intervention to preview the walking route may reverse some of these negative changes, allowing older adults to walk faster without compromised safety. Further planned analysis will identify to what extent particular previewing behaviour is associated with improvements in gait performance during subsequent dual-tasking conditions.ACKNOWLEDGEMENTS AND FUNDING - This project is part of a Brunel University London-funded Deans Scholarship.

P02-C-19 - Gait speed is associated broadly with cognitive function under both normal and dual-task conditions in older adults

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Background and Aim: Various aspects of walking and cognition are correlated in older adults. However, the relationship between walking performance and specific cognitive domains remains unclear. Furthermore, since dual-tasking has greater cognitive processing demands compared to normal walking, it is important to determine whether normal and dual-task walking performance relate differentially to particular aspects of cognition. This study examined the relationship between gait speed under normal and dual task conditions and performance in five cognitive domains in older adults.Methods: Baseline data from older adult participants of the “Investigating Gains in Neurocognition in an Intervention Trial of Exercise (IGNITE)” study were analyzed. Participants completed a comprehensive neuropsychological evaluation and a gait assessment. A confirmatory factor analysis reduced the dimensionality of the cognitive data to five cognitive domains: processing speed, episodic memory, working memory, visuospatial processing, and executive function (EF)/attentional control. Three, 45sec trials of gait were collected under normal (i.e., quiet walking) and dual-task conditions (i.e., walking while counting backward by 3 from a random three-digit number). Gait speed was used as the primary outcome. Separate linear regression models evaluated the association between gait and each cognitive domain while controlling for age, sex, BMI, race, education, and study site. An interaction term was also included to test whether gait

speed during the two walking conditions was differentially related to cognitive performance.Results: Data from 351 participants (70±4 y/o; 249 females; BMI: 30±6 kg/m2; education: 16±2 years) were included. Gait speeds were slower ($p<.0001$) during dual-task walking (1.05±0.19m/s), as compared to normal walking (1.14±0.18m/s). Performance across the five cognitive domains was positively associated with gait speed. Relationships to normal walking gait speed included: EF/attentional control (β=.19, $p<.001$), processing speed (β=.19, $p<.001$), working memory (β=.18, $p<.001$), visuospatial (β=.12, p=.026), and episodic memory (β=.12, p=.028). Relationships between dual-task walking gait speed and each cognitive domain appeared stronger: EF/attentional control (β=.27, $p<.001$), working memory (β=.26, $p<.001$), processing speed (β=.25, $p<.001$), visuospatial (β=.18, p=.001), and episodic memory (β=.16, p=.003). However, the interaction between walking condition and each cognitive domain was not significant ($p>.2$), indicating that the strength of association between cognitive performance and gait speed did not differ between normal and dual task walking.Conclusions: Results indicated that gait speed was broadly associated with all aspects of cognitive function in older adults. Despite significant costs in gait speed under dual-task conditions, dual-task gait speed was not significantly more dependent upon cognition than normal walking.

P02-C-21 - Gait adaptations following exercise-induced muscle fatigue in older adults: Awareness and intentionality

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Background and aimExercise-induced muscle fatigue alters gait which leads to an increased risk of falling in older adults. Nonetheless, these gait adaptations seem to be non-homogeneous, indicating that older adults have individual strategies to respond to exercise-induced fatigue. Moreover, exercise-induced fatigue is shown to have a negative effect on proprioceptive acuity and thereby motor control in older adults. This raises the question whether older adults are able to congruently perceive adaptations in gait parameters and if they actively change movement behaviour. Therefore, the three-fold aim of this study is to determine: (1) whether older adults are aware of adaptations in gait parameters; (2) whether the strategies to cope with (perceived) fatigue are intentional or unintentional; and (3) based on what information gait adaptations are executed. The study findings will give insight on awareness and intentionality of gait adaptations when physically fatigued and can be used in fall preventive gait training in the older population. MethodThe study was set-up as a convergent mixed-methods design and eighteen healthy older adults (>65 year, 13 females) participated. The older adults performed walking trails (15m) while gradually becoming more fatigued through repetitive sit-to-stand exercises between the walking trails. Subsequently, participants were interviewed on awareness and intentionality regarding gait adaptations. During walking trails, objective gait parameter data (i.e. step length, step width, gait speed, minimal foot clearance (MFC) and gait stability) was collected with the THEIA Markerless Motion capture system. Objective and subjective data on individual level was used to determine whether older adults' perceived gait adaptations were congruent with gait parameter data.ResultsFourteen participants perceived gait adaptations in fatigued state. Most frequent reported changes, reported by half of the participants, were slower gait speed and decreased stability. Increased variability and decreased stride length were reported by seven and six participants, respectively. Seven participants made only one intentional adaptation in their gait, one participant made two intentional adaptations, and the other eight participants made no intentional adaptations. The intentional changes reported were changes in stride length (n=2), MFC (n=2), gait speed (n=2) or foot placement (n=3). Whether these perceptions are congruent with gait parameter data is currently analysed and will be presented at the ISPGR conference.ConclusionOur preliminary conclusion is that the adaptations in gait are perceived, whether the perceptions are congruent with reality is still subject to analysis.

P02-C-22 - Physical capacity and biological age: The contribution of gait characteristics in midlife

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Background and aimsReduced gait quality in old age is associated with adverse health outcomes, such as cognitive decline, falls and mortality. Gait quality is considered a hallmark of aging, as its decline in old age signifies age-related changes. However, these changes are heterogenous among people and can be captured by biological age (BA). Measuring BA offers a unique perspective on aging, starting at a younger age. While gait has previously been used as a marker of BA, primarily in older adults, the physical and cognitive effort required for walking in healthy young individuals may not sufficiently capture aging-related changes during this life period. This study aims to address this gap by examining the relationship between an extended measure of physical capacity and BA in midlife, with a focus on the unique contribution of gait to this relationship.MethodsA cross-sectional study, a cohort of community dwelling healthy midlife adults. BA was estimated based on a set of physiological biomarkers and calculated by Klemera-Doubal method. Physical capacity was assessed using a battery composed by 15 functional tests representing six domains: muscular strength, cardio-respiratory endurance, flexibility, balance, agility, and gait variables during single and dual-task walking, measured using APDM mobility lab. Standardized composite scores for physical capacity and domain-specific scores were calculated based on percentiles.ResultsA total of 112 participants (age 45.7±0.7, 47% women) were included; higher physical capacity composite score was associated with lower BA, after controlling for age, education, and smoking ($b=-0.34$, $p<0.001$). Among the six domains, only endurance, flexibility, and balance remained significant predictors of BA. Gait speed and stride length covariance under single- and dual-task conditions were not significantly associated with BA (p=0.37-0.75).ConclusionsPhysical capacity assessments incorporating all six domains may be useful for estimating BA in healthy midlife individuals. While gait characteristics are prominent markers of aging in older adults, they may not adequately reflect the pace of aging in midlife. These findings highlight the importance of using a comprehensive physical capacity battery to detect subtle aging-related changes in midlife, enabling early behavioral interventions during this critical life period.Acknowledgments and FundingAll authors declare that they have no competing interests; the study was supported by NIH [R01HL088884], the Israeli Science Foundation grant [1065/16], and the Israel National Institute for Health Policy Research [2018/202].

P02-C-23 - Keep exercising & stay steady: Co-design of an exercise maintenance intervention for people exiting falls prevention exercise programs

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Background: Falls prevention exercise programmes led by postural stability instructors (PSIs) improve physical function and reduce falls and injury risk and incidence. However, older adults rarely continue to stay active after programmes end. Observed improvements in physical function are lost and falls and injury rates increase if people do not keep active after programme completion. Aim: To co-design an exercise maintenance intervention that is acceptable for older adults to receive, and service providers to deliver, in community falls prevention exercise programmes. Methods: An iterative three stage, co-design approach was used to develop the exercise maintenance intervention. Key stakeholder consultations were hosted in a community exercise facility and online. In stages 1 and 2, the research team facilitated six round table discussions on a variety of evidence-based intervention strategies to promote exercise maintenance and stakeholders voted on whether each should be included in the intervention. Stage 1 and 2 discussions were audio-recorded, transcribed and analysed thematically. Votes were counted and presented as numbers and agreement percentages. In stage 1, the voting results were organised in hierarchical order and themes derived from the thematic analysis used to develop an intervention framework. In stage 2, the intervention framework was scrutinised in three stakeholder consultations using the APEASE criteria (acceptability, practicality, effectiveness, affordability, side effects, equality) and outcomes used to refine the framework. Based on the refined framework, a further stakeholder consultation was held to develop the intervention and delivery plan (stage 3). Results: Nine older adults (mean age: 79, range 66-87 years), three patient and public involvement members, eight healthcare professionals, two PSIs, a clinical academic and public health commissioner attended a stakeholder consultation. Stage 1 agreement percentages identified the most popular intervention components were providing:

information on local exercise services (87.5%), motivational strategies (81%), follow-up group meetings (69%), education (62.5%), Keep On Keep Up (KOKU) Health App (44%) and exercise booklets (44%). Stage 2 & 3 identified that the intervention should include follow-up group sessions containing motivational interviewing, health education, exercise class transition advice, exercise practice and a home exercise plan delivered by a PSI. The functional Fitness MOT tool, physical activity monitoring tools, exercise booklets, the KOKU Health App and a PSI training package supports the intervention. Conclusion: Facilitated by a co-design process, stakeholder recommendations were integrated into an evidence-informed exercise maintenance intervention to investigate in a subsequent feasibility study.

P02-C-24 - Age-related changes in proprioceptive reweighting: Preliminary insights

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Background and aim : Proprioception is vital for detecting destabilization and the subsequent planning of corrective actions. Proprioceptive reweighting involves selecting the optimal strategy for maintaining postural stability when proprioceptive inputs are disrupted or changing. Decline of the proprioceptive system due to either age or certain pathologies are known to affect balance control, and might require a reweighting of importance of proprioceptive inputs (1). Studies show older adults with low back pain tend to rely more on ankle proprioceptors and struggle to adopt more effective multi-segmental strategies, which has been related to a higher fall risk(2). However, the mechanisms of proprioceptive reweighting in healthy aging adults are still unclear. Therefore, we aim to investigate the effect of healthy aging on proprioceptive reweighting. Methods: Fifteen volunteers were evenly distributed in 3 age groups: young (mean 22y, [22-23y]), middle-aged (mean 51y, [42-55y]), and older adults (mean 74y, [61-79y]). Proprioceptive reweighting was assessed using the Relative Proprioceptive Weighting (RPW) ratio, which quantified postural sway under stable (floor) and unstable conditions (foam) with no vibration, ankle vibration (triceps surae), and back vibration (lumbar multifidus). RPW was calculated as RPW = |ankle|/(|ankle|+|back|), where "|ankle|" represents the absolute mean center-of-pressure displacement during ankle muscle vibration and "|back|" represents the absolute displacement during back muscle vibration. RPW values closer to 1 indicate high ankle reliance and values closer to 0 indicate high multi-segmental reliance. Age-related effects on RPW were analyzed using ANOVA with Tukey HSD post hoc tests and regression analysis.Results: Older adults showed significantly higher reliance on ankle proprioceptive input on stable surfaces compared to younger adults (Figure 1). During the unstable foam condition, older adults reduced their reliance on ankle proprioception, while younger adults maintained their chosen proprioceptive strategy. ANOVA and regression analysis revealed significant effects of age on RPW during stable conditions ($R2 = 0.54$), RPW change score ($R2 = 0.49$), TUG, and Mini-BESTest (all $p<0.05$).Conclusion: Younger adults managed the foam

perturbations using their initial proprioceptive strategy, indicating good postural control, while older adults reduced their reliance on ankle proprioception. Three younger individuals with low back pain struggled to shift to a multi-segmental strategy, consistent with existing literature (3). Interestingly, middle-aged adults had clinical balance scores similar to younger adults, but their RPW strategies resembled those of older adults, possibly indicating early signs of reduced postural control or fear of falling. Although this trend was not statistically significant possibly due to the small sample size, future research with larger samples could determine if RPW is more sensitive to age-related balance decline and fall risk. References: 1) Ferlinc A, et al. (2019) Mater Sociomed.; 2) Ito T et al. (2020) Somatosens Mot Res. ; 3) Claeys K, et al. (2011) Eur J Appl Physiol. Acknowledgement and funding: Funded by the European Union with YUF4postdoc fellowship (EU Horizon Europ MSCA cofund, grant 101081327)

P02-C-25 - Deep learning-based physical exercise assessment of older adults using single-camera video-footage in residential care settings

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BACKGROUND AND AIM: Regular physical activity is essential for older adults to maintain independence and mitigate health decline. However, those in residential care settings often struggle to adhere to structured exercise regimens due to limited access to personalized guidance. Emerging technologies like assistive robotic coaches and interactive platforms aim to promote consistent physical activity. To ensure safety and effectiveness, accurate exercise performance monitoring is crucial. Combining standard video recordings with deep learning (DL) algorithms offers a promising approach for automated exercise monitoring. Despite recent progress, no DL algorithm currently enables objective monitoring of older adults' exercise performance. This study introduced a DL algorithm for (a) fine-grained recognition of exercise types and (b) estimation of 3D joint angle trajectories to derive exercise outcomes like duration and repetition count. METHODS: Seven participants (aged 69-91) from a residential care facility performed six rehabilitation exercises (e.g., sit-to-stand, lateral leg movement) in front of a stationary camera while wearing 17 inertial sensors (Xsens MVN Awinda). Video frames which were manually annotated with exercise labels, and 3D joint angles extracted from the sensors (Xsens MVN Analyze Pro) served as ground truth for exercise recognition and 3D angle regression of 3 axial and 6 lower-body joints. From the videos, 2D pose sequences (AlphaPose) were used as input to a pre-trained DL motion encoder backbone (MotionBERT) with a task-specific network head. The model was evaluated under two training regimes: fine-tuning both backbone and head, and training from scratch. Metrics included the F1 score and Mean Per Joint Angular Error (MPJAE), calculated via leave-one-subject-out cross-validation. Exercise outcome estimation (duration, repetition count) was assessed using correlation between predicted and actual frame labels. RESULTS: The fine-tuned MotionBERT achieved an F1 score of 0.904 for exercise recognition, similar to training from scratch 0.887 ($p>0.05$). For 3D joint angle estimation, the fine-tuned model significantly outperformed training from scratch, with an MPJAE of 7.41 degrees compared to 7.93 ($p<0.05$). Predicted exercise outcomes strongly aligned with ground truth, achieving correlation scores of 0.99 for duration and 0.95 for repetition count across all subjects (Figure 1). CONCLUSIONS: The DL algorithm demonstrated reliable performance in estimating key exercise outcomes, offering a potential solution for unsupervised physical activity monitoring in residential care homes. These promising results highlight the need for future work involving more outcomes and larger samples. ACKNOWLEDGEMENTS AND FUNDING: The research was supported by the province Flemish Brabant as part of smart region project AI@WZC. BF was supported by the Data Sciences Institute at the University of Toronto Postdoctoral Fellowship grant DSI-PDFY3R1P13.

P02-C-26 - Identifying fall-risk factors related to aging using a custom virtual-reality sensory integration in balance assessment

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Introduction: Fall risk increases significantly with age and may begin well before the age of 65. Identifying the contributing factors that increase fall risk can be very difficult to pinpoint, but by evaluating the integration of visual, vestibular, and somatosensory integration during balance tasks may help identify underlying sensorimotor processing deficits that can contribute to fall-risk. One of the best predictors of fall-risk is if someone has fallen in the last year. The Sensory Organization Test (SOT) is also sensitive to the effects of aging on fall-risk, however, size and cost limits its accessibility. Previously, we showed our custom test using a virtual reality (VR) head-mounted display (HMD) can detect balance deficits in older adults as well as the SOT. The current study aimed to compare self-reported falls to objective VR-based measures of fall risk collected across a wide age-range from numerous sites.Methods: Data from healthy adults (n=1301) was collected at 15 clinics, universities, and retirement communities all connected to a HIPAA secure cloud-database. Deidentified data included age (18-98 y.o.), gender, falls in the last year, and results from a network connected VR Sensory Integration in Balance (VRSIB) test. VRSIB is performed by placing a HMD on the participants head and measuring head kinematics during eight static balance tests (Fig 1A). Sway area, normalized based on height and theoretical limits of stability, was used to calculate sensory ratios (Somatosensory, Visual, Vestibular, Sensory Weighting Preference, Visual-Vestibular Mismatch) to get scores between 0-100% (e.g. Somatosensory Ratio = EC Firm/EO Firm; Visual Ratio = EO Foam/EO Firm, etc.). Age-related fall-risk was evaluated using mixed-model repeated measures ANOVA (Age groups x Sensory Ratio) on VRSIB data. Results: Self-reported falls in the past year were 11.1% overall but was relatively consistent across age groups. VRSIB Sensory Ratios showed fall-risk factors significantly increase in every age group ($F_{1,6}$=25.1, p<0.001) with Vestibular and Visual-Vestibular Mismatch Ratio being most greatly affected ($F_{24,5172}$ = 12.8, p<0.001) and Somatosensory Ratio was not significantly affected until late in life.Conclusion: Most falls may be categorized as anticipated or preventable, so it's generally accepted if causes can be identified early, then the opportunity for effective intervention is significantly improved. Results collected from a wide age-range of generally healthy adults, revealed that self-report of falls may suffer from common problems related to subjective report such as faulty memory, unwillingness to disclose, and specificity. The VRSIB test, building on well-established principles of clinical posturography, can help identify fall-risk factors, even as early as middle-age. Its portability increases accessibility and reach, thus making it ideal for use in many settings, including remote or underserved regions.

P02-C-27 - Explainable AI reveals how deep learning classifies age-related gait patterns

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BACKGROUND AND AIM: Gait pattern classification is important for monitoring age-related and pathological changes in mobility, especially in geriatric populations. Advanced deep learning (DL) models, such as convolutional neural networks (CNN), have been employed to enhance the accuracy of gait classification. Although the mathematical principles behind DL are well-established, the inner decision-making process of models is often opaque. This "black-box" nature results in a lack of transparency and limits its clinical applications. Therefore, this study aimed to 1): use Explainable Artificial Intelligence (XAI), specifically SHapley Additive exPlanations (SHAP), to explain the classification process of CNN; 2) validate the robustness of the CNN model and XAI using cross-regional datasets.METHODS: Participants performed a 3-minute walk while wearing a 3D accelerometer (100 Hz) near the L3 lumbar vertebrae. Accelerometer data were segmented into single strides and interpolated to a fixed length of 128 samples for time normalization. To develop and evaluate the CNN model, a total of 267 healthy adults were recruited from the Netherlands (NL). They were divided into adults (aged 18-65, n=130) and older adults (aged >65, n=137) to train (n=213) and test (n=54) the CNN model. SHAP was employed to explain the CNN's classification by highlighting the importance of specific input signals. To evaluate robustness, gait data from 136 older adults in Hong Kong (HK) were collected with the same setup for sensor placement to validate the performance of CNN model and assess the consistency of XAI interpretations.RESULTS: The CNN model achieved a satisfactory accuracy of 81.4% on

NL test data and an accuracy of 78.7% on HK data. In both datasets, SHAP consistently highlighted the data from vertical walking directions, particularly emphasizing data around heel contact, spanning from the terminal swing to loading response phases (Figure 1). CONCLUSIONS: The classification performance highlights the robustness of the CNN model in age-related gait classification in cross-regional datasets collected in Europe and Asia. The consistent SHAP interpretations suggest similar gait patterns among the aging populations from different regions. These patterns were characterized by variations in acceleration and deceleration (from the terminal swing to loading response phases), which serve as key indicators of age-related gait different from the adults. By enhancing transparency, XAI tools such as SHAP may provide valuable insights into gait classification and have the potential to facilitate medical decision-making in managing age-related mobility challenges.

P02-C-28 - Effects of a multicomponent exercise program on mobility and frailty in older adults in care homes: A cluster randomized controlled trial

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BACKGROUND AND AIM: More than 50% of older adults in care homes have mobility issues and require assistance to perform activities of daily living (ADLs). Poor mobility is associated with frailty and falls. Previous research showed that over 20% of falls in care homes occurred during transferring due to poor trunk control. Meanwhile, over 33% of falls involved head impact despite the use of upper arm arresting. Hence, upper limb and core strengthening is essential for older adults to safely perform ADLs and prevent injury. However, most existing exercise programs focus on lower limb strength and are not designed to suit older adults with different functional capacities. This study aimed to examine the effects of a multicomponent exercise program, Mobility-Fit that we previously developed, on mobility and frailty in older adults in care homes. METHODS: We conducted a cluster randomized controlled trial where 148 participants were recruited from 20 care homes. They were randomly assigned into the intervention group or control group. Participants in the intervention group attended the Mobility-Fit program 3 times per week, 45 minutes per session, for a total of 12 weeks. The Mobility-Fit program targets functional mobility with multiple exercise components, including balance and core stability, coordination, agility, lower limb strength, wrist strength, and triceps strength. Participants in the control group maintained usual care. Outcome measures included upper and lower limb strength, postural sway, mobility assessed by SPPB, gait measured by GAITRite, cognitive function, frailty, and fall efficacy. Meanwhile, daily physical activity level and performance were measured by an IMU worn on the waist for consecutive five days. Data were analyzed following the “intention-to-treat” principle. Two-way mixed ANOVA and GEE models were used to compare changes in outcomes

between and within the two groups. RESULTS: The mean age of participants was 84.4±8.0 years. 60% were females. Among the intervention group, elbow extension strength increased by 18% ($p<0.001$), knee extension strength increased by 13% ($p=0.042$), reaction time decreased by 30% ($p=0.004$), and five-time sit-to-stand duration decreased by 16% ($p=0.029$). There were significant interactions between time and group in these variables ($p<0.05$). Conversely, participants in control group had a 6% decrease in handgrip strength ($p=0.043$) and higher fall efficacy score ($p=0.048$). All participants spent an averaged 11.8% of waking time in light physical activity and 3.3% in moderate-to-vigorous physical activity (MVPA). Participants in the intervention group showed an 26% increase in MVPA ($p=0.057$). No significant difference was found in cognitive performance and frailty. CONCLUSIONS: Our results suggest that multicomponent exercises are effective in enhancing strength and mobility among frail older adults. The Mobility-Fit program may suit older adults with different functional capacities in care homes.

P02-D-29 - The association between cerebral blood flow and standing dual task performance is dependent upon age group and cognitive load

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Background: Postural control, especially when standing and performing cognitive “dual tasks,” requires effective regulation of cerebral blood flow (CBF) to support functional neural activation within involved brain networks. Aging from adulthood into senescence diminishes dual task performance and CBF. However, it is unknown whether CBF obtained during dual task execution correlates with performance, or if age influences the nature of this relationship. Methods: Twenty-three relatively healthy younger (26 ± 3 years) and 24 older (76 ± 6 years) adults completed the n-back task of executive function (i.e., identify X [IdX] and 2-back) while standing. CBF of the middle cerebral artery was measured using transcranial Doppler ultrasound and postural control (i.e., elliptical area, range, and path length) was recorded using a wearable motion sensor. N-back task performance was reported as reaction time and accuracy. Results: During the IdX task, the relationship between CBF and postural control was dependent upon age ($p=0.03$). Younger adults with higher CBF exhibited shorter path length (better postural control) while older adults with higher CBF exhibited longer path length (worse postural control). Across both groups, those with greater CBF demonstrated faster IdX reaction time ($p=0.001$). During the higher demanding 2-back task, greater CBF was associated with longer path length irrespective of age group ($p=0.03$), yet faster 2-back reaction time in older adults only. Conclusion: These results indicate that dual task postural control is reliant on upon CBF, yet the nature of this relationship may be dependent upon both age and difficulty of the cognitive task. FUNDING: A.J.J. was supported by the National

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P02-D-30 - Behavioral and neural changes induced by a rehabilitation treatment using an instrumented crutch: A longitudinal fNIRS study

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Background and Aim: Rehabilitation is key to addressing the challenges of multiple sclerosis (MS), particularly in advanced stages when mobility deficits impact on quality of life. Innovative imaging techniques like functional Near Infrared Spectroscopy (fNIRS) provide valuable insights into cortical activity during movement. We aimed to evaluate the effects of a rehabilitation program based on gait training with an instrumented crutch in people with MS (EDSS=6) and to investigate cortical changes induced by the intervention with fNIRS.Methods: Twenty-two people with MS (15 F, age 58.5±9.8 y, disease duration 14.8±12.9 y) underwent a 20-session rehabilitation program focused on gait, balance, and proper use of assistive devices. The study group (FB_group, N=11) used a crutch providing real-time feedback based on user support load; the control group (NOFB_group, N=11) used a standard crutch. To assess the effects of rehabilitation with and without feedback, three evaluations were assessed: before the start of rehabilitation (T0), immediately after the program (T1) and two months after the last rehabilitation session (T2). Following rehabilitation, the FB_group continued to receive feedback from the instrumented crutch. Each assessment included Timed 25 Foot Walk test (T25FW), Timed Up and Go test (TUG) and fNIRS acquisitions to measure cortical activity during linear walking. The fNIRS montage covered prefrontal, sensorimotor, and associative parietal regions through 50 channels, which were then grouped in 28 Brodmann Areas (BA).Results: At baseline (T0), no significant differences were observed between groups across all variables. After rehabilitation (T1), the FB_group showed improved performance in both the T25FW and TUG tests. Also, fNIRS analysis revealed a significant increase in prefrontal areas activity (T1>T0). Two months post-rehabilitation (T2), the FB_group maintained the performance levels in the T25FW and TUG tests. Notably, prefrontal area activity showed further increase compared to the previous assessment (T2>T1). In contrast, the NF_group showed a different pattern after treatment. No improvement was observed in the TUG test, and performance at the T25FW test worsened. Significant differences in cortical activity were found between T0 and T1 in Left BA7 and Right BA44 (T1>T0). However, at T2 activity decreased in Left BA7 and increased in Central BA6.Conclusion: These results suggest that feedback-based rehabilitation leads to significant improvements in functional mobility, as shown by better performance post-intervention and the maintenance of these gains at follow-up. These improvements were accompanied by a progressively increased activity in prefrontal areas, which are

critical for cognitive processing during walking. In contrast, the lack of improvement in the NF_group coupled with declines in T25FW performance and distinct patterns of cortical activity highlights the differential impact of rehabilitation approaches.

P02-D-31 - Understanding walking fatigability in Multiple Sclerosis: Preliminary results of cortical brain activation and gait during 6 minutes of walking

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BACKGROUND AND AIMWalking fatigability (WF) is defined as a ≥-10% decrease in the distance walked (distance walked index-DWI) or ≥-12% in gait speed (GS_ind) ([minute 6 – minute 1/minute 1 * 100]; 6-minute walking test- 6MWT). WF affect up to 73% of people with multiple sclerosis (pwMS) and worsens in magnitude when disability accumulates. MS-related symptoms and lower muscle strength in the lower limbs have been linked to WF in pwMS. Another potential cause is a lower neural capacity or loss of attention. Previous research on fatigability demonstrated that pwMS struggle to sustain optimal levels of cortical activation to maintain motor performance. This study investigated whether the DWI and GS_ind presented by pwMS and healthy controls (HC) correlate to cortical brain activation in attentional, planning and motor areas. METHODSFifteen pwMS (Expanded disability status scale 3.2±2, 49±11 years) and 14 HC (45±10 years) performed the 6MWT while wearing inertial measurement units to assess gait speed and a functional near-infrared spectroscopy (fNIRS, 16x16 configuration). The fNIRS covered the right/left hemispheres of the prefrontal cortex (frontopolar and dorsolateral prefrontal cortex-DLPFC), supplementary motor area-SMA, premotor cortex-PMC and primary motor cortex. A 20-second baseline period, recorded before the 6MWT, was used for the fNIRS calculations. The relative changes in oxyhemoglobin (ΔHbO) and deoxyhemoglobin (ΔHbb) were calculated from the 6MWT to the baseline period. The ΔHbO, ΔHbb, distance walked, and the gait speed were divided per minute, and the DWI and GS_ind were calculated. Spearman rank correlations were performed between the ΔHbO and ΔHbb (frontopolar, DLPFC, SMA, PMC and M1) in minute 6 with the DWI and GS_ind. RESULTSThe HC presented significant correlations between the DWI (-3.2±3.5%) and right and bilateral SMA (ΔHbO, rho = 0.558 and rho = 0.626, respectively) and between the GS_ind (-2.9±2.9%) with the right (ΔHbO, rho = 0.621) and left (ΔHbO, rho = 0.573) SMA cortex. Significant correlations were observed for the pwMS group in the GS_ind (-6.9±6.6%) in the right frontopolar (ΔHbb, rho = -0.666) and bilateral DLPFC (ΔHbb, rho = -0.578). PwMS showed a DWI of -7.8±12.6%.CONCLUSIONSThe differential results of healthy controls with pwMS assist in understanding cortical mechanisms underlying WF in pwMS. While pwMS seems to rely more on attention regions (frontopolar, DLPFC) to modulate gait speed at the end of the 6MWT. At the same time, HC does not need to recruit attentional regions and relies more on regions connected closely with the basal ganglia (SMA cortex) involved in gait automaticity. The results suggest that those with lower cortical activity at minute 6 might have a loss of attention (pwMS) or lower neural resources (pwMS and HC) to preserve DWI and GS_ind. This supports the hypothesis that WF may result from insufficient neural resources to sustain performance during the 6MWT. ACKNOWLEDGEMENTS AND FUNDINGThis study was supported by Research Foundation – Flanders (#11O5823N) and Bijzonder onderzoeksfonds UHasselt (#BOF22INCENT16).

P02-D-32 - Distinct neural correlates of forward and backward walking in Multiple Sclerosis

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Background and Aim: Multiple sclerosis (MS) is marked by axonal demyelination that may lead to motor impairments and increased fall risk. While forward walking (FW) is often used to assess fall risk in MS, backward walking (BW) offers greater sensitivity in distinguishing fallers from non-fallers due to its higher postural and cognitive demands. Despite evidence linking myelin damage to fall risk, the relationship between myelin content and BW performance remains underexplored. Identifying tract-specific associations to BW deficits is vital for understanding the neurological mechanisms driving mobility challenges in MS. Therefore, the objective of this study was to explore how myelin content in key motor tracts relates to BW performance in MS.Methods: This study enrolled 43 individuals with relapsing-remitting MS (aged 18–65, Patient Determined Disease Steps [PDDS] < 6), excluding those with relapses within 3 months. Participants completed FW and BW assessments on a 25-foot walkway to measure gait velocities. Myelin water imaging (MWI) data was acquired at 3T, and the outcome measurements included myelin water fraction (MWF) values from four critical neural regions: the body of the corpus callosum (CCbody), superior cerebellar peduncles (SCP), inferior cerebellar peduncles (ICP), and corticospinal tracts (CST). A multivariate regression model analyzed these regional MWF values as predictors of BW and FW performance, with age and PDDS as covariates.Results: In the SCP, there was a significant positive association between MWF and BW velocity ($\beta = 0.414$, $p = 0.026$), while MWF of other tracts, including the CCbody ($\beta = 0.220$, $p = 0.094$), CST($\beta = -0.036$, $p = 0.821$), and ICP ($\beta = -0.218$, $p = 0.284$), were not significant. This model explained 55.3% of the variance in BW velocity. For FW velocity, MWF of the CCbody was a significant predictor ($\beta = 0.294$, $p = 0.030$), while MWF of the SCP ($\beta = 0.232$, $p = 0.208$), CST ($\beta = -0.008$, $p = 0.960$), and ICP ($\beta = -0.102$, $p = 0.617$) were not significant. This model explained 54.1% of the variance in FW velocity. In both models, greater disease severity (PDDS) was a significant covariate, consistently associated with slower walking performance (BW: $\beta = -0.550$, $p < 0.001$; FW: $\beta = -0.563$, $p < 0.001$).Conclusions: These

findings suggest that BW and FW rely on distinct neural networks, with the SCP predicting BW velocity and the CCbody predicting FW velocity. Identifying these neural correlates may guide targeted rehabilitation strategies to enhance mobility and fall risk prediction in MS. By identifying neural correlates of BW performance, this research aims to inform targeted rehabilitation strategies to improve mobility and fall risk prediction in MS.Acknowledgments and Funding: This work was funded by the NIH (R21HD106133) and the National Multiple Sclerosis Society (MB-2107-38295).

P02-E-33 - Objective measure of balance and fall risk in people with Parkinson's disease: Impact of cognitive impairment

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Background and Aims: Falls in people with Parkinson's disease (PwPD) are multifactorial, including impairments in both balance and cognition. Balance is composed of several different aspects such as static and dynamic balance, sensory integration, reactive balance, sit-to-stand ability, limits of stability, gait speed, as well history of previous falls. However, objective measures of fall risk in PD involving all these factors are lacking. A novel posturography system, called hunova, is integrating all these factors into a composite score, validated for fall risk in older adults (Silver Index). Although cognition is known to affect balance, the impact of cognitive impairment on the Silver Index and specific domains of postural control is unknown. We hypothesize that the Silver Index and objective dynamic balance measurement would be worse in PwPD with cognitive impairment than in those without measurable cognitive impairment. Methods: 68 PwPD were separated into 2 groups based on their Montreal Cognitive Assessment (MoCA) scores: mild cognitive impairment (MCI ≤ 25 points on MoCA; n=24, age= 70.5 years, MDS-UPDRS-III= 40.4 score) and non-MCI (> 25 points on MoCA; n=44, age= 67.8 years, MDS-UPDRS-III= 31.6 score). Both groups performed the tests (On medication) with the hunova platform (Movendo Technology, Genoa, Italy) to measure their Silver Index (0-25%= low fall risk, 26-50%= medium-low fall risk, 51-75%= medium-high fall risk, and 75-100% = high fall risk) and the subscores (static and dynamic balance, sensory integration, reactive balance, sit-to-stand, limits of stability, and gait speed). The number of falls in the last 12 months, age, FOG score, and disease severity were used as covariates in ANCOVA analyses. Benjamini-Hochberg false discovery rate correction and Multiple regression analyses were used. Results: PwPD who have MCI show worse fall risk objectively measured by the Silver Index (52.9[28.2] versus 36.1[22.6]), worse dynamic balance (-0.5[1.4] versus 0.2[0.8]), and limits of stability (0.0[0.5] versus 0.4[0.6]) compared with those without MCI (p-corrected <0.05). Correlational analyses, including both groups, showed that lower MoCA scores were associated with higher Silver Index (r= -0.40, p=0.003), worse dynamic balance (r= 0.35, p=0.001), and higher disease duration

(r= 0.39, p=0.001), age (r= -0.31, p=0.011), and number of falls (r= -0.46, p=0.006). Multiple regression analysis showed that only the Silver Index explained the MoCA variance (39% p=0.001). Conclusions: Fall risk objectively measured by the Silver Index is associated with cognitive impairment in PwPD. These results indicate the feasibility of using hunova, a novel posturography system, to potentially quantify the risk of falls in PwPD taking into consideration their cognitive status. Acknowledgments and Funding: This study is funded by the NIH (R01 HD100383; UL1TR002369).

P02-E-34 - The role of motor reserve in dual-task gait and responsivity to multi-domain interventions for mild cognitive impairment– results from the synergic and compass-nd studies

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Background. Motor deficits have been found to be important markers of Mild Cognitive Impairment (MCI), a pre-dementia risk state, as they may precede a cognitive impairment1. Recently, aerobic exercise (AE) and cognitive training (CT) interventions were shown to significantly improve cognitive and motor function in older adults with MCI2,3.Regarding risk, it has been found that nearly 50% of dementia cases could be mitigated by the elimination of 12 modifiable risk factors, such as low education and physical inactivity, as early as midlife4. Motor reserve (MR) has been characterized as the compensation for cognitive loss and preservation of motor ability through lifelong physical activity5,6. Our objectives are (1) to examine life historical profiles that contribute to MR, which are ordinarily eliminated in RCTs, (2), to examine if MR predicts better mobility at baseline, and (3) to test whether MR affects responsivity to interventions for MCI. Using risk profiles may be effective for designing personalized interventions and lifelong preventative care to maximize the benefit to motor ability. Method. Data were drawn from participants co-enrolled in two studies under the Canadian Consortium on Neurodegeneration and Aging (CCNA) (n=91)7,8. Participants were older adults with MCI, who were randomized to intervention arms: CT +AE, AE only, and sham control arm. Participants were given baseline, immediate post-intervention, and follow-up assessments of mobility (simple gait and cognitive-motor dual tasking). They also provided historical data on lifestyle and physical activity in young, middle, and older adulthood, which are considered factors of MR. Analysis. First, we ran an exploratory factor analysis (EFA) of the relevant life history variables to calculate a weighted MR factor. Second, we ran linear regressions to assess the relationship between accumulated MR and motor ability at baseline. Third, we will use structural equation modelling (SEM) to examine if MR influences responsivity to the intervention arms using residualized change scores from pre- and post-intervention scores. Results. A larger sample of older adults with MCI (n=159) showed a distinct motor factor made up of lifelong moderate exercise and social engagement. The regression analysis revealed that MR was trending to be associated with greater baseline dual-task gait velocity (b=6.38, p=0.076). MR was also trending to predict a lower dual-task gait cost (b=-3.50, p=0.073). MR did not significantly predict single-task gait velocity. Conclusions. MR marginally predicted dual-task gait velocity and gait cost. SEM will reveal whether MR may be more impactful on responsivity to intervention than baseline dual-task gait performance. This far, we conclude that dual-task gait may be more sensitive in detecting the benefits accumulated from MR than simple gait. The completed analysis will illuminate the distinct benefits of MR on motor ability and the impact it may have on intervention efficacy.

P02-E-35 - Dual-task-TUG sensor metrics are related to incident Alzheimer's disease dementia and cognitive decline: A prospective study in older adults

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Background and Aim: The Timed Up and Go (TUG) is a common test of mobility and predicts falls. Growing evidence has reported an association of TUG testing with cognitive function. Cross-sectional studies suggest that the dual-task version, TUG-Cog, may enhance this sensitivity. Building on previous cross-sectional findings, the present study examined if sensor-derived TUG-Cog metrics can predict: (1) incident MCI, 2) incident Alzheimer's Disease Dementia (ADD) and (3) the rate of cognitive decline in older adults.Methods: 1,304 dementia-free older adults completed in-home TUG testing with a belt-worn, lower-back sensor (3D accelerometer+3D gyroscope). The cognitive task for the TUG-cog was the serial seven subtraction task. We extracted and summarized 11 validated TUG metrics from these recordings (A Buchman et al, 2014). 17 cognitive tests were summarized as a global cognitive score. Cox proportional hazard models were used to examine the association of TUG sensor metrics with incident MCI and ADD. Linear mixed effect models were used to identify the association of TUG sensor metrics with the level and rate of change in cognitive decline. All models were adjusted for demographic factors. Results: Increasing age and TUG-Cog pace emerged as the strongest predictors of incident ADD. A faster walking pace in TUG-Cog was associated with a 44% reduced risk of ADD. Age, sex, duration of the second turn in the TUG, stand-up duration and walking pace in TUG-Cog were related to incident MCI. A faster pace in TUG-Cog was related to a 32% reduced risk of developing MCI. Greater step-to-step regularity [(Lag*regularity, EST -.0004 S.E. 0.004, p=0.924)] and faster pace [Lag*pace, EST (0.021 S.E. 0.007, p=0.003)] were associated with a slower decline in global cognitive scores. In models that included measures derived from both the TUG and the TUG-Cog, only measures from the TUG-Cog remained as independent predictors. Exploratory analyses found that an increase in postural sway magnitude was associated with a 17% higher risk of developing ADD and a 20% higher risk for MCI, possibly indicating issues with balance as early signs of neurodegeneration.Conclusions: A parsimonious set of lower-back sensor-derived TUG-Cog metrics, particularly walking pace and gait regularity, predict

the risk of incident MCI and ADD dementia. Divided attention due to dual-task TUG testing may reveal incipient cognitive impairment. These findings highlight the potential of gait biomarkers for the early identification of impaired cognition in aging adults and support the continued development of wearable-based tools for monitoring cognition in aging populations.

P02-E-36 - Compromised COM-COP control in patients with MCI during obstacle crossing: Implications for fall risk and early detection

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BACKGROUND AND AIMMild cognitive impairment (MCI), characterized primarily by memory loss, represents an intermediate stage between normal aging and dementia. Cognitive decline in MCI often extends beyond memory, impairing executive function, attention, and motor coordination, key elements for maintaining balancea nd safe mobility [1]. Biomechanical methods employed during obstacle-crossing, including toe-obstacle clearances and the kinematic strategies using pelvis-leg apparatus, are critical for identifying fall-related risk factors [2]. The purpose of the study was to quantify whole-body balance control in older adults with MCI during obstacle crossing compared to healthy controls. METHODSEighteen patients with MCI (MCI group; male/female: 8/10; age: 67.5±4.2 years; height: 161.4±7.6 cm; mass: 63.5±13.2 kg) and 18 healthy adults (Control group; male/female: 10/8; age: 67.8±4.5 years; height: 156.7±6.7 cm; mass: 57.9±11.4 kg) participated in the study. Each subject walked at their preferred speed and crossed a height-adjustable obstacle set at 10%, 20% and 30% of their leg length. Thirty-nine infrared retro-reflected markers were placed on anatomical landmarks to track the motion of the segments [2], measured using an 8-camera motion analysis system (Vicon MX T-40, OMG, UK) while the ground reaction forces (GRF) were simultaneously measured using three forceplates (OR-6-7, AMTI, USA). The body's centre of mass (COM) position was calculated as the weighted sum of the body-segmental COM positions using the marker data and segmental inertial properties, while the centre of pressure (COP) position was calculated using forces and moments measured from the forceplates. The COM-COP inclination angles (IA) and rate of change of IA (RCIA) in both the sagittal plane and frontal planes [3]. Crossing speed, spatiotemporal and endpoint parameters, and IA and RCIA were extracted for subsequent statistical analyses. A two-way mixed-design analysis of variance (ANOVA) was performed to analyse the effects of between-subjects and within-subjects (obstacle height) on all calculated variables. RESULTSNo interactions between the group and height factors existed for any of the variables. During obstacle-crossing, there were no significant between-group differences in spatio-temporal parameters and end-point variables. In the sagittal plane, patients exhibited increased posterior IA during double limb support (DLS) and when the trailing limb's toe crossed the obstacle, along with increased posterior RCIA during DLS and anterior RCIA at various phases, including trailing limb crossing, toe-off, leading limb crossing, and trailing toe-off, compared to the Control group (Figure 1). In the frontal plane, patients showed greater IA magnitudes during trailing limb crossing, toe-off, leading limb crossing, and heel-strike, as well as increased RCIA magnitudes and ranges during DLS (Figure 2). CONCLUSIONSThe current study aimed to investigate the whole-body balance control, in terms of COM–COP IA and RCIA in patients with MCI when crossing obstacles of three different heights. Compared to healthy controls, the MCI group exhibited compromised body balance control, especially during weight transfer. Such specific balance control strategies enabled the MCI group to maintain leading and trailing toe-obstacle clearances comparable to those of healthy peers. The current results suggest that patients with MCI adopt compensatory strategies to manage obstacle crossing, but this comes at the cost of compromised COM–COP control, which may contribute to their increased fall risk, as reported in the literature [3]. Assessing whole-body balance control strategies may help the early detection of compromised obstacle-crossing abilities in MCI. Further studies may explore the effects of cognitive-motor dual-task on balance control strategies in this population to provide a more comprehensive understanding. ACKNOWLEDGEMENTS AND FUNDINGSFinancial support: NSTC 113-2628-E-038-001-MY3 REFERENCES[1] Fuentes-Abolafio, I.J. et al. Age and Ageing 50(2): 380-393, 2021.[2] Lu, S.H. et al. Frontiers in Aging Neuroscience 14: 950411, 2022.[3] Huang, S.C. et al. Medical engineering & physics 30(8): 968-975, 2008.[4] Montero-Odasso, M. et al. Archives of physical medicine and rehabilitation 93(2): 293-299, 2012.

P02-F-37 - Effects of attentional engagement on vestibular perception and processing

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Background and AimFunctional dizziness disorders are characterised by perceived self-motion and unsteadiness in the absence of any objective postural instability. Conscious attention towards self-motion (‘postural hypervigilance’) has been proposed to underpin the maintenance and development of such disorders. Yet, the underlying neural mechanisms through which conscious attention alters the processing of self-motion remains unknown. This study tested the hypothesis that attention towards self-motion enhances the cortical processing of weak sensory input that would otherwise not reach the level of the cortex.Methods22 healthy participants underwent weak, threshold-level self-motion stimulation (seated yaw-plane rotations in a dark room) whilst EEG was recorded. Rotations were delivered during conditions where conscious attention was directed towards or away from self-motion. In the Vigilant condition, participants were instructed to pay close attention to self-motion and report the direction in which they were rotating after each trial. In contrast, no questions were asked about self-motion during the Passive condition, and they were free to attend to whatever they wished. ResultsParticipants reported directing significantly greater attention towards self-motion during the Vigilant condition ($p<.001$), confirming the effectiveness of the manipulation. Despite the self-motion stimulation being identical across conditions, participants rated rotations as feeling significantly more intense during the Vigilant condition ($p=.001$). Supporting our hypothesis, attentional engagement enhanced the cortical processing of self-motion, represented by significantly greater alpha suppression in the parietal cortex during rotations in the Vigilant condition ($p<0.05$, cluster-corrected). Although alpha suppression occurred throughout the Vigilant condition, this was strongest during trials in which participants correctly perceived the rotation direction (compared to trials with incorrect or missed perception; $p<0.05$, cluster-corrected). ConclusionsThese findings reveal that conscious attention towards self-motion enhances the cortical processing of minor self-motion, leading to enhanced perception of stimulus intensity. They also identify parietal cortex alpha suppression as a crucial neural marker of self-motion perception – one that can be enhanced via top-down attentional processes.

P02-F-38 - Associations between regional brain volumes and dual decline in gait speed and memory

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BACKGOUND AND AIM: Dual decline in gait and cognition is associated with an increased risk of dementia, with the strongest association seen between gait speed and delayed memory. However, the underlying brain correlates remain unknown. This study aimed to explore the associations between regional brain volumes and dual decline in gait speed and delayed memory.METHODS: Participants over 60 years were randomly selected from the Southern Tasmanian electoral roll (Australia). Baseline brain MRI and three serial gait speed and delayed memory assessments were performed on average 2.5 years apart. Participants were classified into four groups depending on tertiles of annual decline in gait speed and memory: non-decliners, gait only, cognition only, and dual decliners. Twenty-one regional brain volumes (in frontal, parietal, temporal, subcortical, brain stem and cerebellar areas) were preselected based on previous studies. Multinomial logistic regression was used to examine the associations between baseline regional brain volumes and the four groups. RESULTS: The mean age of participants was 70.9 ± SD 6.7 years (n=266). Lower baseline volume in six regions (superior frontal gyrus, anterior cingulate cortex, middle frontal gyrus, thalamus, orbitofrontal cortex, hippocampus) were associated with a higher risk of dual decline. Lower volumes in the thalamus and cerebellum were associated with a higher risk of gait only and cognitive only decliners respectively. CONCLUSIONS: Regions related to memory, executive function, motor, and sensory motor integration were associated with dual decliners. A higher number of baseline regional brain volumes were associated with the dual decline compared to gait only and memory only decline groups, suggesting that the dual decline

in gait and memory is capturing a broader range of brain regions than decline in either gait or memory alone.ACKNOWLEDGEMENTS AND FUNDING: Nil

P02-F-39 - Effects of a training program for older adults based on simultaneous challenging dynamic balance and cognitive tasks

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Background: Older adults experience age-related declines in balance and cognitive functions, increasing their susceptibility to falls. Dual-task training, which simultaneously engages the balance and cognitive domains, presents a promising strategy to mitigate these declines. This study evaluated the efficacy of a novel intervention, a dual-task training program that combined challenging dynamic balance exercises in unipedal stance with concurrent cognitive tasks, on improving balance and cognitive performance in older adults. Methods: Sixty-four participants were randomly allocated to either a dual-task (DUAL; n=35, 4 male) or a single-task (SING; n=29, 2 male) training group. Both groups participated in a 12-week training program, consisting of two 1-hour sessions per week. The SING group performed dynamic balance exercises in unipedal stance, associated with coordinated movements of the arms and free leg. The DUAL group performed the same balance/coordination tasks while simultaneously engaging in cognitive tasks, including: recalling movement sequences (about 6 items), counting movement repetitions by performing numerical calculations (multiplication, addition, subtraction), switching counting between different languages, and generating alphanumeric sequences (e.g., 1-A-2-B), and dividing attention between the motor and cognitive tasks. Outcomes were assessed before, immediately after, and in a 30-day follow-up through: (a) the Rey Auditory Verbal Learning Test, (b) the number of correct mental operations performed during dynamic balance, and (c) dynamic balance stability measured on an oscillating support base.Results: Analysis of short-term memory revealed higher scores in the post-test ($\Delta = 4.91$ words, SE = 1.12, $p < 0.001$) and retention ($\Delta = 8.50$ words, SE = 1.12, $p < 0.001$) compared to the pre-test, and higher scores in retention than in the post-test ($\Delta = 3.58$ words, SE = 1.12, $p = 0.006$). For correct responses in the cognitive-motor dual-task subtraction, we found higher values in the post-test ($\Delta = 2.03$, SE = 0.40, $p < 0.001$) and retention ($\Delta = 2.67$, SE = 0.40, $p < 0.001$) compared to the pre-test. Analysis of dynamic balance showed the reduced center of pressured RMS values in the AP direction in the post-test ($\Delta = 7.06$ mm, SE = 2.51, $p = 0.02$) and retention ($\Delta = 6.72$ mm, SE = 2.51, $p = 0.03$) compared to the pre-test. For the ML direction, results indicated an interaction: the DUAL group had lower values in the post-test ($\Delta = 7.00$ mm, SE = 1.99, $p = 0.011$) and retention ($\Delta = 8.81$ mm, SE = 1.99, $p < 0.001$) compared to the pre-test, while no significant differences were found for the SING group. Conclusion: Cognitive and balance improvements were observed in both the SING and DUAL groups. Notably, only the DUAL group showed a reduction in mediolateral balance sway. This suggests that high-demand balance training elicits similar cognitive

gains to dual-task training, with dual-task training providing additional benefits to ML balance control.

P02-F-40 - Daily life postural transition kinematics in neurodegenerative and immune-mediated inflammatory disease from a lower back-worn inertial measurement unit

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Background and AimFatigue, characterized by a lack of energy or tiredness, is prevalent in conditions such as Huntington's disease (HD), Parkinson's disease (PD), inflammatory bowel disease (IBD), primary Sjögren's syndrome (PSS), rheumatoid arthritis (RA), and systemic lupus erythematosus (SLE). Fatigue has physical and mental dimensions: physical fatigue interferes daily activities, while mental fatigue reduces cognitive efficiency. Its clinical assessment relies on patient-reported outcomes (PROs), which are subjective, prone to recall bias and which fail to capture variability over time. Advances in wearable technology, such as inertial measurement units (IMUs), enable objective, continuous monitoring of fatigue. Postural transitions (PTs) – sit-to-stand (SiSt) and stand-to-sit (StSi) – are mechanically demanding, frequently performed activities essential for daily functioning. This study aimed to quantify associations between IMU-based kinematic features of PTs and physical/mental fatigue.MethodsParticipants included individuals with HD, PD, IBD, PSS, RA and SLE, as well as healthy controls. Four times daily, participants reported physical and mental fatigue on a 7-point Likert scale while wearing a lower back IMU. PTs were detected using a validated algorithm, and kinematic features – PT duration (s), the trunk angular range (°), peak trunk angular velocity (°/s), peak vertical velocity (m/s), peak vertical acceleration (m/s2), peak vertical jerk (m/s3), and peak PT power (m2/s3) – were extracted. Features were aggregated as median mean, 5th and 95th percentiles over 2-hour windows centred around PRO prompts. Mixed-effects models assessed associations between kinematic features and fatigue.ResultsFor SiSt transitions, the 95th percentile of peak trunk angular velocity was significantly associated with physical fatigue, and the 95th percentile of trunk angular range was associated with mental fatigue (Fig 1).For StSi transitions, physical fatigue showed significant associations with the 95th percentile PT duration and 5th percentiles of peak trunk angular velocity, jerk, and angular range (Fig 1).ConclusionsIn participants with and without diverse fatigue-associated diseases, significant associations between PT and fatigue in the usual environment were primarily observed at the upper and lower performance extremes rather than median kinematic features. More associations were identified for StSi than SiSt transitions and for physical fatigue compared to mental

fatigue. These findings highlight the potential of wearable-based PT assessments for objective, at-home monitoring of fatigue, supporting the development of surrogate clinical endpoints for non-motor conditions.

P02-F-41 - Effects of postural threat and attentional interference on postural sway in older adults

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BACKGROUND AND AIMPostural balance is crucial for fall prevention in older adults, influenced by factors such as postural threats and attentional interference. Recent research indicates that the postural sway complexity during quiet standing can be affected by these factors, which are interpreted through both cognitive and affective factors (e.g., Stins et al., 2011). However, the mechanisms underlying these interactions remain unclear. This study aims to investigate how postural threat and attentional interference impact the variability and complexity of postural sway by incorporating cognitive tasks while standing at different heights.METHODSFifty older adults performed single and dual task conditions (cognitive factors, simple reaction time task) at two heights: floor (Low) and platform (High) (affective factors). Participants maintained a 35-second quiet standing position. Center of pressure (COP) trajectories were measured using a stabilometer. Standard deviation (SD) of the COP trajectory was calculated to assess variability, while sample entropy (SEn) was estimated to evaluate complexity in the mediolateral (ML) and anteroposterior (AP) directions.RESULTSIn the AP direction, significant main effects for both height and task on SD were observed, with no significant interaction. Post-hoc tests revealed smaller SD in the high condition compared to the low condition, and in the dual task condition compared to the single-task condition. For SEn, there was a significant main effect of height, while the main effect of task and the interaction were not significant. Post-hoc tests showed that SEn was significantly larger in the high condition compared to the low condition.The reduced postural variability in the high condition suggests participants minimized fall risk by decreasing variability (Adkin et al., 2018). Similarly, the dual-task condition showed reduced postural variability, consistent with findings that cognitive tasks lead to postural automaticity (Salihu et al., 2022).Regarding postural complexity, this study suggests that complexity is influenced solely by postural threat, not attentional interference, under these experimental conditions. These findings contrast with Ellmers et al.'s (2021) study, which found no significant differences in postural variability due to height or task but reported increased complexity with standing at heights and dual-tasking. The discrepancy may stem from differences in task type and difficulty level. CONCLUSIONSThis study suggests that postural variability and complexity are differently influenced by affective and cognitive factors and dual-task types, highlighting the importance of using both linear and nonlinear methods to provide complementary insights. The findings

emphasize considering task types and difficulty level when examining postural control. Further research is needed to better understand affective and cognitive factors' impacts on older adults' postural control.

P02-F-42 - Understanding balance control in response to gait pertubations in adutls with attention deficit hyperactivity disorder (ADHD)

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Background and Aim: Previous balance studies have found that children with attention deficit hyperactivity disorder (ADHD) exhibit greater variability in baseline gait parameters [1]. Both adults and children with ADHD also exhibit greater postural instability, and deficits in balance responses to perturbations [2][3]. There are no studies on balance during gait in adults with ADHD, despite the greater instability involved in walking. The aim was to investigate differences in balance responses in adults with and without ADHD after unexpected perturbations during gait. It was hypothesized that adults with ADHD will be more unstable and have longer onset latencies and greater muscle activation in comparison to control/non-ADHD after perturbations. Methods: 22 participants (12 ADHD, 10 control), age 18-35, walked across an 8-meter walkway for 24 walking trials. 12 trials contained unexpected uneven walking surface perturbations in 1 of 4 directions (medial, lateral, anterior, posterior). The other 12 trials included no perturbations/random perturbations and were interspersed to ensure unpredictability. Stability was measured using OptoTrak Motion Capture (Northern Digital Inc., Canada) for center of mass (COM) and lateral base of support (BOS). Force plate data (AMTI, Waterdown, MA) was used for center of pressure (COP). Surface electromyography (EMG) was taken for four muscles of each leg using the Ultium EMG system (Noraxon, Inc, USA). The Adult ADHD Self Report Scale (ASRSv1.1) was also used to record ADHD symptom severity to assess if symptoms had a correlation with stability measures. Results: The ADHD group had a significantly higher COM-COP separation maximum (max) in the anteroposterior direction (AP), a lower COM-BOS minimum (min) and a higher COM-BOS range in comparison to controls. COM-BOS was negatively correlated with ASRSv1.1 scores. No muscle response differences were seen.Conclusions: These results indicate adults with ADHD exhibit greater instability when responding to gait perturbations, as an overall lower COM-BOS minimum increases the likelihood of crossing stability limits. The correlation showed that more severe ADHD symptoms may be related to greater instability. In conclusion, this study demonstrates that ADHD is associated with balance control deficits in adults and provides insight on specific differences in stability during walking perturbations. References:[1] Simmons RW, Taggart TC, Thomas JD, Mattson SN, Riley EP (2020) Gait control in children with attention-deficit/hyperactivity disorder, Hum Mov Sci (70); 102584.[2] Jansen I, Philipsen A, Dalin D, Wiesmeier IK, Maurer C. (2019) Postural instability in adult ADHD - A pilot study. Gait Posture (67); p. 284-289.[3] Kooistra L, Ramage B, Crawford S, Wormsbecker S, Gibbard B, Kaplan BJ, et al. (2009). Can attention deficit hyperactivity disorder and fetal alcohol spectrum disorder be differentiated by motor and balance deficits? Hum Mov Sci. 28(4); p. 529-542.

P02-F-43 - Chronic neck pain is associated with worse gait health: Cross-sectional observations

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Background and Aim: Chronic musculoskeletal pain negatively impacts gait health, but the impact of neck pain on gait remains unclear. This study aimed to assess key measures of gait health in individuals with chronic neck pain (CNP) compared to non-CNP controls across various walking conditions. Methods: Sixty participants with CNP and 41 controls were recruited. Pain, disability, general health, and gait were measured. Gait outcomes included gait speed, stride time variability (STV), and a multi-component gait variability index (GVI) across four different walking conditions: quiet walk, cognitive task (i.e., serial sevens test), horizontal head turning, and vertical head turning. Linear regression models were used to obtain adjusted group means, difference of means, and 95% confidence intervals for gait outcomes. Exploratory analyses assessed the relationship between CNP intensity and gait across conditions. All models adjusted for age and sex. Results: The CNP group (median age: 36.5y, 75% female) reported more pain, disability, pain medication use, and multisite pain ($p<0.001$) than controls (median age: 32y, 61% female). CNP participants exhibited slower gait speed (mean difference -7.0 cm/s; 95% CI: -15.0 to 0.10), greater STV (mean difference 0.43 %CV; 95% CI: 0.05 to 0.89), and higher GVI (mean difference 4.16; 95% CI: 0.03 to 8.46). While the negative effects of pain were present across walking conditions, the magnitude varied depending on the task and outcome measure. Conclusion: CNP was associated with reduced gait speed and increased variability of walking patterns. Slight variations under different dual-task conditions suggest potential relationships between pain, mobility, and cognitive-motor coordination.

P02-G-44 - High-demand cognitive-locomotor dual tasking interferes with locomotion as reflected in gait kinematics: A virtual reality study

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Background and aim: Independent and purposeful locomotion requires the ability to efficiently fulfill individual motor goals while adapting to environmental constraints, leading to almost continuous concurrent cognitive processing during walking. As the attentional resources of an individual are assumed to be limited, every type of dual task (DT) triggers some level of competition between independent performances.

Investigations into the attentional control during walking is not unprecedented, but studies that inspect the synergy of cognitive and motor skills in simulated naturalistic environments are sparse. Here we use a unique mobile activity paradigm introducing validated neurocognitive evaluation during virtual immersive scenarios which require complex multi-motor skills such as walking, visual searching, and gross manual movements. Specifically, we used a virtual reality (VR) version of the Color Trails Test (VR-CTT), which is designed to assess sustained visual attention (SVA) and divided attention (DA), to investigate cognitive-induced modulations in gait kinematics. Methods: Twenty-seven young healthy participants completed the VR-CTT in a fully immersive large scale VR system containing a self-paced treadmill while kinetic and kinematic data of their walking was recorded. Effect of different cognitive loads (baseline – no load (BL), SVA, DA) on gait parameters (gait speed, step length, cadence, phase coordination index, composite score of gait speed variability) were studied. Results: We found gait less coordinated and gait speed more variable, as the level of concurrent cognitive load increased (BL<SVA<DA; see Fig 1). Additionally, we found that the interference index (measured in the normalized difference between performance of the DA versus SVA tasks) of the cognitive load (in terms of completion time) is positively correlated with the interference indices of gait speed, cadence and step length (the latter is shorter in DA compared to SVA). Conclusion: The need to allocate attentional resources to a more demanding cognitive-locomotor dual task, increasingly interferes with the execution of purposeful locomotion as measured in gait kinematics. Its impact is proportional to the additional time required to complete the more demanding cognitive task (DA).

P02-G-45 - Difference in gait termination of healthy young adults and elderly

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BACKGROUND AND AIM: Gait analysis is often based on steady-state gait. Only a few studies have investigated gait termination (GT). GT is a transitional task between the steady-state gait and the static stance, which requires an advanced balance function. Balance is maintained by multiple components, and they are well coordinated during the stopping motion. Since it is known that the lack of balance affects GT, understanding how people terminate gait would be the key to assessing an individual's balance function much deeper. Since the internal forces generated during GT would affect balance, examining the relationship with postural response to external disturbances can help understand balance during GT. Therefore, the purpose of this study was to compare balance after GT and postural response to external disturbances between healthy young and older adults to describe how they terminate gait.METHOD: Eighteen healthy adults (9 younger, 9 older) participated in this study. Participants were asked to walk on a 7m straight walkway at their comfortable pace, and then to stop on the force plate at the end with their feet together. After stopping, they kept a quiet stance on the force plate for 10 seconds. The route means square, and mean velocity of the center of pressure (COP) were calculated during the 10 seconds after stopping walking (RMS, COP velocity). In addition, they performed a push and release test (PRT) for forward and backward. Three accelerometers were attached to the participants' pelvis and both feet to calculate the time to stabilize during PRT (TTS forward, TTS backward). We used the independent t-test to detect the possible differences in both COP and PRT parameters among younger and older adults. Spearman's rank correlation coefficient was used to investigate the relationship between COP and PRT parameters.RESULTS: COP velocity was significantly larger in the elderly group. In addition, both TTS forward and TTS backward were significantly longer in the elderly group. However, no significant difference was found for RMS. Furthermore, both TTS were significantly correlated to COP velocity (forward: rho = 0.589; backward: rho = 0,587). CONCLUSIONS: Elderly people required a longer time to stabilize their posture after an external disturbance and showed higher COP velocity for stabilizing their posture after terminating their gait. While the COP moved faster during GT, the range of movement did not change in the elderly. These results suggest that the elderly need more effort to achieve the same level of stability as younger adults during the GT. Moreover, when TTS were longer for both forward and backward, COP velocity was faster. This result indicates that elderly people lack their stability when their base of support are moved in the transitional tasks. Moreover, individuals with higher COP velocity during GT had lower stability in PRT. Therefore, an increase in COP velocity during GT indicates a decreased ability to respond to internal forces generated by GT.ACKNOWLEDGEMENTS AND FUNDING: This study was supported by Grant-in-Aid for Early-Career Scientists (20K19371, 24K20491, NH) from the Japan Society for the Promotion of Science.

P02-G-46 - Automated detection of freezing of gait from video recordings in complex environments using a multi scale ST GCN

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Authors:Mr. Arie Shkolnikov Department of Biomedical Engineering, Tel AvivUniversity, Tel Aviv, Israel Dr. Or PerlmanDepartment of Biomedical Engineering and Sagol School of Neuroscience, Tel AvivUniversity, Tel Aviv, IsraelProf. Jeffrey HausdorffSagol School of Neuroscience and Department of Physical Therapy,Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, IsraelAimTo develop an automated method for detecting and characterizing freezing of gait (FOG) from video recordings using 2D pose estimation.BackgroundTraditional approaches to video-based detection of freezing of gait (FOG) often fail under real-world clinical conditions, where multiple individuals and diverse walking behaviours complicate the analysis. Small datasets, occlusions, and limited camera angles further reduce reliability of those approaches. Recent advancements in object detection and tracking make it possible to accurately follow a single participant in challenging settings, even when other people are in view. Meanwhile, Graph Convolutional Networks (GCNs) show strong potential for modelling the spatiotemporal relationships needed to identify FOG events. Improving the detection of FOG may help us better understand this phenomenon and, ultimately, reduce fall risk.MethodsPreviously collected videos of 20 participants (mean age 66.7 ± 7.5 years; 17 men; NFOGQ 18.05 ± 3.65) who performed the Ziegler FOG-provoking protocol were analysed. Each frame was processed with YOLOv11 to detect all individuals in view, followed by StrongSort to isolate and track the intended participant. RTMPose then generated 2D skeletal keypoints from the tracked individual, which were passed into a Multi-Scale Spatio-Temporal Graph Convolutional Network (ST-GCN) enhanced by attention mechanisms. A transformer-based cross-temporal attention module integrated information across varying time windows. We evaluated performance using a Leave-One-Participant-Out (LOPO) scheme.ResultsOur previous standard GCN model yielded an accuracy of 0.52, AUC of 0.82, precision of 0.84,F1-score of 0.59.Using the multi-scale ST-GCN+Transformer pipeline, overall accuracy improved to 0.82, AUC to 0.86, and precision to 0.82. For FOG events specifically, recall reached 0.80 and precision 0.62. Few studies report FOG-specific metrics despite their clinical importance.ConclusionsThe multi-scale ST-GCN+Transformer model, augmented by attention-based fusion, reliably detects FOG from simple 2D skeletal data. Its strong performance suggests potential as a tool for automated gait assessment and personalized rehabilitation in both clinical and home settings. Ongoing work will apply this pipeline to 532 videos and aim to extract FOG triggers and subtypes.

P02-G-47 - Sensory cortical contributions during standing balance are altered in individuals with Parkinson's disease

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Background & Aim: Individuals with Parkinson's Disease (PD) present with sensory deficits, peripherally in the form of increased thresholds for sensing pain, thermal and proprioceptive sensations, and centrally in form of altered sensory evoked potential (SEP) during electroencephalography. When healthy adults perform a task while receiving an afferent nerve stimulation, there is gating i.e. filtering out of the irrelevant sensory input from nerve stimulation, leading to a reduction in SEP amplitude, thereby optimizing neural resources for task execution. The more challenging the task, the greater the reduction in SEP amplitude, and greater the gating of irrelevant sensory inputs. While altered SEP has been related to poor upper limb function in patients with PD, the implications of altered sensory cortical activity for balance control are not known. The aim of this study was to examine the neurophysiology of sensory activity contributing to standing balance in individuals with PD. We hypothesized impaired gating in individuals with PD, with greater impairments in more challenging balance conditions. Methods: Thirty-three individuals (11 high functioning adults with PD, 11 age- and sex-matched older adults or OA, 11 young adults or YA) were recruited. Participants completed three trials of one minute standing under four increasingly challenging conditions presented in a random order, eyes open on firm surface (EO), eyes closed on firm surface (EC), eyes open on foam surface (EOF), and eyes closed on foam surface (ECF). Postural sway was measured using an AMTI force plate. The primary outcome measure was 95% confidence interval of center of pressure (COP) area. EEG measurements were used to measure SEP induced by tactile sensory input from the foot using a Digitimer stimulator. We analyzed our data using repeated measures ANOVA, with group (PD, OA, YA) as the between subject factor and the balance condition (EO, EC, EOF, ECF) as the within subject factor. Results: Our results show that (1) for postural sway, PD and OA groups produced significantly more sway than YA on foam, indicating that age-related changes in balance control may largely contribute to the impairments seen in PD, (2) for SEP, as balance condition got progressively more challenging, the SEP amplitude reduced in YA and OA, showing that the sensory cortex was able to gate the irrelevant sensory input. The PD group showed no significant difference in the SEP amplitude across all conditions, showing altered processing of the sensory input arriving from the periphery. Conclusion: These results are seminal in showing that sensory processing during balance control is impaired in PD. Further, because balance was comparable between OA and PD despite sensory impairments, these results show that high functioning people with PD can compensate for sensory deficits and perform at par with their peers.Funding: Visiting Scholar Award to Dr. Sansare from Parkinson's Foundation (PF-VSA-1300-235).

P02-G-48 - Intersegmental coupling of the trunk during gait in people with PD: A predictor of postural instability?

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Background and aimControlled motion between segments of the trunk during static and dynamic activities is critical for the control of posture and stability. Studies of relative intersegment trunk movement in people with Parkinson's disease (PD) have principally focused on movement during turning, which is characterized by increased in-phase ("en bloc") motion. To date, no studies have investigated intersegmental trunk motion during gait in people with PD. This study explored the hypothesis that people with PD would demonstrate greater in-phase synchronization between their upper and lower trunk segments than matched controls during steady-state gait. MethodsData were collected in 13 people with PD (off medication) and 13 age- and sex-matched controls. Kinematic data was collected using a six sensor (wrist x 2, foot x 2, sternum, lumbar) Opals IMU system (APDM Wearable Technologies). Participants were instructed to walk at their normal, self-selected pace in a narrow 15-m long oval. Postural function was evaluated using a reactive stepping task involving rapidly induced forward and backward translations of an instrumented treadmill belt (Cmill, Motekforce Link). Angular velocity (rad/s) about the IMU transverse plane ("yaw" left/right rotations) was extracted from the

sternal and lumbar IMUs and analyses were restricted to the straight steady-state walking segments of the task. Cross correlations were performed between the two sensor signals and the timing and magnitude of peak correlations above an r = 0.5 threshold were identified. The phase lag of peak correlations was normalized by each participant's average stride time. Differences between groups were calculated via unpaired t-test with significance levels set to $p < 0.05$. ResultsPeople with PD had a significantly smaller lumbar range of motion during gait compared to controls (lumbar = 6.6 ± 1.7° vs. 9.8 ± 1.7° respectively, p = 0.032; sternal = 7.7 ± 1.6° vs. 8.3 ± 1.6°, p = 0.473). There was a significant difference in lumbar-sternal segment lag between people with PD and controls (t = 2.84, p = 0.005). Moreover, there was a distinct bimodal distribution of phase-lags for all participants characterized by lags centered near 38% of the gait cycle and lags near 10% (en-bloc). 12 of the 26 participants (7 PD, 5 controls) had lags near 10%. 5 of the 26 participants showed poor performance in the reactive stepping task (3 PD, 2 controls) and 4 of these individuals also had lags near 10%. ConclusionThe data supports our hypothesis that people with PD demonstrate greater in-phase synchronization between their upper and lower trunk segments than age- and sex-matched controls during steady-state natural cadence gait. Increased synchrony between the trunk segments may reflect disordered spatio-temporal control of muscle activations across the rostral-caudal axis and/or increased stiffness of the trunk. Increased intersegmental trunk coupling may be a contributor to postural instability and falls.

P02-G-49 - Understanding gait variability and muscle synergy in children with developmental coordination disorder: Protocol of a cross-sectional study and preliminary findings

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Background and aim. Developmental Coordination Disorder (DCD) is a neurodevelopmental disorder that affects children's learning and control of motor skills, and hence their daily activities. Despite poor dynamic balance in general [1], current evidence from both neuroimaging and behavioural studies remained equivocal as to clear signatures of gait deficits among DCD children [2,3]. Gait control, which requires complex coordination of the musculoskeletal system, may rely on muscle synergies encoded by lower-level interneuronal networks. However, few studies have investigated the muscle activities during walking among DCD children. Therefore, we aim to understand the neuromuscular control of walking gait through muscle synergy and its relevance to gait variability. Methods. We target to recruit 23 DCD children aged between 7-10 years and 23 typically-developed (TD) counterparts. All participants first performed two-minute overground walking trials at each of the three self-selected speeds (natural, slow and fast), followed by three trials of two-minute treadmill walking with matching speeds. 22 reflective markers and 16 EMG channels were adhered symmetrically to the participants' lower limbs to enable 3D motion capture and synchronous measurement of muscle activities. Variability of gait spatiotemporal characteristics were quantified using coefficients of variation (CoV). Muscle synergies were extracted using the non-negative matrix factorization algorithm. A mixed three-way 2 (group) x 2 (condition) x 3 (speed) ANOVA will be performed to compare the differences of outcome measures at each factor level and possible interactions among levels. Results. Pilot analyses for one participant in each group were performed. The normalized overground walking speeds for the DCD participant and his TD counterpart were "0.51x, 0.70x and 0.80x body height/s" and "0.37x, 0.52x and 0.72x body height/s", respectively. However, their walking speeds on the treadmill were "0.33x, 0.48x and 0.63x body height/second" and "0.36x, 0.51x and 0.69x body height/second", respectively. In terms of gait spatiotemporal characteristics, the TD participant adopted a neutral strategy with balanced adjustments of both step length and time, whereas the DCD counterpart adjusted the walking speed primarily through changing the stride time (slow: 1.38±0.05s vs. natural: 1.25±0.08s vs. fast: 1.00±0.03s). Similar trends were observed in terms of CoV, especially with a heightened stride length variability during slow treadmill walking for the DCD participant (15.57% vs. 7.11%). Muscle synergy analysis revealed three unilateral synergies for both groups in overground walking, and four synergies in treadmill walking were observed only for the TD participant. Conclusions. DCD children may be less adaptive to treadmill walking, especially in adjusting stride lengths. Our on-going data collection and further investigation may provide insights into the mechanism underlying their gait deficits. References. [1] Verbecque et al. Gait Posture, 2021;83,268-279. [2] Biotteau et al. Front Neurol, 2016;7,222356. [3] Wilson et al. Dev Med Child Neurol, 2017;59(11),1117-1129.

P02-G-50 - Responders and non-responders to external and internal cueing in the international UNITE-PD study

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Background – Gait impairment is a key symptom of Parkinson's disease (PD), significantly affecting independence and quality of life. An important part of gait rehabilitation is the use of compensation strategies – including external cueing (e.g. walking to a metronome) and internal cueing (e.g. counting in one's head).1 The effectiveness of cueing, however, varies greatly; some individuals experience a clear improvement of gait, while others show no effect or even decline in gait.2 It remains unclear which patient characteristics are related to cueing responsiveness, how the effects of cueing evolve over time, and what neural mechanisms underlie these responses. The international UNITE-PD consortium addresses these knowledge gaps, involving Radboudumc (Netherlands), KU

Leuven (Belgium), Tel Aviv Sourasky Medical Center (Israel), and IRCCS Policlinico San Martino (Italy). Methods – A total of 384 participants with PD undergo a baseline assessment, including clinical evaluations and objective gait analysis. Five inertial measurement units quantify spatiotemporal parameters during two-minute walking trials under three conditions: uncued, external, and internal cueing. Gait variability, a marker linked to fall risk3, is used as the primary outcome. Cueing efficacy is calculated as the change in stride time variability, expressed by the coefficient of variation (CoV), compared to uncued gait. Using pragmatic thresholds informed by previous work4, participants are classified as responders (efficacy < -0.5%), non-responders (efficacy > 0%), or intermediates (efficacy between -0.5 and 0%) based on absolute change in CoV between uncued and cued conditions. Results – Since December 2023, 190 participants completed the baseline assessment. For external cueing, 52 (28%) responders and 93 (49%) non-responders were identified, with a median CoV during uncued gait of 3.2% (1.7–6.8) and 2.0% (0.7–5.4), respectively. For internal cueing, 59 (31%) participants were identified as responders and 65 (34%) as non-responders, with a median CoV during uncued gait of 3.0% (1.3–6.9) and 2.3% (0.7–5.3), respectively. Notably, 37 participants were responders to both cueing types. Conclusion –Preliminary findings again show varied responses to cueing, consistent with prior research.4 Ongoing analyses aim to identify clinical characteristics predictive of cueing efficacy, to determine future personalized treatment approaches and understand the neural mechanisms underlying cueing. We hypothesize that within the group of non-responders there may be two profiles: either a lower cognitive reserve affecting response capacity or low uncued gait variability leaving little room for improvement. Funding - This is an EU Joint Programme - Neurodegenerative Disease Research (JPND) project, funded by national organizations under the aegis of JPND.1Nonnekes et al, JAMA Neurol, 20182Tosserams et al, Neurology, 20213Schaafsma et al, J Neurol Sci, 20034Tosserams et al, Neurology, 2022

P02-G-51 - Muscle co-contraction in people with Parkinson's disease suffering from freezing of gait

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BACKGROUND AND AIM:Muscle co-contraction (CC) is defined as the simultaneous activity of agonist and antagonist muscles crossing the same joint, helping stabilize joints during movement. CC typically increases with age, task difficulty (e.g., standing on one leg), and neurological diseases like Parkinson's disease (PD). Prior research suggests that freezing of gait (FOG) is linked to CC, potentially as a protective mechanism to stiffen the leg. However, these studies focused on CC during FOG episodes. This study aimed to: 1) test the feasibility of using novel disposable EMG electrodes for measuring CC, and 2) compare CC in PD patients with FOG (PD+FOG) and without FOG (PDnoFOG) during walking and turning, particularly when there is no FOG.Methods: We used a wireless EMG

system and accelerometers at the Tibialis anterior (TA) and gastrocnemius (GS). An acquisition unit transferred the data to an Android app via Bluetooth. The EMG was segmented into gait cycles based on a pattern-matching algorithm applied to accelerometer data. 27 patients with PD were studied [table1]: 12 PDnoFOG (age=70.2±4.4; 9 men; MDS UPDRS3=40.2±12.3; MOCA=25.2±2.3; H&Y=2 [2-3]) and 15 PD+FOG (age=70.9±8.8; 11 men; MDS UPDRS3=36.9±12.9; MOCA=25.3±2.5; H&Y=2 [2-3]). The subjects completed a 2-minute walking test in a corridor and 360° turns, both single and dual task (serial subtraction of 3). CC of the two muscles was obtained from the cleaned and segmented EMG data, defined as the % time when both muscles were activated for each gait cycle, during stance.Results: A mixed effect model revealed no time effect (p=0.5) but a group effect (p=0.037). PD+FOG had higher CC (18.4±3.7%) vs. PDnoFOG (9.7±3.2%) (Difference of means 8.7%, 95% CI: 0.54%-16.7%). When analyzing the first and last 25 steps, in the last steps group effect (p=0.02) was found but no time effect (p=0.5), however there was an interaction between both (P=0.004) but not in the first steps (p=0.8). Surprisingly, during the turns, CC was similar (p=0.3) in PD+FOG (20.7±12.3%) and PDnoFOG (18.5±8.5%).CONCLUSIONS: A novel wireless EMG system using disposable electrodes effectively quantified CC. Higher CC was observed in PD+FOG patients during the stance phase of walking compared to PDnoFOG. This abnormal CC may predispose patients to FOG events or serve as a compensatory mechanism. However, no group difference was found during turning, which is puzzling. The results suggest fatigue may elevate CC in PD+FOG. Studying CC and fatigue during daily activities like walking and turning could further clarify the complex interplay between FOG, fatigue, and mobility.ACKNOWLEDGEMENTS AND FUNDING: I would like to thank my thesis supervisor, Professor Jeffery M. Hausdorff, for his wise and thorough supervision as well as the team in the lab for their help and support.

P02-G-52 - Targeted visual biofeedback-based intervention improves trunk mobility in stroke patients: Interim results

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BACKGROUND AND AIMOver the last decade, the global incidence of stroke has significantly increased, leaving many patients with varying degrees of functional motor and/or sensory deficits. These impairments, ranging from minor to severe, can often be mitigated through timely and specialized rehabilitation focused on restoring lost neurological functions, such as independent movement. Trunk stabilization plays a critical role in retraining essential activities, including standing and walking. Dynamic seated balance in the initial days after a stroke varies from case to case and therefore requires an individualized approach. In stroke patients with hemiparesis, an asymmetric trunk position is often characterized by unilateral tilting or restricted mobility on one side.

Recent studies have shown that integrating additional sensory information into standard motor skills training can enhance rehabilitation outcomes. Building on this evidence, we developed and implemented a targeted visual biofeedback-based intervention aimed at modulating trunk symmetry and improving trunk mobility in stroke patients. METHODSA total of 18 patients (16 men, 2 women; mean age: 63.3 years) participated in an additional intervention during their hospitalization at the University Hospital. This intervention involved visually guided trunk tilts performed in a sitting position using an original methodology. The system included a specialized chair with a built-in force platform, a portable control unit, a height-adjustable monitor, software, and a set of training tasks.The intervention lasted eight days, with sessions of 15–20 minutes per day. The training comprised eight tasks, including voluntary trunk tilts with visual feedback, involuntary tilts induced by trunk muscle vibration, and a combination of both. Pre- and post-intervention assessments evaluated postural stability in the sitting position (with eyes open and closed) and functional limits of stability, defined as the maximum volitional trunk tilts in the medio-lateral direction. RESULTSOur study introduced targeted sensory intervention designed to enhance trunk symmetry and improve trunk mobility in stroke patients, presenting a promising approach to optimize recovery after stroke. Interim results revealed a significant increase in the functional limits of stability on the paretic side, ranging from 6 % to 54 %, with a mean increase of 34 % ($p < .001$, Wilcoxon signed-rank test).CONCLUSIONSRestoring the balance function and symmetry of the trunk, even if partial, is crucial for improving the ability and independence of stroke patients to perform daily activities. Incorporating additional sensory information can positively influence neural mechanisms, contributing to improved motor performance and facilitating the effective reacquisition of lost motor skills.ACKNOWLEDGEMENTS AND FUNDINGWe thank all post-stroke patients and the hospital staff for their help and collaboration. Supported by APVV-20-0420 and VEGA 2/0098/25.

P02-G-53 - Validating an fMRI foot-tapping paradigm to study the neural mechanisms of cueing strategies in people with Parkinson’s disease

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Background and aim: Gait impairments significantly affect mobility and quality of life for people with Parkinson’s disease (PD). One evidence-based method to improve gait in PD is the application of external (e.g. walking to a metronome) and internal (e.g. counting in one’s head) cueing strategies. However, clinical effectiveness of cueing varies across patients while the underlying neural mechanisms of cueing strategies are poorly understood. This is not surprising as functional neuroimaging of gait-related networks is hampered by motion constraints. Therefore, the present study set out to validate custom-built foot-ankle orthoses specifically designed to objectively study foot-tapping performance during fMRI in response to cueing strategies. Methods: A total of 50 people with PD will be included as part of the UNITE-PD study. The present abstract is based on the data of a convenience sample of 24 people with PD and self-reported gait impairments who completed the study. They performed two-minute overground walking trials and a foot-tapping task while lying supine in an fMRI scanner under three conditions: uncued, external and internal cueing. The primary outcome of stride time variability was measured using five inertial measurement units during walking and derived from the foot-ankle orthoses fitted with high-resolution optical shaft encoders (100Hz) at the axis of the ankle joint during fMRI scanning. The difference in stride time variability between the cued and uncued conditions was set as a secondary outcome. Pearson's r correlations were conducted to investigate the association between overground gait and foot-tapping stride time variability.Results: PD patients were able to operate the foot-ankle orthoses during the fMRI scanning as instructed, with limited observed head motion. Weak correlations were found between gait and foot-tapping stride time variability ($r = -.28$, $p = 0.189$), as well as for the difference in stride time variability between cued and uncued conditions (external cueing $r = .17$, $p = 0.418$; internal cueing $r = -.06$, $p = 0.770$). Conclusions: The foot-ankle orthoses proved feasible to use during fMRI and provide rich foot-tapping performance metrics to study gait-related neural mechanisms in PD. These preliminary results, however, showed no significant correlations between gait and foot-tapping stride time variability, although they are underpowered and should be interpreted with caution. Upon completion of data collection, we will redo the analysis and explore additional foot-tapping metrics that may be better able to reflect gait impairment in PD, as well as cueing responsiveness (Figure 1).

P02-G-54 - Reactive stepping behavior during dual-tasking is associated with falls among community-dwelling older adults

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Background and aim: Reactive stepping is important for the recovery of balance from unexpected large perturbations in older adults. Although divided attention has been reported to affect reactive stepping performance in older adults, the association between deficits in reactive stepping performance during dual-tasking and falls has not been conclusively determined. Thus, we aimed to determine whether reactive stepping during dual-tasking is associated with falls in community-dwelling older adults.Methods: Community-dwelling older adults (age: 78.7±5.9 years; 69 females) who had participated in preventive healthcare services were enrolled. The following balance control measures were obtained: quiet standing stability, limits of stability, and reactive stepping performance during single- and dual-tasking. To measure reactive stepping, the participants were suspended in a forward-leaning position using a lean control cable with a load of 12% of their body weight and were instructed to regain balance upon release by taking a single step forward. Reactive stepping was induced under two conditions: (1) simple front-fixed gaze (single-task condition) and (2) reading color names written in different colors (dual-task condition). Reactive stepping performance was measured using the onset latency of the medial gastrocnemius muscle and number of steps required to recover balance from forward balance loss. Participants were asked if they had experienced falls during the prior 12 months and were accordingly classified as fallers or non-fallers. Participants were assessed using the Montreal Cognitive Assessment (MoCA), Falls Efficacy Scale-International (FESI), and Timed Up and Go tests. A mixed-model repeated-measures analysis of variance was performed to determine differences in the task effect for medial gastrocnemius onset latency and number of steps between fallers and non-fallers. Logistic regression evaluated if the measures of balance control were related to falls.Results: Twenty-two participants (28.2%) reported one or more falls during prior 12 months. Both fallers and non-fallers exhibited a significantly increased number of steps during dual-tasking than single-tasking ($F_{1,\ 76} = 45.9$, $P < 0.01$); an interaction between group and condition was observed ($F_{1,\ 76} = 6.9$, $P = 0.01$). The increased number of steps to balance recovery from forward balance loss during dual-tasking was significantly associated with experiencing falls, when controlling for age, sex, body mass index, MoCA, and FESI (odds ratio = 2.4, 95% confidence interval = 1.3–5.6, P = 0.01).Conclusions: Dual-task interference was observed during reactive stepping in fallers. Additionally, the number of steps taken to recover balance during dual-tasking was independently associated with fall histories among community-dwelling older adults. Our results suggest that fall prevention strategies for older adults should consider measuring and improving response to balance loss during dual-tasking.

P02-G-55 - Trunk instability during single task, fast paced, and dual task gait in Huntington's disease

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Background and Aims: Trunk instability during gait is underexplored in Huntington's Disease (HD). Abnormal trunk range of motion (ROM) and its variability might serve as potential postural instability measures and fall risk biomarkers in HD. This study aimed to determine trunk ROM alterations during various gait tasks in HD and their associations with self-reported balance confidence and retrospective falls.Methods: An inertial sensor system (APDMTM) was used to measure sagittal, coronal, and transverse total trunk and lumbar ROM and their variability in 17 HD participants (55 ± 9.7 years) and 17 controls (56.5 ± 9.3 years). Walking conditions included: 1) single task (ST) at a self-selected pace, 2) fast as possible pace (FP), and 3) dual task (DT) with concurrent verbal

fluency (animal naming) during 25-meter, 2-minute walk tests. Trunk variability was calculated as the coefficient of variation (CoV=SD/mean). Administered scales included the: 1) Unified Huntington's Disease Rating Scale total motor score (UHDRS-TMS), 2) Berg Balance Scale (BBS) for performance-based balance measurement, and 3) Activities-Specific Balance Confidence Scale (ABC) for self-reported balance. Participants (with caregiver assistance when possible) also reported the number of falls in the past 12 months. Mann-Whitney U tests or unpaired t-tests compared trunk (sternal sensor) and lumbar (lumbar sensor) ROM and ROM CoV between HD and control participants.Results: HD participants exhibited significantly increased trunk ROM in the sagittal plane during ST, FP, and DT walking compared to controls (p=0.015, 0.015, 0.009, respectively). There were no significant differences in lumbar ROM between HD and controls groups; however, statistical trends showed increased lumbar ROM in HD participants in the sagittal plane during ST gait and under DT gait in all three planes relative to controls. Trunk and lumbar ROM CoV was significantly increased in all planes under all 3 conditions in HD (p=0.045—0.0001). There were no significant differences in dual task costs for trunk or lumbar ROM or their variability between HD and control participants. There were no significant correlations between trunk or lumbar ROM and their variability in any of the gait conditions and the number of self-reported falls, BBS scores, or ABC scores in HD participants. Trunk sagittal ROM during FP gait correlated positively with UHDRS total dystonia subscale scores in HD (p=0.04, r=0.51). Lumbar sagittal ROM variability during ST gait positively correlated with UHDRS maximal trunk chorea subscale scores in HD (p=0.022, r=0.57).Conclusions: Increased trunk and lumbar ROM and their variability may be hallmark gait features in HD and suggest compromised trunk stability. Future studies with larger samples can explore their associations with postural instability and prospective falls. Additionally, examining premanifest/prodromal individuals may offer insights into early markers of trunk instability in HD.

P02-G-56 - Effects of lifestyle activity level on crowd navigation preference and performance in young adults

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BACKGROUND AND AIM: Navigating crowded environments is a crucial skill for daily life to move efficiently and safely through public spaces. Physically inactive lifestyles have been shown to reduce muscular strength, increase levels of social anxiety and, when circumventing a pedestrian, induce cautious strategies. This study explores the relationship between physical activity levels and crowd navigation preferences and performances in young adults. We hypothesized that inactivity would primarily affect walking preferences in denser crowds and that the locomotor performance would be

poorer. METHODS: Fifteen healthy active adults (AA) and fifteen healthy inactive adults (IA) were recruited from the university community. Participants in the AA group were required to engage in at least 3 sessions of high-intensity physical activity per week, achieving a minimum of 1500 Metabolic Equivalent Task minutes/week. IA participants engaged in sedentary behavior for more than 8 hours per day and did not participate in organized physical activity. A virtual environment (VE) representing a large park was created using Unreal Engine and downloaded onto a Meta Quest Pro head-mounted display (HMD). The VE included groups of static agents to simulate crowd densities ranging from 0.25 to 1.5 agents/m^2. Participants navigated through the VE while their trajectories, walking speeds, and gaze behaviors were recorded using a 10-camera Vicon system and the HMD motion, and eye tracking data. The experiment consisted of a first block of 35 trials aimed to understand navigation preferences, with participants navigating different crowd densities and goal placements. A second block of 5 trials focused on navigation performance, with participants following a single, sinuous path through a high-density crowd. The NASA Task Load Index (TLX) was used to report their perceived mental and physical demands and NparLD analyses were used to identify group differences. RESULTS: No differences were noted between the two groups' walking speeds during unobstructed walking. However, for the first block, the IA walked slower than AA, regardless of the density. Additionally, IA chose different paths than AA that were longer involving larger gaps between agents. Yet, despite these differences in navigation strategies, no significant differences were observed in the number of collisions or perceived mental and physical demands between the two groups. For the 2nd block, when taking the same path, IA showed a slower walking speed than AA during the approach to and navigation of the crowd, suggesting that physical inactivity may lead to more conservative navigation strategies. Eye-tracking data revealed that IA focused more on nearby agents within the crowd than AA, indicating heightened attention to immediate interactions. No between group difference was present on the shoulder angle when navigating through the crowd. CONCLUSION: These findings suggest that physical inactivity may impact one's ability to navigate confidently through crowded environments, potentially affecting daily activities and social interactions. This research not only contributes to better understanding of how physical activity level influences crowd navigation preferences and performance, but it can also provide insights that could inform interventions aimed at improving mobility and social engagement in different population with a physically inactive lifestyle.

P02-G-57 - Effects of simulated crowd density on gait dynamics in virtual reality environments

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Background and AimVirtual reality (VR) technology provides a controllable experimental environment; however, the effects of VR-manipulated environments on gait dynamics remain unclear. Therefore, this study aimed to investigate how changes in virtual environment complexity, specifically in crowd density, influence gait patterns. MethodSix healthy young adults (3 males, 3 females) participated in the study. Participants walked on a treadmill wearing an Oculus Quest 2 headset and accelerometers on their waist. Three conditions were tested: (1) No avatar condition, (2) Simple condition (low crowd density, 5 avatars/10 seconds), and (3) Complex condition (high crowd density, 15 avatars/10 seconds). Avatars were arranged in four columns, 1 meter from participants, moving at 4 km/h in the opposite direction. Gait data were collected using accelerometers. The Coefficient of Variation (CV) assessed step interval variability, while Detrended Fluctuation Analysis (DFA) quantified fractal dynamics through the scaling exponent α. Results and DiscussionResults showed no statistically significant differences in CV across conditions, but a slight trend towards reduced variability in the complex condition. The DFA scaling exponent α was significantly lower in the complex condition compared to the simple condition, suggesting more random gait dynamics with increased visual complexity.These findings imply a decrease in gait rhythm fractal nature (i.e., temporally correlated) as visual complexity increases in VR environments. The combination of slightly reduced variability and increased randomness aligns with characteristics observed in experienced long-distance runners (Nakayama et al., 2010). In visually complex conditions with dense crowds, participants may have adopted a flexible gait pattern to avoid collisions with avatars. They likely maintained a state of readiness by slightly reducing gait variability while releasing some active degrees of freedom (DoF) in their movement system. This interpretation suggests that when α approaches 0.5, the system with numerous DoF is not necessarily walking with a regular rhythm by coupling DoF, but rather maintaining a state with some DoF released while exhibiting less correlated behavior. ConclusionCrowded VR scenarios induced more flexible and adaptable gait patterns, characterized by reduced fractal scaling and slightly decreased variability. These findings have potential applications in developing VR-based training and rehabilitation programs for diverse populations. Future research should investigate individual differences in crowd navigation and explore additional factors like avatar speed and spacing. Such insights could lead to more effective VR environments for gait training and rehabilitation, particularly benefiting those with mobility challenges.

P02-G-58 - Turns increase the impact of impaired eye movements on locomotion in cerebellar ataxia

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BACKGROUND AND AIM: Turning movements are a highly relevant component of everyday walking behavior, since 35-45% of steps are taken during turning. Turning movements are thought to be more challenging in terms of dynamic balance than straight walking, as they require more anticipatory postural adjustments and trunk-limb coordination strategies. In addition, certain types of degenerative cerebellar ataxias are associated with disturbances in eye movements such as nystagmus and disturbed VOR reflexes, which occur particularly during head rotation and peripheral gaze and may therefore affect turning more than straight walking. In this study, we compared the turning movements of SCA27B ataxia patients with downbeat nystagmus (DBN) to those of patients with spinocerebellar ataxia (SCA, types 1, 2, 3, 6) without nystagmus and investigated the influence of the drug 4-aminopyridine (4AP) on the reduction of DBN during turning movements. METHODS: We performed a cross-sectional analysis of motion data collected by three body-worn inertial sensors from subjects with SCA1, 2, 3, 6 (n = 359, SARA = 6.81) as well as SCA27B (n = 49, SARA = 7.0) in two conditions: a) lab-based supervised walking of a 60m corridor at preferred speed, b) lab-based turn task, i.e., subjects were instructed to walk along a T-junction of a corridor, including several 90° turns. Turning analysis included standard measures (i.e., mean and peak angular velocity (MAV, PAV), turn duration (TD), number of steps during turning (NoS)) and a measure quantifying dynamic balance during turning (lateral velocity change, LVC), which has been shown to be sensitive to ataxic-specific changes in turning and has strong correlations with self-reported balance confidence as measured by the ABC score. RESULTS: Turn analysis of the LVC revealed significantly greater impairments during lab-based 90° turning ($p = 0.001$, Cliff's $\delta = 0.45$) in SCA27B patients with DBN (n = 18) than in SCA1/2/3/6 patients without oculomotor impairment (n = 359). Small or no effects were found for the standard turn parameters (e.g., PAV ($p = 0.49$, $\delta = 0.10$), TD ($p = 0.30$, $\delta = -0.15$). Single-subject analysis of a 4AP-treated SCA27B patient with prominent DBN at right and left gaze directions showed both a reduction in DBN and LVC in the ON treatment phase compared to pre-treatment. The slow phase velocity was reduced by 16.1% in right and by 51.2% in left gaze. Accordingly, the LVC decreased by -0.46 m/s (-85.3%) during right and by -0.51 m/s (-98.38%) during left turns. Here, no improvements were found for the standard turn parameters. CONCLUSIONS: Ataxia-related oculomotor impairments may increase abnormalities in dynamic balance control during turning, which are not reflected in common compensatory strategies such as slowing down and taking smaller steps. The 4AP-induced reduction in DBN in SCA27B patients improves turning performance, with potentially beneficial implications for everyday walking behavior.

P02-G-59 - Older fallers maintain predictive stability during walking with increasing asymmetric loads

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Background and Aim: Approximately 30% of older adults (≥65 years) experience one or more falls annually, often leading to injuries, fractures, functional decline, and diminished quality of life. Older adults with a history of falls typically demonstrate impaired gait performance, balance deficits, and altered perception of verticality compared to their non-faller counterparts. Carrying asymmetrical loads (e.g., bags or objects in one hand) challenges postural stability and requires the predictive (feedforward) control system to accurately estimate the destabilizing effects of the ongoing load carriage, generating joint torques and postural adjustments necessary to preserve balance. However, little is known about how predictive control mechanisms function in older adults with a history of falling. This study aimed to investigate whether these individuals demonstrate appropriately scaled predictive adjustments in balance control in response to increasing asymmetrical loads during walking.Methods: Eighteen community-dwelling older adults with a self-reported history of falls in the previous six months participated. Participants walked along a 9-meter walkway under six experimental conditions: without load and while carrying a handheld dumbbell with their dominant hand corresponding to 2%, 4%, 6%, 8%, and 10% of their body mass. Each participant completed 30 randomized trials. A total of 39 retroreflective markers were placed on anatomical landmarks, and two additional markers were affixed to the dumbbell. These markers were tracked by a 9-camera Vicon motion analysis system. The extrapolated center of mass (XCoM) was used to compute the margin of stability (MoS) in the mediolateral (ML) direction at foot contact on the ground. A one-way repeated measures ANOVA (within-subject factor: six load conditions) was conducted to examine the effects of load magnitude ($p<0.05$).Results: The participants were 70.9 (±2.8) years old and experienced 2.8 (±1.0) falls in the past six months. ANOVA revealed significant effects of load condition on ML MoS for both lower limbs when the dumbbell mass was not included in the center of mass (COM) calculation (non-dominant limb [opposite to the load side]: $p<0.001$ | dominant limb [same side as the load]: $p<0.001$). Bonferroni-corrected post-hoc analyses indicated a progressive reduction in the MoS for the non-dominant limb, accompanied by a progressive increase for the dominant limb with the load increments. When incorporating the dumbbell into the COM calculation, predictive adjustments made by the participants were evident, as ANOVA revealed no effect of load condition on ML MoS for both non-dominant ($p=0.064$) and dominant ($p=0.234$) limbs.Conclusion: In the ML direction, older adults with a history of falls demonstrated the ability to properly predict the destabilizing effects of asymmetrical load carrying and appropriately adjusted their XCoM to preserve a constant MoS while walking. AcknowledgmentsSão Paulo Research Foundation (FAPESP), Brazil (Grant # 2024/07236-4). FAPESP played no role in the design, execution, analysis, interpretation of data, or writing of this study.

P02-G-60 - Objective gait variability measures- comparisons between people with and without abnormal amyloid pathology (AB42/40)

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Background and aim:Greater intraindividual variability in gait is suggested to be a sensitive measure of cognitive decline. Biomarkers in cerebrospinal fluid (CSF) can provide measures of pathology, where an abnormality of amyloid-β (Aβ) can be a prodromal measure of Alzheimer's disease. Our aim was to compare digital gait variability measures between people with and without abnormal CSF Aβ42/40 ratio, i.e., in people with mild cognitive impairment (MCI), subjective cognitive decline (SCD) and cognitively healthy (CH), respectively.Methods: This cross-sectional study included people with MCI (n=230, mean age: 75.6, SD 4.9, 43% women), SCD (n=122, mean age: 75.5, SD 4.7, 48.4% women) and CH (n=288, mean age: 77.8, SD 5.2, 62.2% women), respectively. People were classified as having MCI based on standardized performance (i.e., z-score) on cognitive tests that related to four domains (memory; executive/attention, verbal and visuospatial). People performing 1.5 z-score worse than a normative score on any of the four cognitive domains were classified as MCI. Spatiotemporal gait data were collected using an electronic walkway (GAITRite©, platinum, active mat length 4.88m and width 0.69m). Gait was assessed in comfortable gait speed (6 trials). Coefficients of variation (CoV) was calculated for three variability measures: step velocity variability, step width variability and swing time variability. The CSF Aβ42/40 ratio was considered abnormal if ≤0.08. Mann-Whitney U-tests were used to examine potential within-group differences in the three groups, respectively. Results:Step width variability showed a statistically significant difference between people with normal CSF Aβ42/40 ratio compared to abnormal CSF Aβ42/40 ratio in the MCI group (mean 23.6 SD 11.2 versus mean 26.8 SD 10.4, p=0.025) and the SCD group (mean 24.0 SD 9.5 versus mean 29.8 SD 11.8, p=0.038). That is, those with an abnormal CSF Aβ42/40 ratio had an increased step width variability. This was not the case for the CH group (p=0.064). No statistically significant differences were found in any of the other two gait variability measures, which applied for all three groups (p≥0.221). Conclusions:Our findings indicate that an increased step width variability may be an early marker of cognitive decline and Alzheimer's disease. This finding should be replicated, and future studies should have a longitudinal design, including considering dual task gait, confounding factors and co-pathologies.

P02-G-61 - Metabolic energy expenditure in quiet standing and gait initiation is similar over a wide

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Background and aim: Human movement control is shaped by the optimization of different cost functions to achieve movement goals. In locomotion, humans optimize gait parameters to minimize metabolic energy, but whether this principle drives control in

standing balance is unclear. This study assessed whether humans minimize metabolic cost during standing by determining (i) how the cost of standing varies with whole-body angle, (ii) whether humans assume a whole-body angle with (near) minimal cost, and (iii) whether metabolic optimization also dictates balance behavior prior to initiating gait.Methods: In Experiment 1, 13 participants stood at 6 different whole-body angles (-0.02 rad backward to 0.10 rad forwards) and their preferred posture while measuring whole-body kinematics (motion capture) and energy expenditure (metabolic analyzer). In Experiment 2, 20 participants performed a gait initiation task from a prescribed or preferred posture while knowing the varying probabilities of being prompted to walk in a forward vs backward direction (0%, 50%, or 100%). Musculoskeletal models were used to estimate joint angles and energy expenditure for both experiments, computed using either the body's simulated kinematic and potential energy or the muscle activations. Muscle activations were estimated using static optimization and validated using EMG data collected from eight muscles in Experiment 1.Results: The metabolic energy expenditure during quiet standing in Experiment 1 was similar at prescribed whole-body angles over 0-0.04 rad (0-2.29°) and not significantly different from the preferred posture as far forward as 0.06 rad (3.44°). Furthermore, the preferred postures (0.027 rad, SD 0.013) fell within this optimal range. In Experiment 2, participants maintained their preferred posture before the gait initiation cue regardless of the direction probability. Simulations showed no significant metabolic cost reduction between maintaining a central (0.02 rad) and backward or forward (-0.02 or 0.06 rad, respectively) whole-body angle when initiating walking in the corresponding direction.Conclusions: Human movement control is commonly characterized as a metabolic cost optimization problem, but this assumption may not be sufficient to describe standing balance control. Within a broad range, standing postures (i) have similar costs and (ii) impose little posture-dependent cost on gait initiation, suggesting that minimizing energy expenditure during quiet standing may not benefit much from precise postural regulation. In contrast, common modeling methods, like the inverted pendulum assumption and set-point controllers, strictly penalize deviations from a single fixed angle with zero net moment rather than allowing a range of postures with minimal energy expenditure. These findings highlight the need to carefully consider how the nonlinear and dynamic characteristics of our body are represented in postural modeling and control assumptions.Acknowledgements and funding: This work was funded by the Dutch Research Council (NWO, VI.Vidi.203.066).

P02-G-62 - Steps against the burden of Parkinson's disease: A multicenter speed-dependent treadmill training protocol to unravel underlying mechanisms and translations to the home-based environment

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Background and aimPeople affected by Parkinson's disease (PD) often demonstrate reduced gait quality and an associated increased fall risk. 70% of PD-fallers experience recurrent falls [1]. Speed-dependent treadmill training can improve gait quality, demonstrated by improvements in gait speed [2]. The underlying mechanisms and the extent to which treadmill training translates to improvements in daily life gait remain unclear. The StepuP project will investigate:If the effectiveness of treadmill training is reflected in improved gait stability control and associated electrophysiological markersThe transfer of treadmill training to improved home-based gaitIf individual characteristics influence training outcomes and retentionMethodsAcross centers in Sydney, Kiel, Bologna and Tel Aviv, 126 individuals with PD will be randomized to undergo 12 sessions of progressive speed-dependent treadmill training either a) standard or b) plus virtual reality and/or mechanical perturbations. All participants undergo a baseline (T0), post (T1) and retention (T2) assessment of their gait performance. A pre-baseline (T-1) assessment, performed in Sydney, will serve to investigate measurement reliability. In Amsterdam, 21 age-matched healthy adults will undergo T0 as a reference. At T0/T1/T2 a 20-meter walk test will provide the primary outcome measure: comfortable walking speed. Clinical tests will assess general functionality. Motion capture data will be used to assess stability-related foot placement control [3], and EEG and EMG data to assess associated cortical and muscle activity. Mobility data will be collected using inertial measurement units (IMUs) in the lab and in the home-based situation, to gain insight into daily life gait outcomes. Questionnaires will add context to the IMU data. Semi-structured interviews will explore user experiences and barriers and enablers to long-term behavioral change. ResultsData collection is ongoing. We expect initially that foot placement is impaired in PD patients compared to healthy age-matched controls. Furthermore, we expect an increase in gait speed following treadmill training (T1). As novel findings, we expect better gait performance to be associated with improved sensorimotor integration, as reflected by improved foot placement control and evidenced by lower cortical beta power and higher cortico-muscular coherence during walking. We expect lab-based improvements to relate to improvements in daily life gait outcomes. We expect better retention (T2) to be related to physical activity engagement. ConclusionWe expect to provide (1) a better neuromechanical understanding of speed-dependent treadmill training, (2) insights into the transfer of treadmill training effects to daily life mobility and (3) a more personalized understanding of who may benefit from treadmill training and who may not. Such insights could facilitate a more effective and more personalized training intervention in the future.Acknowledgements and FundingWe acknowledge funding support from the Joint Programme for Neurodegenerative Disease (JPND grant acronym StepuP).References1. Allen, N.E., A.K. Schwarzel, and C.G. Canning, Recurrent falls in Parkinson's disease: a systematic review. Parkinson's disease, 2013. 2013(1): p. 906274.2. Pohl, M., et al., Immediate effects of speed-dependent treadmill training on gait parameters in early Parkinson's disease. Archives of physical medicine and rehabilitation, 2003. 84(12): p. 1760-1766.3. Wang, Y. and M. Srinivasan, Stepping in the direction of the fall: the next foot placement can be predicted from current upper body state in steady-state walking. Biology letters, 2014. 10(9).

P02-G-63 - Exploring harmonic walking development in children with unilateral cerebral palsy and typically developing toddlers: Insights from walking experience

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Background and AimThe acquisition of independent walking represents a pivotal milestone in human motor development, often characterized by the emergence of gait harmony, a self-similar structure of gait phase ratios converging towards the golden ratio (Phi ≈ 1.618..). This study explores the role of walking experience in the development of gait harmony, comparing typically developing (TD) children and children with unilateral cerebral palsy (CP). Our aim was to investigate the influence of independent walking on the maturation of gait patterns and to assess the impact of asymmetry in CP on the development of harmonic locomotion. MethodsThis longitudinal study analyzed gait phase ratios (stride/stance, stance/swing, swing/double support) in 30 TD children (age range between 1.0 and 23.6 months) and 18 children with unilateral CP (age range between 11.2 and 60.7 months). Participants were recorded before and after the onset of independent walking. Gait ratios were calculated using kinematic and video data from 3D motion capture systems (Vicon, Oxford, UK), and their convergence towards the golden ratio was assessed using exponential fitting models. For children with CP, additional analyses were performed to compare the most and least affected legs. ResultsTD children demonstrated a rapid convergence of gait ratios towards the golden ratio within one month of independent walking. In contrast, children with CP required approximately seven months to achieve comparable harmonic patterns, and these were marked by asymmetry between the most and least affected legs. Specifically, the least affected leg often exceeded the golden ratio (1.7), while the most affected leg fell short (1.5). Despite these asymmetries, an overall trend towards harmonic walking was observed in the CP group, albeit with reduced symmetry compared to TD children. ConclusionsOur results showed that the first independent steps serve as a critical trigger for the development of harmonic gait patterns. While TD children rapidly achieve symmetry and harmonic walking, children with CP exhibit delayed and asymmetrical development, reflecting the interplay between preserved motor functions and compensatory strategies. These findings highlight the importance of early walking experience and provide insights for targeted interventions in pediatric neurorehabilitation to promote symmetrical and harmonious gait in children with CP. Acknowledgements and FundingWe would like to thank the parents and children who participated in this study. Special thanks go to those who provided support during the measurements involving children with cerebral palsy: the paediatric physiotherapists D. Cornelissen, E. Muselaers, and E. Verwaaijen at the Amsterdam UMC, I. Moll at the University Medical Center in Maastricht, and T. Marro, A. Medici, and A. Sarni at the Santa Lucia Foundation of Rome; and typically developing children: J.N. Kerkman and M.M. Bach.This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (No. 715945 Learn2Walk), from the Dutch Organisation for Scientific Research (NWO) VIDI grant (016.156.346 FirSTeps). MG was funded by the Johanna Kinderfonds and Kinderrevalidatie Fonds Adriaanstichting (20200028). MI worked in the framework of the fundings of MIUR for the Progetto di Eccellenza PACE.

P02-G-64 - Temporal relationships of trunk stability and muscle synergy to gait characteristics in persons with subacute stroke

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Background and aims.Gait, which is characterized by forward body movement, relies on coordinated lower limb movements and precise trunk control. The coordination of the lower limb movements during gait can be represented by muscle synergy. Following a stroke, impairments in this control often result in reduced trunk stability and poor gait performance. Clinically, there are cases where improvements in lower limb muscle activity and trunk stability precede recovery of gait performance. This study aimed to investigate the temporal relationships between gait recovery, muscle synergies, and trunk stability during walking in individuals with subacute stroke. Methods.Thirty independently ambulatory post-stroke patients (age: 69.0 ± 13.0, days since stroke onset: 62.1 ± 29.1) participated in this longitudinal study. Participants walked at a comfortable speed, and data were collected at the three time points, each separated by one month. Lower limb angles were measured using OpenPose, while trunk stability, and muscle synergies were analyzed using Delsys sensors and non-negative matrix factorization respectively. The number of synergies selected for further analysis was the highest number for which the variance accounted for (VAF) exceeded 90%, with additional synergies contributing less than a 5% increase in VAF. Trunk stability was quantified as the Root Mean Square of the anterior-posterior and lateral acceleration components recorded by an inertial sensor at the third lumbar level. Cross-lagged panel modeling (CLPM) was used to analyze the temporal relationships between gait speed, trunk stability, and muscle synergies across the three points. Results.The CLPM analysis revealed no significant temporal relationship between the number of synergies and gait

speed at any time point (GFI = 1.00, CFI = 1.00, RMSEA = 0.03). However, gait speed at the second time point showed a significant negative association with trunk stability at the third time point ($p < 0.001$, GFI = 1.00, CFI = 1.00, RMSEA = 0.02). Interestingly, in contrast to previous studies, a subset of the participants exhibited four muscle synergies but had a slower gait speed compared to other participants. Conclusions.Although no overall temporal relationship was found between the number of muscle synergies and gait speed, the subgroup with four muscle synergies and slow gait at the first time point showed significant longitudinal improvement. These findings suggest a potential temporal precedence of the four-synergy module, which is similar to patterns observed in healthy individuals. Furthermore, the negative temporal association between trunk stability and gait speed suggests that trunk stability may improve following increases in gait speed, highlighting the interplay between these factors in stroke rehabilitation.

P02-G-65 - Step accuracy in ADHD adults is influenced by visual distraction and reduced visual information

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Background and Aims: Individuals with Attention Deficit Hyperactivity Disorder (ADHD) face a heightened risk of musculoskeletal injuries, primarily due to falls1. Existing studies on children with ADHD have revealed gait and balance impairment, including deficits in tasks requiring increased coordination and sensorimotor integration, such as beam-walking2. Recently, visual-motor attention has been identified as a key player in ADHD motor control3,4. The current study aims to assess the effects of distractive visual stimuli and reduced availability of visual information during a precision stone-stepping task. Methods: Fifteen young adults aged 18-35 with ADHD (10 female; 21.8±1.9yrs) and 15 without ADHD (12 female; 21.6±1yrs) walked along a 10-meter walkway with projector produced stepping-targets. Participants were instructed to step as accurately as possible on the target midpoints. Target size and spacing was adjusted to individual gait patterns and the distal half of the walkway was modified to assess distractive and reduced visual stimuli; additional irrelevant targets instantaneously either appeared a) near the participant's position, or b) further down the walkway. In total 36 randomized trials were performed. Kinematic data was collected using the Optotrak camera system, used to determine center of mass (COM) and foot location (BOS). Data analysis included margin of stability (COM-BOS) minimums (mm) and anteroposterior and mediolateral error of foot placement relative to the target center (mm). Results: ADHD participants had smaller COM-BOS (ADHD: 92.4±14.6, CON: 95.2±17.5; F=9.49, p=.002). This indicates greater instability in the ADHD group, especially during no perturbation (ADHD: 93.1±17, CON: 97.9±19.8; p=.042) and delayed information trials (ADHD: 91.8±12.2, CON: 96.4±17; p=.033). The ADHD group were significantly more accurate in foot placement mediolaterally (ADHD: -2±15.8, CON: -8±23.3; F=49.27, p<.001) and anteroposteriorly (ADHD: -2.9±27.8, CON: -16.9±40.8; F=92.59, p<.001). Interactions revealed that ADHD group mediolateral error significantly increased with delayed visual information (-5.1±14.7, no delay: 1±16.2; F=14.11, p<0.001). This was seen as a more lateral step relative to the target, non-significantly different than that of controls. Additionally, ADHD group anteroposterior error increased with distraction target trials (-6.6±24.6, no distraction: -0.9±31.5; F=3.64, p=.026). Conclusion: Young adults with ADHD are at greater risk for falls and subsequent injury compared to controls when performing tasks with a precision stepping component. We theorize that our findings indicate motor coordination and motor inhibition problems, as ADHD group task-adherence came at the cost of stability. References: [1] Kaya, et al. J Int Med Res (2007), 36(1):9-16. [2] Buderath, et al. Gait & Post (2009), 29(2):249-254. [3] Fabio, et al. Res in Dev Dis (2022), 123:104193. [4] Del Campo, et al. Bio Psychiatry (2011), 69(12):e145–e157.

P02-G-66 - Forward-lateral load shifts in half-squats: A strategy for targeting intrinsic foot muscles

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[Background and aim] Age-related atrophy of intrinsic foot muscles is associated with balance. For example, an increased medial-lateral sway of the center of pressure (COP) can distinguish those who have experienced falls (Pizzigalli et al., 2016). Additionally, individuals with a history of falls require more steps to recover balance due to a medially shifted COP (Kelly et al., 2012). As balance demands increase, intrinsic foot muscles such as the abductor hallucis, flexor digitorum brevis, and quadratus plantae become more active. These findings suggest that examining muscle activity when the COP shifts anterior-laterally may lead to new insights for preventing the medial shift of COP and reducing the fall risk in older adults. Although the abductor hallucis muscle activity during increased balance demands has been examined, studies on the abductor digiti minimi are lacking. Both the abductor hallucis and abductor digiti minimi are important for balance control due to their thin, elongated morphology (Kusagawa et al., 2023). Therefore, it is also necessary to investigate the abductor digiti minimi. The present study aimed to investigate lower limb muscle activity under anterior-lateral loading, with a focus on the abductor digiti minimi. [Methods] The participants were 13 healthy adult males, and left lower limb muscle activity was recorded while they performed half-squats with their weight distributed equally on both feet. The measured muscles were the gluteus maximus, gluteus medius, iliopsoas, rectus femoris, lateral hamstrings, medial hamstrings, abductor hallucis, and abductor digiti minimi. Surface electromyography (EMG) was recorded using active electrodes. A pressure measurement device was used to ensure and monitor an anterior-lateral load. Participants stood with their feet shoulder-width apart and with their knees flexed at 90° and aligned so that the femoral axis stayed within the foot width. The trunk was kept as vertical as possible, as confirmed by a goniometer and visual inspection. After stabilization, EMG activity was recorded for 5 seconds, and a stable 3-second interval was analyzed. EMG waveforms were RMS-processed and normalized to %MVC. One-way ANOVA was conducted, and Dunnett's test was used to compare other muscles with the abductor digiti minimi. Participants practiced maximizing their muscle strength output for 1 week before testing. This study was approved by the Ethics Committee of the Kanazawa Orthopedic Sports Medicine Clinic (Kanazawa-OSMC-2024-008). [Results] One-way ANOVA showed a significant difference ($F(7, 96) = 7.177$, $p < 0.001$). Dunnett's test revealed that the abductor digiti minimi had significantly higher activity than the gluteus maximus, gluteus medius, iliopsoas, lateral hamstrings, and medial hamstrings ($p < 0.05$). In contrast, there were no significant differences between the abductor digiti minimi and the rectus femoris or abductor hallucis. [Conclusion] Shifting the load anterior-laterally during half-squats may suppress hip muscle activity while enhancing abductor digiti minimi activity.

P02-G-67 - The relationship between turning and falls in Parkinson's disease: A survey

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Background and Aim: Falls are common in people with Parkinson's (PwP), with causes related to both motor and non-motor symptoms. Turning, either on the spot or during gait, is one risk for falls in PwP. Due to a sideways landing, a fall during turning is eight times more likely to result in a hip fracture. There is currently a lack of evidence around turning difficulties in PwP, compared to other mobility measures. Furthermore, there is very limited evidence for treatments to improving turning and therefore reduce falls. This study aimed to further understand turning difficulties and the association between turning and falls from individuals with Parkinson's disease and their family members, friends and carers.Methods: An anonymous online survey was sent to PwP and those affected by Parkinson's (carers, family members and friends), April 2019. The survey was distributed by Parkinson's UK through their Research Support Network via their mailing list and monthly newsletter. The survey collected demographic information from participants (such as age and disease duration), previous falls, and falls related to turning. Questions were posed around falls frequency, concern around future falls and issues specific to turning and falls, participants were asked to tick boxes for the response that most applied to them.Results: A total of 264 people responded to the survey, n=225 PwP and n=39 carers/family members/friends of PwP. The majority of PwP had previously had a fall (63%), with over 64% of fallers falling at least once per month. The vast majority of PwP surveyed were worried about future falls either sometimes, frequently or all the time (83%). Over 80% of PwP reported issues with their turns, including reduced turning speed, instability during turning and additional concentration requirements during turning. Twenty PwP reported that they try to avoid turning due to these concerns. Over

half of PwP reported a fall because of a turn, with a further 25% suggesting that turning might have been a factor in a fall.Fewer carers/family members completed the survey, but over 85% of the people they cared for had experienced a fall, with 72% falling at least once per month. All carers were worried about future falls, with over 45% reporting they were worried ‘all the time’. All but 2 carers reported that the person they cared for had issues with turning, with slower and more unstable turning reported. Over 50% reported the person they cared for had experienced a fall during turning.Conclusions: This anonymous survey has revealed self-reported issues with turning in PwP, with similar concerns expressed by carers/family members. Turning as a cause for falling emerged for most participants, with future falls a huge concern for PwP and their carers. Future research needs to explore the mechanisms of turning in PwP and develop rehabilitation strategies to optimise turning, as well as increased awareness of turning as a risk factor for falls.

P02-G-68 - Comparison of postural control between tai chi exercise and modified ronggeng exercise in community-dwelling older adults

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Background and aims: Tai Chi is a practice that enhances balance, strength, and coordination. Its measured, intentional movements and emphasis on posture and body awareness provide it a favored technique for improving postural control in older persons. Rongngeng, a traditional dance form, encapsulates rhythmic motion and cultural significance. Transforming this dance into a systematic workout regimen could render it an intriguing and culturally appropriate intervention for elderly individuals. The rhythmic movements, weight transfers, and dynamic postural adjustments inherent in Ronggeng provide the potential to enhance balance and coordination. The present study aimed to compare the postural control between Tai Chi Exercise and Modified Rongngang Exercise in Community-Dwelling older adults for a period of 5 weeks. Methods: This study involved 23 volunteers, divided into two groups: Tai Chi exercise (n=9, with a mean age of 72.50 (9.29) years) and Rong Ngen dance exercise (n=15, with a mean age of 68.27(8.19) years). The participants were older adults who could communicate effectively, follow instructions, and walk independently without a walking aid. Postural control was evaluated through functional reach and physical performance tests, including Berg Balance Scale, timed single leg stance, Time Up and Go, and a 2-minute step test for cardiovascular endurance, including a 30-second chair stand for strengthening lower legs. The training program began during the first week of the intervention, with close supervision from students, instructors, and experienced personnel. The research team developed video media specifically for Tai Chi exercises and modified Rongngeng dance routines, which were reviewed and approved by professionals. Each training session included a warm-up phase with muscle stretching exercises targeting key muscle groups, followed by a cool-down phase to relax muscles. The program consisted of 30-minute

sessions conducted three days per week, and participants completed the program over four weeks. Upon completion, participants underwent a fall risk assessment to evaluate the effectiveness of the interventions. Results: No significant differences in the timed single leg stance including open eyes comparing between groups. No significant differences were found other variables between groups. There was significant difference in functional reach test, timed single leg stance including closed eyes and 2-minute step test on functional balance the same as Time up and Go test Tai Chi Exercise group after a period of 5 weeks. In the other hand, significant differences were found only Time up and Go test in Modified Rongngang exercise group. Conclusion: Tai Chi and Modified Ronggeng Exercise have been found to improve postural control, mobility, and fall prevention in community-dwelling older adults. Tai Chi showed significant improvements in functional balance, mobility, and cardiovascular endurance, while Modified Ronggeng improved single-leg balance and functional mobility. Both exercises have the potential to enhance quality of life and reduce fall risks, supporting their inclusion in public health initiatives. Future studies should examine the long-term effects of Tai Chi and Modified Ronggeng Exercise on postural control, physical performance, and fall risk reduction. Investigating the sustainability of benefits after the cessation of training would also be valuable.

P02-G-69 - The impact of age on muscle and kinematic responses following an unpredictable slip while walking

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Background and Aim: Slips represent a common fall circumstance in older people. This study aimed to determine the age-related differences in muscle and kinematic responses following an unpredictable slip whilst walking on an overground walkway.Methods: 127 people (25 young and 102 older) were recruited and exposed to a single unpredictable slip, induced via a moveable tile at foot-strike whilst walking along an 8-m overground walkway. Surface electrodes (electromyography) were used to record bilateral muscle responses in lower limb muscles: rectus femoris (RF), semitendinosus (ST), tibialis anterior (TA) and gastrocnemius medialis (GM). Muscle response outcomes included onset latencies, peak magnitude, time to peak magnitude and co-contraction. Reflective markers were also attached to the body and a Vicon motion capture system was used to measure kinematic responses for slip parameters (slip duration and slip velocity), stepping time and length for the first (REC1) and second (REC2) recovery steps , centre of mass (CoM) height, support limb loading time. Peak harness loading and falls (>50% harness loading) were determined from a strain gauge in series with the ceiling-suspended safety harness. Results: Compared to young, older people displayed greater contralateral muscle activation in the TA, ST and GM in the step prior to the slip onset ($P<0.05$). Following the slip onset, older people had longer onset latency and time to peak in the contralateral ST and greater peak magnitudes in GM bilaterally, compared to young

(P<0.05). During the slip, older people experienced greater peak slip velocity (young: 219±53 cm/s, older: 239±39 cm/s, P=0.045), compared to young, with no between-group differences for slip duration or support limb loading time. Older people also took longer to take the second recovery compared to young (P<0.05).Older people had greater harness loading compared to young people (young: 20±14 kg, old: 34±22 kg, P=0.005), with no significant differences in fall rates (young: 23%, old: 41%, P=0.088).Conclusions: Age-related differences in muscle and kinematic responses between young and older people were evident following an unpredictable slip. Older people displayed slower and less efficient muscle responses compared to young which may contribute to impaired balance recovery, observed as slower recovery stepping time and greater peak harness loading. Interventions such as perturbation-based balance training may enhance reactive balance in older people and assist to prevent falls following unexpected slips.Acknowledgements and Funding: Martin Heroux for expertise in analysing EMG data collected. Funding: National Health and Medical Research Council (NHMRC).

P02-G-70 - The impact of unstable load carriage on gait variability in healthy adults: A proof of concept study

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Background and aim: Load carriage has been shown to impact multiple gait characteristics but has not typically been studied as a method to improve normal (unloaded) gait. Use of variability and instability in athletic performance training has led to an increase in inexpensive tools for inducing movement variability. Since these tools might also improve gait robustness in non-athletic populations with an increased risk of falls, this proof of concept study aimed to establish whether unstable (water) load carriage increases gait variability to a greater extent than stable load carriage at different walking speeds in healthy adults, as a first step towards evaluating its potential benefits for improving walking robustness in older adults. Methods: Twenty-six healthy adults (11 women; age 26.12±3.91 years; height: 173.65±8.91cm; weight: 70.31±11.58kg) participated in the study, which assessed gait under three conditions: unloaded, stable-loaded, and unstable-loaded walking. The unstable load was achieved using the Hydrovest (ultimateinstability, Breda, The Netherlands), a combination of a 90cm long, 20cm diameter cyclindrical container (filled with air and water until it weighed 5kg) positioned horizontally across the back of participants' shoulders on a purpose-built vest. For the fixed load, we constructed a weight using industrial PVC pipe of the same diameter and attached small sand bags inside it to match the weight and centre of mass of the Hydrovest. Gait was measured using the Computer Assisted Rehabilitation Environment (Motek, Amsterdam, The Netherlands), comprised of a dual-belt force plate-instrumented treadmill and a 12-camera Vicon motion capture system. Each session began with 2.5 minutes of walking familiarisation for each speed. During the three conditions, all participants walked for 3 minutes at each speed (0.6, 1.0, 1.4

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and1.8m.s-1). The means and coefficient of variation (CoV) for step length, step time, step width, and double support time were calculated. A two-way ANOVA was performed to analyze the effect of load condition and speed on gait variability.Results: The two-way ANOVAs revealed that there were statistically significant interactions between the effects of load condition and speed for mean and CoV of step length (p=0.0002; p=0.02), mean step time (p<0.0001), mean and CoV of step width (p=0.01; p=0.002), and mean double support time (p=0.01), but not for step time CoV (p=0.45) and double support time CoV (p=0.71). The main effects for the load condition were significant for all parameters (p<0.05) with CoV being the highest in the unstable load condition. Step length CoV was more pronounced at higher speeds, while step time CoV was higher at lower speeds.Conclusions: Unstable load carriage consistently and significantly increased gait variability compared to stable-loaded walking. Future studies should investigate whether training with such tools can lead to improved gait robustness, particularly in older adults.

P02-G-71 - Digital daily life activity and gait measures show promise to track progression in early Parkinson’s disease

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Background and Objective. While digital gait measures have shown greater sensitivity than clinical scales in cross-sectional studies, digital gait measures also need to be able to capture longitudinal changes within short time frames (such as 1 year) to be valid early disease progression endpoints. Our aim was to investigate gait measures sensitive to longitudinal changes in people with Parkinson’s disease (PD). Methods. 19 individuals with PD (age: 53 ± 12 years, MDS-UPDRS Part III Total score: 27 ± 7) participated in the study. Participants wore instrumented socks (containing Opal sensors on each foot) and a waist sensor for continuous monitoring over a week (≥8 hours/day). Daily activity using smart socks and the MDS-UPDRS were performed at baseline and after 1-year follow-up in the clinic. Effect size between baseline and 1-year follow-up measures was calculated as standardized response mean (SRM) for both clinical and digital daily life activity and gait measures. Results. Several gait and activity measures demonstrated statistically significant changes over 12 months compared to baseline, with larger effect sizes than MDS-UPDRS. For instance, median bout length decreased substantially over 12 months, showing a stronger effect size than the MDS-UPDRS Part III total score (SRM = -0.61 vs. 0.05). Additionally, gait metrics such as stride length variability (SRM = 0.59) and foot pitch angle variability (SRM = 0.55) exhibited medium effect sizes, compared to a smaller effect size observed for the MDS-UPDRS Part II total score (SRM = 0.19). Conclusions. Unlike the MDS-UPDRS Part II & III total scores, digital daily life gait measures assessed by wearable sensors captured the natural progression of early PD within just one year

suggesting a promising outcome for upcoming early intervention multicenter clinical trials.

P02-G-72 - Gait characteristics and recovery process of cerebellar stroke patients with ataxia

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Background and aimGait disturbances in cerebellar ataxia are defined by irregular patterns resulting from impaired multi joint coordination and stability. While much of the existing research has focused on progressive diseases such as spinocerebellar degeneration, the recovery process in cerebellar stroke patients with ataxia remains poorly understood. The study aimed to clarify the gait impairment and recovery characteristics of patients with post-stroke cerebellar ataxia, with particular attention to the relationship between gait instability, regularity, and the severity of ataxia.MethodsThe study included fifteen patients with cerebellar ataxia after stroke (mean age: 64.2 ± 14.7 years; 46.0 ± 20.0 days post-stroke) and twenty-nine healthy elderly individuals (mean age: 72.4 ± 10.8 years). Participants were asked to walk along a 10-meter path at a comfortable pace while eight inertial sensors were attached to their trunk and lower extremities. Gait characteristics were quantified based on gait speed, trunk sway instability in anterior-posterior and left-right directions, trunk sway regularity, and the coefficient of variation (CV) of gait cycle time. The severity of ataxia was evaluated using the Scale for the Assessment and Rating of Ataxia (SARA). Stroke patients were reassessed 30 days after their initial measurements.Results and discussionCerebellar stroke patients showed slower gait speed, increased trunk sway instability, and higher variability in gait cycle time compared to healthy elderly participants . These characteristics improved over the 30-day observation period, although the increased variability in gait cycle time persisted. Interestingly, trunk sway regularity was comparable to that of healthy participants at both measurement points, suggesting that its control is governed by mechanisms distinct from those regulating gait speed and stability. Correlation analysis revealed that at the initial measurement, more severe ataxia was associated with higher regularity of left-right trunk sway. After 30 days, however, a moderate positive correlation emerged between ataxia severity and the regularity of anterior-posterior trunk sway. This finding indicates that patients with severe ataxia may initially rely on compensatory mechanisms involving conscious repetition of movement patterns to stabilize gait. As their condition improved, this compensatory reliance diminished, and their movements became more controlled, even in the presence of residual irregularities.ConclusionCerebellar stroke patients exhibit distinct gait

characteristics compared to healthy elderly individuals, and these characteristics show a clear potential for improvement over time. Initially, trunk sway regularity appears to act as a compensatory mechanism that restricts the range of movement, but, as ataxia severity decreases, the capacity for dynamic and controlled gait increases. This study highlights the importance of understanding compensatory mechanisms in the rehabilitation of cerebellar stroke patients with ataxia.Declaration of conflicts of interestThere were no conflicts of interest in relation to the preparation of this manuscript or the research discussed in this study.

P02-G-73 - Gait analysis and aplication of normal population based on long static platform

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Background and aimTo analyze gait characteristics across different age groups in healthy individuals, establish reference ranges for gait parameters in the Tianjin region, evaluate fall risk factors in the elderly, and provide guidance for fall prevention and balance rehabilitation in an aging society.MethodsA total of 120 healthy participants (66 males, 54 females; mean age: 43 years, range: 13–75 years) were recruited. All participants underwent six gait and balance tests simulating daily movements using a static long-platform system at the Vestibular Balance Center of Tianjin First Central Hospital. The tests included sit-to-stand, walking, tandem walking, walking with quick turns, step-up and step-down, and forward lunge. Participants were divided into young, middle-aged, and elderly groups based on age. Group differences in gait and balance parameters were compared, correlations between age and gait parameters were analyzed, and participants aged ≥60 years were further classified into fall-risk and non-fall-risk groups. Regression analysis was used to predict fall risk intensity.Results(1) Reference ranges for gait and balance parameters were established for healthy individuals across age groups.(2) Age showed linear correlations with stride length, gait speed, quick-turn time, turning sway, and lunge distance ($P < 0.05$). The elderly group exhibited significantly slower gait speed, longer movement time, and shorter lunge distance compared to the middle-aged and young groups ($P < 0.05$).(3) For individuals aged ≥60 years, the walking test, walking with quick turns test, and forward lunge test demonstrated higher accuracy in fall risk assessment. Increased stride width (P = 0.027, OR = 1.99, 95% CI = 1.08–3.66), slower gait speed (P = 0.020, OR = 0.82, 95% CI = 0.70–0.97), elevated terminal sway velocity (P = 0.031, OR = 2.85, 95% CI = 1.10–7.39), increased left/right turning sway velocity (P = 0.040, OR = 1.16, 95% CI = 1.01–1.30; P = 0.037, OR = 1.35, 95% CI = 1.02–1.80), and higher left/right step impact indices (P = 0.010, OR = 1.07, 95% CI = 1.02–1.12; P = 0.015, OR = 1.05, 95% CI = 1.01–1.09) were associated with increased fall risk.ConclusionThis large-scale clinical study established reference ranges for six gait and balance parameters simulating daily movements in the Tianjin population, with statistically significant differences across age groups. Compared to younger adults,

individuals aged ≥60 years demonstrated slower gait speed, prolonged movement time, and reduced lunge distance. Parameters such as stride width, stride length, gait speed, and terminal sway velocity effectively predicted fall risk in the elderly.

P02-H-74 - The cortical control of reactive balance recovery in adults with Developmental Coordination Disorder: An EEG feasibility study

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BACKGROUND AND AIM: Developmental Coordination Disorder (DCD), or dyspraxia, affects approximately 6% of the population and is associated with long-term balance difficulties and increased fall risk. Yet, the neural mechanisms underpinning these balance deficits are poorly understood. In typical adults, sudden balance loss evokes a distinct cortical signal (the N1), which plays a critical role in supporting postural recovery. The N1 is sensitive to balance challenge severity and attentional load, becoming maladaptively smaller when cognitive resources are diverted. Since individuals with DCD often struggle with dual-tasking and experience frequent falls, the cortical N1 may provide a neurophysiological marker of their postural control difficulties. This feasibility study aims to determine whether N1 responses can be reliably recorded during reactive balance recovery in adults with and without DCD and whether these responses are disrupted by dual-tasking.METHODS: Twenty-four adults (12 with DCD, 12 typically developing controls) will complete a perturbation-based balance task while EEG, EMG, and kinetics are recorded. Participants will be stood on a treadmill that delivers discrete, unpredictable anterior-posterior perturbations at two speeds (slow and fast). Each participant will face 9 blocks of 8 perturbations across three counterbalanced conditions: (1) single-task balance, (2) dual-task with a visual cup-game (requiring online tracking of a ball hidden beneath shuffled cups), and (3) dual-task with a memory game (recalling features/quantities of items shown during the block). EEG activity will be analysed to assess the presence, amplitude, and timing of the N1 component, with comparisons across group and task conditions.RESULTS: As this is a feasibility study currently in progress, no results are available at this stage. We anticipate that the N1 will be reliably measurable across all conditions, and that individuals with DCD will show altered N1 responses, particularly during dual-task conditions.CONCLUSIONS: We expect that this study will demonstrate the feasibility of assessing perturbation-evoked EEG responses in adults with DCD and provide preliminary insights into how attentional demands influence cortical control of balance in this population. These findings will help inform future large-scale studies and the development of targeted neurorehabilitation strategies.ACKNOWLEDGEMENTS AND FUNDING: This project is funded by the Dowager Countess Eleanor Peel Trust. We gratefully acknowledge the support of our Public Involvement and Engagement group for shaping the study design.

P02-H-75 - Six-month follow-up of cortical frontoparietal brain activity during an anticipatory postural control task in children with developmental coordination disorder: An fNIRS study

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Background&aim: Developmental coordination disorder (DCD) is a neurodevelopmental disorder with a prevalence of 5-6% in school-aged children. It is characterized by a delay in the acquisition of motor skills, with 60-87% of the children experiencing balance problems. Interventions focussing on postural control can improve these problems, but little is known about the effects on brain activity. However, before potential intervention effects can be assessed, it is crucial to investigate whether brain activity during a functional balance task remains stable longitudinally. Therefore, the present work aims to examine cortical brain activity in frontoparietal regions in children with DCD, over a period of six months without performing an intervention. Methods: Twenty-two children with DCD between the age of 6 and 12 years were included (mean age ± SD at baseline: 8.2y ± 1.6). All participants performed one balance task, alternate stair touch (i.e. 8 steps as fast as possible, 5 repetitions), while undergoing functional Near-Infrared Spectroscopy (fNIRS). The children were assessed at two measurement sessions (T1, T2), with a six-month interval between measurements. fNIRS data were recorded using the NIRSport 2 (NIRx Medical Technologies, Berlin, GE). Specific channels were chosen to probe two regions of interest (supplementary motor area (SMA)/premotor cortex (PMC) and inferior (IPL)/superior parietal lobule (SPL)). Changes in cortical oxyhemoglobin (ΔHbO) were measured, and compared between the two sessions using a paired-samples t-test.Results: Mean brain activity (ΔHbO) for the SMA/PMC showed no significant differences between the two measurement sessions, $t(21)=-1.530$ (two sided $p=0.141$). Also for the IPL/SPL, mean brain activity (ΔHbO) showed no significant differences between time points $t(21)=-1.756$ (two-sided $p=0.94$). The visual inspection of the data revealed a marginally lower activity at T1 in both regions of interest, compared to T2 (Figure1). Conclusion: This preliminary work indicates that the pattern of frontoparietal activation during an alternate stair touch task remains stable in children with DCD over a six-month period. However, this pattern appears to be susceptible to fluctuations over time, which warrant further investigations with additional analyses. Overall, the present findings highlight the importance of characterizing cortical brain activity in a functional balance task in children with DCD during a non-treatment baseline before exploring changes in brain function related to specific treatments.
Acknowledgements and funding: We would like to thank all children and parents for their participation in the data collection. This study was supported by the special research fund of Hasselt University (BOF23OWB20).

P02-I-76 - Comparing continuous foslevodopa-foscarbidopa infusion (Produodopa) with standard oral therapy on gait and imbalance in advanced Parkinson's disease

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Background Imbalance with falls is a key milestone in Parkinson's disease (PD) and one which is generally unresponsive to levodopa. Indeed, postural sway may increase on levodopa, potentially reflecting worse balance. Conversely, some features of gait dysfunction (e.g. stride length, gait speed) are levodopa-responsive, whilst others (e.g. double limb support time variability) are not. Foslevodopa-foscarbidopa (Produodopa) is a new continuous dopaminergic infusion therapy for PD, which smooths motor fluctuations by reducing OFF-time and increasing ON-time without troublesome dyskinesia. We hypothesise that the levodopa-responsiveness of imbalance (and gait) is linked with the temporal delivery of levodopa. Hence, we predict that Produodopa will show benefit upon imbalance (and gait) above that seen with standard oral dopaminergic treatment in advanced PD. Methods Produodopa initiation at Charing Cross Hospital (Imperial College Healthcare Trust) in London began in November 2024. Patients referred for Produodopa initiation were invited to undergo gait and balance assessments: a) before initiating; b) 1-month after initiating Produodopa. The assessments, performed in best medication-ON only, were: Static posturography (4 combinations of hard/soft surface and eyes open/closed) Timed Up-and-Go (TUG) (+/- cognitive dual task [DT]) 7m walk (+/- cognitive DT) 720 degree turns (360 in opposite directions, +/- cognitive DT)Our primary outcomes were gait and postural sway measures collected from 6 APDM Opal wearable sensors (2x wrists; 2x ankles; lumbar; sacral). Cognitive DTs were semantic (e.g. naming animals). Participants also completed clinical (e.g. UPDRS III) and quality of life assessments. This preliminary analysis includes 6 participants. Data collection is still ongoing, and we plan to repeat assessments at 6 months.   Results Our pilot data shows that gait speed and cadence were significantly improved after 1-month of Produodopa, with and without DT (all $p < 0.01$). Unexpectedly, stride length (generally levodopa responsive, p 0.011) worsened and double limb support time (generally levodopa unresponsive, p 0.007) improved with DT. Despite trends towards improvements in TUG time (with and without DT), these were non-significant. There were no significant differences in sway root mean square in easy or difficult posturography conditions, despite improvements in dyskinesia. Motor fluctuations (measured by UPDRS-IV, p 0.003) and functional ability (measured by Schwab & England score, p 0.025) were significantly improved after 1-month of treatment with Produodopa. There were also non-significant trends towards improved confidence in balance and falls avoidance and improved non-motor and freezing of gait questionnaire scores. UPDRS-III in ON was unchanged. Our overall Produodopa complication rates were similar to those in the literature: 20% distressing hallucinations; 7% mild cellulitis; 7% discontinuation.

Conclusions Our preliminary data suggest that gait dynamics are generally improved with Produodopa, excluding the unexpected reduction in stride length, and postural sway is unaffected. This does not support our main hypothesis regarding imbalance and the temporal delivery of levodopa, though more data is required to make firm conclusions. Produodopa appears to be a useful adjunct for the levodopa-responsive features (e.g. motor symptoms) of advanced PD. Limitations include the small study population, lack of blinding/control, lack of PD sub-phenotyping and short follow-up.

P02-I-77 - Systematic review of wearables assessing medication effect on motor function and symptoms in Parkinson's disease

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Background and Aim: To improve motor function and symptoms, people with Parkinson's (PwP) often take dopaminergic medication (e.g., Levodopa) (1). However, due to complex medication regimens, medication adherence is often poor in PwP, with clinicians typically adapting regimens based on isolated appointments, in which snapshot insights are gained. Wearable technology (WT) can provide objective and continuous insights into medication effect, which can be used to optimise medication regimens. This review aims to identify and explore studies which use WT to quantify the effect of medication on motor function and symptoms in PwP.Methods: Nine databases (PubMed, Scopus, Cochrane, IEEE, PsychInfo, Embase, Web of Science, Medline, and CINAHL) were searched between January 2000 - October 2024. Study quality was assessed using the Downs and Black quality appraisal. After duplicate removal, 4626 articles were screened by title and abstract, 209 articles underwent full-text review, and 79 articles were included.Results: Amongst the 79 included studies, medication effect was assessed on 13 different motor function/symptoms, with gait most commonly assessed in 50 studies. There was great heterogeneity in the WT used, and its placement on the body, with 50 different WTs placed across 20 locations on the body. Research was generally conducted in controlled environments (57 studies), exploring short-term medication effects (e.g., one hour after medication intake), with 64 studies comparing motor function/symptoms between ON-OFF medication states. Across the studies which utilised ON-OFF monitoring, 22 different timings were used to assess ON state, and 15 different timings were used to assess OFF state. Synthesised results highlighted that in PwP, medication improves pace related gait metrics, turning, bradykinesia, and tremor, but has a negative effect on balance, and limited to no effect on sit to stand variables. Conclusions: This review highlighted that there are no standardised procedures to objectively monitor medication effect in PwP, with great heterogeneity in the technology and protocols used. To provide more in-depth insights, and enable optimal adaptation of medication regimens in PwP, future research should explore medication effect in the real-world, over

prolonged time periods (e.g., 7 days), and identify/utilise gold-standard protocols to assess medication effect in PwP. Armstrong MJ and Okun MS. Diagnosis and Treatment of Parkinson Disease: A Review. JAMA. 323, 548-560 (2020).

P02-I-78 - Prosthetic foot design mitigates amputation-related increases in performance fatigability among unilateral traumatic transtibial prosthesis users

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Background and aim: Activity-induced fatigue often precedes falls experienced by lower limb prosthesis users1 and increases the odds a fall will be injurious.2 Fatigability is often assessed by measuring metabolic cost of walking or by evaluating changes in gait speed during timed performance tests, but neither method accounts for self-pacing strategies prosthesis users adopt to avoid fatigue. These methods may therefore be less effective at evaluating interventions or detecting group differences, potentially fueling the debate about whether traumatic transtibial prosthesis users (TTPUs) are more fatigable than matched controls.3 Performance fatigability indices incorporate self-pacing by relating changes in gait speed to total distance walked.4,5 Although this method may improve detection of group differences and intervention efficacy it has yet to be tested in TTPUs. The aim of this study was to determine whether traumatic unilateral transtibial amputation and/or prosthetic foot design influences fatigability. Methods: 18 traumatic unilateral TTPUs (2 female, age:42.6±12.4 yrs, time since amputation:12.7±11.2 yrs) participated in a randomized crossover study of a novel prosthetic foot.6 12 adults (2 female, age:34.1±8.71 yrs) were recruited as controls. Fatigability was quantified as the ratio of change in walking speed to total distance walked during the six-minute walk test.3 Participants wore either an energy storing foot (ESF) or a crossover foot (XF) for one month before testing. The protocol was repeated a month later with the other foot. An independent t-test was run to compare fatigability between TTPUs and controls. A paired t-test was run to compare fatigability between prosthetic feet. Common language (CL) effect sizes were calculated to compare differences between groups and feet.7Results: Fatigability was greater in TTPUs ($\bar{x}$=1.76, 95%CI:1.65,1.87) than controls ($\bar{x}$=1.39, 95%CI:1.31,1.47), (t(28)=4.73, p<001). CL effect size of 0.90 suggests there is a 90% probability a TTPU will have greater fatigability than a control. Fatigability was lower among TTPUs when wearing the XF ($\bar{x}$=1.72, 95% CI:1.63,1.82) than the ESF ($\bar{x}$=1.76, 95% CI:1.65,1.87), (t(17)=1.755, p=0.049). CL effect size of 0.67 suggests there is a 67% probability a TTPU is less fatigable when wearing a XF than ESF. Conclusion: The crossover foot design appears to reduce amputation-related increases in performance fatigability, suggesting the standard-of-care ESF may limit TTPUs walking efficiency. Further research is needed to identify those factors responsible for TTPUs' greater fatigability and any related consequences.1. Sawers A et al. (2022)PloS One.17(7)2. Tobaigy M et al. (2023)PM&R.15(4)3. Miller & Esposito (2021)PeerJ(9) 4. Schnelle et al.

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P02-I-79 - The immediate effects of Vibrotexture insoles on quiet standing balance and lower limb neuromuscular responses in healthy older adults

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BACKGROUND AND AIM: Improved postural control is associated with a decreased risk of falls. Sensory-stimulating footwear devices are an emerging rehabilitation tool aimed at improving balance by enhancing sensory feedback to the soles of the feet. Devices incorporating single sensory-stimulating elements such as texture and vibration have been shown to improve balance in both healthy and clinical populations. Insoles combining multiple stimuli ('Vibrotexture') may offer greater benefits for postural control. This study aimed to investigate the immediate effects of wearing Vibrotexture insoles compared to vibrating, textured, and smooth insoles on quiet standing balance and lower limb muscle activity in healthy older adults. METHODS: Thirty healthy older adults (14 males; 69.8±5.8 years; 76.9±14.9kg; 171.0±8.4cm) stood on a force plate with standardised foot and body position. Participants completed 30-second quiet standing balance tests under four conditions: eyes open and closed, on both firm and foam surfaces, while wearing each of the four insole types (2 trials/condition) within standard footwear. Balance was assessed using centre of pressure (COP) anteroposterior (AP) and mediolateral (ML) range, and total COP velocity. Surface electromyography (EMG) was used to measure the amplitude of lower limb muscle activity from the medial gastrocnemius (MG), soleus, peroneus longus, rectus femoris, biceps femoris, and gluteus medius (dominant leg). A one-way repeated measures analysis of variance for COP, and a Friedman test for EMG, was used to analyse the data between insole conditions for each of the balance conditions, with post-hoc pairwise comparisons conducted using Bonferroni adjustment.RESULTS: Analysis of COP AP range indicated an interaction between insole conditions ($p=0.007$), while standing with eyes closed on a foam surface. Pairwise comparisons revealed less COP AP range while wearing the vibrotexture insoles compared to the textured ($p=0.028$) and smooth ($p=0.024$) insoles. There was also an interaction for COP AP range while standing with eyes open on a firm surface, with no post-hoc differences between insoles ($p\geq0.055$). Analysis of MG muscle activity showed an interaction between insoles while standing with eyes open on a firm surface ($p=0.028$), and post-hoc analysis indicated less amplitude while wearing the vibrating compared to smooth insoles ($p=0.031$).CONCLUSIONS: Wearing Vibrotexture insoles for the first time provides beneficial effects towards quiet standing balance in comparison to both insoles with a single sensory design (texture), and with no stimulation (smooth). Vibrating insoles may have the capacity to improve lower limb muscle activity, although these responses were not accompanied with changes in balance control within the specific balance condition. These findings provide new insights into sensory-

stimulating insole design features that can inform the development of innovative strategies for balance rehabilitation.

P02-I-80 - Development and safety assessment of a mobile electrical stimulator for therapeutic vestibular modulation

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Background and aimLow-intensity noisy galvanic vestibular stimulation (nGVS) has emerged as a promising, non-invasive method for improving vestibular perceptual performance and postural control in individuals with chronic vestibular hypofunction. To date, research on nGVS has primarily been limited to controlled laboratory settings. Recent evidence suggests that continuous application of nGVS during daily activities is needed to achieve sustained therapeutic benefits. For this reason, we developed a mobile nGVS stimulator and conducted a series of pilot studies to assess its safety, tolerability, functionality, and therapeutic potential.MethodsFirstly, the safety and tolerability of prolonged nGVS use were evaluated in healthy subjects over a two-hour stimulation period at a subthreshold intensity of 0.3 ppmA. Questionnaires assessing both mental and physical condition were completed before, during, and after stimulation. Secondly, the devices' ability to elicit vestibular sensorimotor reflex responses at suprathreshold intensities (1 ppmA) was assessed with an inertial measurement unit (IMU), recording body sway. Thirdly, to determine whether subthreshold nGVS could reproduce previously described positive effects on vestibular perception and static postural control, two tests were performed. Perception thresholds were evaluated as direction recognition thresholds (DRT) for head-centred roll-tilt motion using a six degrees-of-freedom motion platform. Participants received either sham stimulation or subthreshold nGVS at 0.3 ppmA in a randomised order. Postural stability was assessed using a force platform while applying nGVS at varying intensities (0 [sham] to 0.7 ppmA) in a randomised order. Changes in body sway across the trials were calculated to determine the impact of nGVS on postural control.ResultsDuring stimulation, 60% of participants reported a mild sensation of dizziness, which resolved immediately after the stimulation was turned off. No other notable sensory or postural effects were observed. Mild headaches were likely attributable to the electrode fixation via the headband. Suprathreshold stimulation elicited significant vestibulospinal responses, consistent with established patterns. Furthermore, subthreshold stimulation effectively reduced vestibular perceptual thresholds, with the degree of reduction depending on the participants' baseline perceptual thresholds. Analogously, postural control was stabilised in 69% of participants during stimulation.ConclusionsThe device largely met our requirements of being comfortably wearable, portable, and energy-efficient enabling long-term usage. However, improvements in electrode fixation are necessary to enhance comfort during prolonged use. All other tested parameters were

fulfilled reliably and satisfactorily by this stimulator, comparable to those of established devices.Acknowledgements & FundingThis research was funded by the German Federal Ministry for Education & Science (13GW0490B).

P02-J-81 - Digital biomarkers of fatigue in chronic diseases: Systematic review

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Digital Biomarkers of Fatigue in Chronic Diseases: A systematic review BACKGROUND AND AIM:Fatigue is a common and debilitating symptom in chronic diseases, significantly impacting quality of life and daily functioning. It is characterized by persistent tiredness and reduced energy, both mental and physical, and is often subjective and challenging to measure. Fatigue varies between individuals and across disease states, limiting physical activity, disrupting routines, and exacerbating symptoms like pain and cognitive impairment. This creates a cycle that worsens overall health.In conditions like multiple sclerosis (MS), rheumatoid arthritis (RA), and chronic obstructive pulmonary disease (COPD), fatigue is highly prevalent and disabling. It reduces daily engagement and physical function.Wearable technologies and digital health devices now enable objective measurement of physical activity and physiological signals, such as step counts, heart rate, and movement intensity. Digital biomarkers—quantifiable, objective data from these devices—offer a non-invasive and convenient way to monitor fatigue over time. When combined with self-reported measures, they provide a comprehensive view of fatigue impact.Recently, there has been growing interest in developing digital biomarkers of fatigue measured using smartphones and wearable devices in people with chronic diseases. This systematic review synthesizes current research examining the relationship between digital biomarkers and fatigue in individuals with chronic diseases. METHODS:Two reviewers (NA & CH) systematically reviewed 570 abstracts during title and abstract screening. 88 articles passed through for full text review, after exclusions based on study setting, design and full-text availability, the final sample comprised 51 articles. Studies were included if they had participants with at least one chronic disease, measured fatigue and used wearable sensors in a real-world environment to measure digital biomarkers. Studies were excluded if they monitored participants under controlled conditions (such as a laboratory or hospital), or if they explored physiological fatigue or fatigue induced by exercise. Articles were excluded if written in a language other than English.RESULTS: This review analysed 51 studies encompassing 5,573 participants across 15 chronic disease domains. Commonly measured digital biomarkers included physical activity, heart rate variability (HRV), gait, and sleep metrics. Fatigue was often associated with reduced physical activity and increased sedentary behaviour. Autonomic dysfunction, as evidenced by HRV abnormalities, was prominently observed in conditions with prevalent fatigue. Gait

analysis highlighted the impact of fatigue on mobility, particularly in neurodegenerative diseases like Parkinson's. Additionally, poor sleep was identified as a significant contributor to fatigue.CONCLUSIONS: This review underscores the potential of digital biomarkers—including physical activity, HRV, gait analysis, and sleep patterns—in assessing and managing fatigue across chronic diseases. The findings also emphasize the need for further research to enhance the use of digital measures in fatigue monitoring and intervention.FUNDING:This work was done as part of a PHD studentship funded by the NHIR Biomedical Research Centre(BRC) Newcastle .

P02-J-82 - Effect of advanced footwear technology on ground reaction forces at moderate running speed (14 km/h) and sprinting speed (18 km/h)

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Effect of Advanced Footwear Technology on Ground Reaction Forces at Moderate Running Speed (14 km/h) and Sprinting Speed (18 km/h)Priyadharshini Ramalingam1, R S Badhmanaban11School of Footwear Design and Production, Footwear Design and Development Institute, Chennai, IndiaBACKGROUND AND AIM: The running-related injury rate remains high at 37-56% [1], with impact-related ground reaction force (GRF) variables potentially playing a key role in injury causation [2][3]. Advanced footwear technology (AFT) has evolved significantly, with innovations such as carbon-fiber plates and specialized midsole materials claiming to enhance performance and reduce the risk of injury [4][5]. Despite advancements in footwear, the precise influence of AFT on GRF variables relative to standard footwear technology (SFT) across a spectrum of running speeds requires further investigation [6]. This study aimed to investigate the biomechanical effects of AFT on ground reaction forces during moderate (14 km/h) and high-speed running (18 km/h), focusing on peak vertical GRF, vertical impulse, peak propulsive force, propulsion impulse, vertical loading rate, peak braking force, and braking impulse [7][8].METHOD: Eighteen experienced runners (aged 20-25 years) will participate in this study. All participants will have prior experience running in AFT shoes and will be free from any lower limb injuries. This study will employ an experimental, repeated-measures design. Each subject will complete running trials under two footwear conditions (AFT and SFT) at two different speeds (14 km/h and 18 km/h)[9]. The trials will be conducted in a controlled laboratory setting on a running track with embedded force plates to measure ground reaction forces. Participants will complete four randomized running trials: (1) AFT at 14 km/h, (2) SFT at 14 km/h, (3) AFT at 18 km/h, and (4) SFT at 18 km/h. Upon traversing the force plates, three-dimensional GRF data will be collected at 1000 Hz[10]. Primary outcome measures will include peak vertical GRF, vertical impulse, peak propulsive force, propulsion impulse, vertical loading rate, and peak braking force [5][11]. To ensure accurate speed control, two sets of timing gates, positioned 5 meters before and after the force plates (covering a 10-meter distance), will be used to measure each runner's split time. Trials will be considered successful only if the runner's measured speed is within ±3% of the target speed (14 km/h or 18 km/h). If a runner's split time falls outside the acceptable range, the trial will be discarded, and the subject will be asked to repeat the trial. Each runner will complete three successful trials per speed per shoe condition. A two-way repeated measures ANOVA (footwear × speed) with post-hoc Tukey tests will be conducted to analyze differences between footwear conditions at each speed ($\alpha=0.05$).RESULTS: We expect AFT will significantly reduce peak vertical GRF compared to SFT at both 14 km/h (-8.5%, $p<0.05$) and 18+ km/h (-7.0%, $p<0.05$)[5][9]. Vertical loading rates are anticipated to be 12-15% lower in AFT at both speeds ($p<0.01$)[4][11]. At moderate running speeds, AFT is expected to significantly alter vertical impulse compared to SFT ($p<0.05$), while increasing peak propulsive force (+6-8%, $p<0.01$) and enhancing propulsion impulse (+5-7%, $p<0.01$)[5][12]. During high-speed running, AFT is expected to reduce peak braking force by 8-10% compared to SFT ($p<0.01$) and decrease braking impulse ($p<0.05$)[5].CONCLUSIONS: Advanced footwear technology is expected to significantly alter GRF characteristics during both moderate and high-speed running, with potentially beneficial modifications to impact forces, loading rates, and propulsive capabilities [4][5][9]. These alterations may have implications for both performance enhancement and injury risk modification [6]. The anticipated reduction in impact forces and loading rates with concurrent enhancement of propulsive forces suggests that AFT might provide a dual benefit of improved performance metrics while potentially lowering injury risk[4][5]. These findings would provide evidence-based guidance for footwear selection based on individual running speed preferences and training goals [6].

P02-J-83 - Home-based digital augmented-reality rehabilitation for individuals recovering from stroke: Protocol of a clinical trial

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Home-Based Digital Augmented-Reality Rehabilitation for Individuals Recovering from Stroke: Protocol of a Clinical TrialD.J. Geerse1, A.T. van Dam1, J.S. van Bergem1, S.J. van Hall1, E.M. Hoogendoorn1, M. Roerdink11Department of Human Movement Sciences, Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam, Amsterdam Movement Sciences, The NetherlandsBACKGROUND Physiotherapy post-stroke is essential for improving gait, balance, upper-limb functioning and reducing falls risk, with home-based therapy playing a key role. Augmented-reality (AR) technology like Strolll AR, which has shown promise in Parkinson's disease rehabilitation (Geerse et al., 2025; Hardeman et al., 2024), has now been adapted for stroke. This AR platform delivers therapeutic exercises via AR glasses, which can be performed under direct supervision of the therapist in the clinic, but also independently at home.AIM The objective of this clinical trial with Strolll AR is to examine its feasibility and effectiveness for improving clinical indicators of gait, balance, upper-limb functioning and falls risk in post-stroke individuals.METHODS 100 post-stroke individuals will participate in this clinical trial. Clinical assessments will be performed before and after the intervention to test the effectiveness of Strolll AR. The 8-week Strolll AR intervention period starts supervised in the clinic and continuous independently at home. The primary study parameters are feasibility (safety, adherence, performance, and user experience) and effectiveness for improving clinical indicators of gait, balance, upper-limb functioning and falls risk.RESULTS AND CONCLUSIONS This clinical trial will evaluate feasibility and effectiveness of Strolll AR in real-world settings for stroke rehabilitation. Strolll AR may facilitate the transition from supervised to independent care at home, offering personalized rehabilitation in a resource-efficient manner (i.e., more care with fewer staff).ACKNOWLEDGEMENTS This collaboration project DARE-STROKE between Vrije Universiteit Amsterdam and Strolll is co-funded by the PPP Allowance made available by Health~Holland, Top Sector Life Sciences & Health, to stimulate public-private partnershipsREFERENCESGeerse DJ, Hoogendoorn EM, van Doorn PF, van Bergem JS, van Dam AT, Hardeman LES, Roerdink M. Cueing-assisted gamified augmented-reality gait-and-balance rehabilitation at home for people with Parkinson's disease: protocol of a pragmatic randomized controlled trial implemented in the clinical pathway. Front Neurol. 2025 Feb 24;16:1512409.Hardeman LES, Geerse DJ, Hoogendoorn EM, Nonnekes J, Roerdink M. Remotely prescribed, monitored, and tailored home-based gait-and-balance exergaming using augmented reality glasses: a clinical feasibility study in people with Parkinson's disease. Front Neurol. 2024 May 30;15:1373740.

P02-J-84 - Steps to health: Backward walking predicts physical activity levels in Multiple Sclerosis

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Background: Physical activity is a key determinant of health, linked to improved physical and mental well-being. In populations with limited physical activity, such as those with Multiple Sclerosis (MS), mobility impairments, cognitive challenges, and fear of falling can affect daily movement. While connections between these factors and step count, a common measure of physical activity, are established, methods for predicting who meets recommendations remain scarce. Identifying individuals who meet activity recommendations, like step count goals, is crucial for the development of targeted interventions. This study aimed to develop a clinically practical method for determining whether individuals with MS meet step count goals, integrating patient-reported outcomes with objective measures of mobility and cognition to guide strategies for enhancing physical activity and health outcomes.Methods: Participants provided demographic information and completed patient-reported outcomes on perceived mobility disability (PDDS, MSWS-12) and fear of falling (FES-I). Walking was assessed in

forward (FW) and backward (BW) directions at a self-selected pace. Static and reactive balance were evaluated using the eyes-closed feet-together test and push-and-release test, respectively. Cognitive function was assessed via a comprehensive battery including the Symbol Digit Modalities Test, Brief Visuospatial Memory Test, Trail Making Test (parts A & B), and California Verbal Learning Test. Participants then wore a Fitbit for 3 months to track physical activity. Based on their average daily step counts over the 3-month period, participants were categorized into two groups: those who, on average, achieved the recommended daily step goal for individuals with MS (7,500 steps), and those who did not.Results: A total of 46 individuals with MS (age: 51.30±11.05; median PDDS: 1; 83% female) participated, with 15 meeting the 3-month average daily step goal. Wear time compliance was 90.15 ± 7.56% over 3 months. Step count correlated significantly with PDDS (-.36), MSWS-12 (-.49), FES-I (-.38), FW (.46), and BW (.58). Significant predictors were included in a logistic regression model using backward selection to identify the best predictors of meeting the daily step goal. The analysis identified a backward walking speed cutoff of 0.89 m/s as a strong predictor of meeting the step goal, with a sensitivity of 90.3%, specificity of 60.0%, an area under the ROC curve of .80, and a Nagelkerke R^2 of .32.Conclusions: This study identifies backward walking speed as a clinically feasible predictor of meeting the recommended daily step goal for individuals with MS. The model demonstrates good sensitivity, moderate specificity, and a significant area under the curve, providing a valuable tool for healthcare providers to assess physical activity levels. These findings emphasize the clinical significance of using objective mobility measures, such as BW, to target interventions aimed at improving physical activity and health outcomes for people with MS.Acknowledgements: This project was supported by the National Multiple Sclerosis Society Mentor-Based Postdoctoral Fellowship in Rehabilitation Research (MB-2107-38295), National Multiple Sclerosis Society Research Grant (RG-2111-38718), and the NIH (R21HD106133).

P02-K-85 - Clinical management of concerns about falling: Gaps, barriers and future directions

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Background and Aim:Concerns (or “fears”) about falling are common in older adults and people with clinical balance disorders. Experimental and epidemiological data highlight that such concerns can disrupt balance and increase fall risk. Although various evidence-based guidelines exist to address concerns about falling (e.g., World Falls Guidelines), anecdotal evidence suggests low levels of adoption within clinical practice. The aims of this programme of research were to (i) explore gaps and barriers to the clinical management of concerns about falling, and (ii) identify practical, evidence-based intervention strategies that can be implemented alongside usual care.Methods:First, a

scoping review was conducted to identify psychologically informed techniques currently being used to address concerns about falling. Next, a mixed-methods survey examining current practices regarding the management of concerns about falling was completed by 114 falls-prevention healthcare professionals. Finally, semi-structured interviews were conducted with 30 falls-prevention healthcare professionals. These interviews aimed to gain deeper insights into experiences of managing concerns about falling (specifically barriers and facilitators for successful implementation) and to explore their perspectives on the most feasible and acceptable way to clinically manage concerns.Results:The scoping review revealed a wide range of existing psychological techniques/interventions, the most common being cognitive behavioural therapy, followed by exposure therapy and motivational interviewing. However, the time and resource demands of many interventions (average total dose = 5 hours 50 minutes) may challenge their integration into clinical practice. Results from the survey identified low rates of adoption of the evidence-based recommendations presented within the World Falls Guidelines regarding the management of concerns about falling, particularly within hospital settings. Interview data further underscored systemic barriers to implementing current evidence-based strategies, including time constraints, training gaps, competing priorities, and lack of awareness about the impact/importance of concerns about falling.Conclusions:This research highlights a critical mismatch between best-practice recommendations regarding the management of concerns about falling and what is currently feasible in everyday clinical practice. Findings point to the need for time-efficient, evidence-based strategies to address concerns about falling which can be delivered alongside current clinical practice. We present recommendations on how this can be clinically achieved, based on the present findings.Acknowledgements and Funding:The Sir Henry Wellcome Doctoral Training Programme Postdoctoral Fellowship by the Economic and Social Research council (Grant Number: ES/V010131/1) and the London Interdisciplinary Social Sciences Doctoral Training Programme by the Economic and Social Research council, both awarded to Dr. Toby J Ellmers.

P02-K-86 - Flywheel power training improves gait initiation, rate of force development, functional mobility and balance in older adult fallers

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Background and aim: Aging leads to declines in neuromuscular performance, particularly in rate of force development (RFD), which significantly increases fall risk. These deficits are more profound in the musculature that controls center of mass (CoM) motion in the frontal plane, crucial for gait initiation (GI). While GI is strongly driven by voluntary control, the mechanisms that drive the anticipatory postural adjustments are inherently similar to those of balance reactive control. Power training has been shown to enhance RFD and neuromuscular performance, with eccentric loading through flywheel training offering unique benefits, particularly for underutilized frontal plane muscles.

However, its effects in older adults, particularly in GI, remain largely unexplored. Hence, this study aimed to investigate the effects of 10 weeks of lower limb flywheel power training, on GI parameters, neuromuscular performance, functional mobility and balance in older adult fallers.Methods: Fifteen older fallers (72.67±4.81 years) participated in a 10-week progressive flywheel power training program (twice per week), where participants performed bilaterally 3 sets of 10 repetitions of ankle dorsiflexion (DOR), hip abduction (ABD) and adduction (ADD). GI was assessed with simple reaction time (SRT) and choice reaction time (CRT) stepping tasks on a force platform (10 trials each condition, 5 trials per side). Maximal voluntary isometric contractions (MVIC) were used to evaluate the trained muscles' neuromuscular performance. Functional mobility and balance were evaluated with Mini-BESTest, Timed Up and Go (TUG), Dual-task TUG, and Four-Square Step Test (FSST). A linear mixed-effects model was used to assess the effects of the intervention, with statistical significance set at $p<0.05$.Results: Flywheel power training Improved isometric normalized RFD for ankle DOR (Pre: 0.21±0.10 vs Post: 0.26±0.13, $p<0.05$), hip ABD (Pre: 0.18±0.09 vs Post: 0.24±0.16, $p<0.05$) and hip ADD (Pre: 0.18±0.08 vs Post: 0.25±0.11, $p<0.05$). Similarly, Mini-BESTest scores increased (Pre: 23.33±3.5 vs Post: 25.5±2.47, $p<0.05$) and FSST times decreased (Pre: 7.59±1.53s vs. Post: 6.53±1.49s, $p<0.05$). CRT showed improved reaction times (Pre: 0.240±0.092s vs Post: 0.215±0.066s, $p<0.05$), reduced mediolateral normalized RFD (Pre: 0.20±0.10 vs Post: 0.16±0.08, $p<0.05$), CoP displacement (Pre: 0.053±0.026m vs Post: 0.044±0.020m, $p<0.05$) and velocity (Pre: 0.125±0.039m/s vs Post: 0.102±0.036m/s, $p<0.05$) and anteroposterior CoP displacement (Pre: 0.096±0.025 vs Post: 0.090±0.023, $p<0.05$) and velocity (Pre: 0.232±0.103 vs. Post: 0.169±0.057, $p<0.05$).Conclusions: The present results may be indicative that flywheel power training can improve dynamic control and stability during GI, neuromuscular performance and ultimately reduce fall-risk, even among those older adults that have experienced falls in the past, making it a promising intervention for fall prevention.

P02-K-87 - Relationship between plantar friction perception and Somatosensory modalities

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BACKGROUND AND AIM: Falls in bathrooms are common among the elderly, with slipping of the plantar surface identified as a major contributing factor. Age-related deterioration in somatosensory function may hinder elderly individuals from accurately perceiving slipping events. Therefore, elderly individuals may have difficulty accurately perceiving slips due to age-related deterioration in somatosensory function. However, few studies have examined the relationship between plantar friction perception and somatosensory perception, and how this relationship may influence slip-related falls. This study aims to experimentally investigate the relationship between plantar friction perception on floor surfaces with varying coefficients of friction and somatosensory function, including both plantar tactile sensation and proprioception.METHODS: 22 young adults (11 males and 11 females, 21-26 yrs.) participated in this study. Plantar tactile sensation and proprioception were assessed using a tactile pressure test with monofilaments, foot height discrimination and foot position reproduction tests, respectively. Participants were asked to slide their dominant foot on plastic floor surfaces under different lubrication conditions including dry, water lubrication, and soapy water lubrications with varying concentrations (0.50 wt%, 2.44 wt%, and 9.09 wt%). The friction coefficient at the time of sliding out was calculated by measuring the friction force with force plates and tracking the foot position with a motion analysis system. Sensory evaluation scores of plantar friction (Es) were investigated by assigning a value of 100 to the dry condition and 0 to the highest concentration of soapy water. The Pearson correlation coefficient (rs) between the difference in friction coefficient from the highest soapy water concentration and Es was used as an index for plantar friction perception accuracy. The relationship between rs and the scores from the somatosensory sensation tests was analyzed.RESULTS: There were individual differences in the results of the somatosensory and cutaneous sensation tests. There was no correlation between rs and proprioception ($r < 0.1$), whereas a weak positive correlation ($r = 0.37$) for plantar tactile sensation. Furthermore, a negative correlation ($r = -0.61$) was observed with Dm (mDry−m9.09 wt%), indicating that the higher precision in friction perception is associated with the greater difference in friction coefficient. These results suggest that not only plantar tactile sensation but also the intensity of the frictional stimulus affects the precision of plantar friction perception.CONCLUSIONS: This study was the first attempt to investigate the effects of the plantar friction coefficient and somatosensory sensation on the precision of plantar friction perception. Our findings indicated that the plantar tactile sensation and the intensity of the frictional stimuli influence the accuracy of plantar friction perception in young adult participants. The results for elderly participants will also be presented at the conference.

P02-K-88 - Age related differences in stability: Examining initial and final responses to balance perturbations

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Background & Aim: Mediolateral (ML) stability is critically important among older adults, given the link to lateral falls and hip fracture. Compensatory postural adjustments (CPA) are an often-overlooked component of balance recovery during a stepping response, because they are typically too small and brief to impact ML centre of mass (COM) kinematics (McIlroy & Maki, 1993). During a stepping response, there are two main phases when ML stability can be controlled through applied force generation: the initial phase, which includes the CPA, and the restabilisation phase, where lower limb force generation is timed, scaled and directed to arrest the COM. While age-related differences in stability have been linked with the restabilisation phase, it remains unknown if CPA, when present, can have a meaningful effect on stability during the restabilisation phase of a compensatory step. We aimed to conduct a preliminary analysis of the influence of initial phase balance variables on the restabilisation phase. Methods: Whole body motion analysis and force platform data were collected during a 10% body weight lean-and-release perturbation. 20 younger (YA) and 20 older adults (OA) participated. The magnitude and timing of the CPA were quantified during the initial phase, along with the impact of the CPA on the ML COM displacement. During the restabilisation phase, instability was quantified by COM incongruity and time to stability. The kinetic response was quantified by the magnitude and timing of the peak divergence of the net ground reaction force relative to the COM (P1 and P2 peaks) (Singer et al., 2016). Spearman rank correlation coefficients were calculated within each age group to quantify the association between initial and restabilisation phase variables.Results: Among both groups, an increased CPA led to increased displacement of the COM towards the stance limb, and a smaller lateral velocity before toe-off (TO), while an increased COM velocity at heel contact (HC) was associated with increased step width and time. Among OA, a reduced COM velocity at TO led to a reduced COM velocity at HC. Among YA, an increased COM velocity at HC was associated with increased peak ML ground reaction force during restabilisation. No initial phase variable was related to instability or kinetic outcomes during restabilisation.Conclusions: The lack of associations between the initial response phase and restabilisation phase variables suggests that restabilisation during compensatory stepping may occur independent of initial phase parameters. Restabilisation in response to balance perturbations may be improved by focusing on restabilisation phase kinetics, like stepping force magnitude, orientation and timing. Continued work in this area may help determine biomechanical targets for falls prevention.Acknowledgements & Funding: We acknowledge financial support from the University of Manitoba and the Natural Sciences and Engineering Research Council of Canada (NSERC).

P02-K-89 - A systematic review of the evidence of interventions to reduce falls and improve safety on stairs

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Background and AimsStair negotiation presents a serious safety hazard for older adults, with stair falls being the leading cause of accidental death [1,2]. Mechanistic, proof-of-principle, research has informed the development of interventions to improve staircase safety by improving the users' ability to progress the foot over the step edge ensuring sufficient foot clearances and place it accurately on the step with adequate foot contact lengths, while also meeting the physical demands of balance and strength. The aims of this systematic review are to synthesise, evaluate and assess stair fall interventions, to identify those which show effectiveness and potential for implementation, and to

establish a pathway for implementation for these interventions. MethodsFive databases (PubMed, Web of Science, CINAHL, Scopus and MEDLINE) were searched for studies investigating any form of intervention that sought to reduce risk or occurrence of falls on stairs. Quality was assessed using the Cochrane RoB-2 tool as well as a modified tool, adapted for use with proof-of-principle studies. Study data were extracted and grouped according to their independent variable: stair dimensions and visual properties, surrounding environment, or human behaviour. Findings were interpreted in two round-table events to understand the synthesised evidence on their effectiveness, and to recommend and prioritise future research to progress interventions along a pathway to implementation (adapted from MRC Complex Intervention Framework [3]). ResultsFifty-seven interventions were included. Using the Cochrane RoB 2 tool n=49 papers were deemed to have high risk of bias. The modified tool rated n=37 studies as low risk for proof-of-principle. No study used fall rate as an outcome measure. Only step-edge highlighters were studied in a real-world environment [4], outside the laboratory. Synthesis highlights several interventions show potential to improve stair safety. However, due to varied outcome measures and lack of real-world testing, further translational research is required before implementation can be supported. The pathway to implementation (Figure 1) synthesises the current research landscape and acts as signposting for future intervention development. Despite limited evidence, step-edge highlighters, step dimensions, and the use of handrails are already implemented in the real-world; these interventions warrant further evaluation in naturalistic and real-world settings to provide the evidence supporting and optimising their application. Priorities should also be placed on interventions which are widely acceptable due to their lower cost and ease of application, these include wall décor, step décor and changes of lighting. Behavioural and physical interventions require further investigation due to the important interaction of the person and the staircase itself. ConclusionThis review identified no interventions directly assessing stair fall rates. Instead, studies have proven effectiveness on measures of stair fall risk in laboratory studies. These interventions require targeted translational research for implementation in real-world environments. Effective interventions should then be used to inform healthcare professionals and policies to improve safety and reduce falls on stairs. ReferencesStartzell, J.K., et al. Journal of the American Geriatrics Society, 48, 567-580, 2000. [LINK]Jacobs, J.V. Gait & Posture, 49, 159-167, 2016. [LINK]Skivington, K. et al. British Medical Journal, 374, n2061, 2021. [LINK]Brown, C.B., et al. Ergonomics, 66, 1219-1228, 2023. [LINK]

P02-K-90 - A randomized study on the effects of action observation with motor simulation for improving reactive stepping in older adults with a history of falls

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BACKGROUND AND AIM. Reactive stepping responses are critical for preventing falls following balance perturbations. Perturbation-based training has shown to improve reactive stepping performance, but requires expensive equipment and supervision. Currently, there is no safe and feasible way to practice reactive stepping at home. Previously, we showed that action observation with motor simulation of reactive steps (AOMS) yielded gains in reactive stepping performance in healthy young adults [1]. We aimed to investigate whether AOMS is effective to improve reactive step quality in older adults at risk of falling as well. Additionally, we investigated whether the effects differed between AOMS of a humanoid avatar or a human actor.METHODS. Seventy older adults (68.3±5.2 y/o; 52 f) with a history of at least one fall in the past year were randomly allocated to a control group (CTR) or one of the two AOMS groups (Fig1a). They were subjected to the same series of 20 real balance perturbations (i.e., a forward translation of a movable platform at 3 m/s^2) that elicited backward steps. The instruction was to recover balance with a single step. Before experiencing the real balance perturbations themselves, the HumanAOMS participants observed and simulated a human actor's reactive steps in response to the same series of platform perturbations. The AvatarAOMS group observed and simulated a virtual humanoid avatar's reactive steps instead, whose balance was perturbed by a large bird colliding from the front. The CTR group was tested without any prior AOMS. Our primary outcome was the quality of the reactive step during the 20 real balance perturbations, as quantified by the leg angle at first foot contact. RESULTS. Leg angles were poor (i.e. well below zero) in the first perturbation trial, without significant between-group differences, but improved at different rates across groups over the course of repeated trials. In the CTR group, the mean leg angles of the first nine trials were significantly lower than the grand mean of the last trial, whereas this was true for the first four trials only in the joint AOMS groups (Fig1b). The HumanAOMS and AvatarAOMS groups demonstrated similar performance (i.e., significant differences between grand mean and trials 1-3 and trials 1-4, respectively).CONCLUSIONS. Reactive step quality improved upon repeated real perturbations in all groups, however, the AOMS groups needed fewer repetitions to reach plateau performance without additional differences between the HumanAOMS and AvatarAOMS conditions. The lack of effect in the first real perturbation trial suggests that AOMS alone may not be sufficient for preventing real-life falls in this population. A next step would be to investigate whether this could be achieved by combining brief real perturbation practice with home-based AOMS.[1] Hagedoorn, et al., Gait Posture, 2024;109:126-132

P02-K-91 - The effectiveness of a nation-wide implemented fall prevention intervention in reducing falls and fall-related injuries among community-dwelling older adults with an increased risk of falls: A randomized controlled trial

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Background and aim Fall prevention programs have been proven effective in reducing falls and fall-related injuries in specific target groups and settings. However, implementing these programs on a larger scale often requires adjustments for feasibility. This study assessed the effectiveness of a nationally implemented fall prevention intervention compared to usual care in community-dwelling older adults. MethodsThis single-blinded, multicentre randomized controlled trial included 264 community-dwelling non- and pre-frail adults, aged 65 years or older with an increased fall risk. The intervention group participated in the In Balance intervention and the control group received general physical activity recommendations. Primary outcomes were the number of falls and fall-related injuries over 12 months. Secondary outcomes included the Timed Up and Go and Four Stage Balance Test, and the 36-Item Short Form Health Survey. We imputed missing data by multiple imputation, and analysed outcomes using generalized linear- and linear mixed-effects models. Analyses were done for the total group and stratified for frailty status. Results The mean number of falls per person over 12 months was not statistically different between the intervention and control group (respectively 1.67 (SE 0.24) and 1.98 (0.37); incidence rate ratio 0.85 (95% CI 0.51-1.43)). Similarly, the mean number of fall-related injuries was lower in the intervention group compared to the control group, but also not statistically significant (respectively 0.70 (SE 0.11) and 0.97 (0.18); incidence rate ratio 0.73 (95% CI 0.44-1.19)). Secondary outcomes also showed no significant differences between group, frailty status and over time. Conclusions Although the number of falls and fall-related injuries was lower among In Balance participants, and balance, mobility, physical function, and emotional well-being improved, these differences were not statistically significant. The implemented In Balance program appears to be less effective than a priori assumed, possibly due to insufficient adherence to the program in practice. To enhance the long-term efficacy of fall prevention interventions, it is crucial to focus on strategies that foster consistent participation and encourage follow-up physical activity.We want to thank all participants and therapists for participating in this study.Moreover, this research was funded by a research grant (#555002018) from the NetherlandsOrganisation for Health Research and Development (ZonMw). The funders had no role in studydesign, data collection and analysis, decision to publish, or preparation of the manuscript. We want to thank all participants and therapists for participating in this study.Moreover, this research was funded by a research grant (#555002018) from the NetherlandsOrganisation for Health Research and Development (ZonMw). The funders had no role in studydesign, data collection and analysis, decision to publish, or preparation of the manuscript.

P02-K-92 - Development of a concern about falling scale for older adults living in long-term care settings

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BACKGROUND AND AIMSConcern about falling (CaF) affects over half of older adults in long-term care (LTC). Existing tools to measure CaF do not adequately capture balance-related daily activities unique to LTC or accommodate the cognitive impairment commonly seen in this population. Questions are often limited to short verbal phrases without sufficient context, which reduces the validity of the tool. This study aimed to co-design and develop a CaF scale, called the Iconographical Falls Efficacy Scale – Long-Term Care (IconFES-LTC), that reflects the lived experiences of older adults living in the LTC context. Additionally, the study aimed to identify gaps in CaF management within LTC. METHODS This study involved a multi-phase process. In the initial phase, we conducted one-on-one interviews with 15 LTC residents aged 60+, with no cognitive impairment, to identify activities that elicit CaF and challenges related to living in LTC. To gain a broader perspective, ten LTC staff members were interviewed to get further insights into resident experiences and barriers and facilitators for implementing a CaF scale. Thematic analysis of interviews informed the adaptation of items from the original IconFES and the generation of new items. In the second phase, the IconFES-LTC was pilot-tested with nine residents and feedback was obtained to refine the scale.RESULTS The final scale consists of 18 items, six of which were adapted from the original IconFES. The scale covers a broad range of activities relevant to LTC, including basic activities of daily living (e.g. getting dressed/undressed while standing), navigating the facility (e.g. walking around the garden) and community-related activities (e.g. getting on/off excursion buses). Each item is scored on a 4-point Likert scale (1=not at all concerned to 4=very concerned) and includes facial icons to assess the level of concern, contextual images and brief explanatory text. Preliminary scoring data from the pilot indicated a wide range of CaF levels among residents (median total score = 32, IQR = 11), suggesting the scale's potential to capture meaningful variations in concern. In addition to the scale development, several gaps in the management of CaF in LTC were identified, including the need for an appropriate tool to assess CaF, low participation rates and opportunities for residents to engage in exercise programs, residents' restrictive beliefs and limited knowledge of falls prevention and the need for more evidence-based interventions to treat CaF in LTC settings. CONCLUSIONThe IconFES-LTC is the first-ever scale co-designed and developed for older adults in LTC. Its inclusion of activities highly relevant to the LTC environment and the use of visual aids ensure accessibility and accuracy, regardless of cognitive status. This tool offers significant potential to improve the assessment and management of CaF and to support the development of tailored fall prevention strategies for residents.

P02-K-93 - Rethinking the role of ambulatory activity in falls risk in aged residential care: Influence of physical capacity and cognitive status

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Background: Aged care residents have 2-4x greater fall risk than older community-dwellers. Cognitive and physical impairments are prevalent in aged care, likely exacerbating fall risk. Facilities often restrict residents' ambulatory activity due to major concerns regarding increasing falls risk. Falls are a significant concern in aged residential care as they lead to injuries, hospitalisation and death. Risk factors for falls include low physical capacity and greater cognitive impairment, which are prevalent in aged residential care. However, evidence of the relationship between ambulatory activity and falls rates in aged residential care is unclear. To address this risk versus reward conundrum presented by care staff, we aimed to explore the relationship between ambulatory activities and falls rate in ARC with consideration to the influence of physical capacity and cognitive status. This will support empirical decision-making regarding the safety risk of promoting ambulatory activities for supporting residents' quality of life and autonomy.Methods: 281 aged care residents were included from the New Zealand-based Staying Upright randomised controlled trial. Step count was assessed via an accelerometer worn on the lower back for seven days at baseline. Falls rates were monitored for participants' study duration (mean±SD: 581±264 days). Cognitive impairment was assessed with the Montreal Cognitive Assessment (15±6). Residents were categorised as High-Moderate (n=71) or Low-Very Low physical capacity (n=205) based on clinical cut-off scores from the Short Performance Physical Battery. Quasi-Poisson generalised linear models explored associations between steps, cognition and physical capacity with falls rates, and examined interaction between physical capacity and daily steps in predicting falls rate. Relative risk of falling and having a falls-related injury were estimated between different activity levels (2000, 4000, 6000 steps per day). Results: Key results indicate that the Low-Very Low physical capacity group had a higher falls rate than High-Moderate (p=0.001). Higher daily steps were associated with increased falls rate (p=0.046), with a significant interaction (p=0.036) indicating that the High-Moderate Group had a positive association between daily steps and falls rates; the lower group did not (see Figure 1). Cognitive impairment was not associated with steps or falls. Contextually, participants in the higher group were estimated to have a ~23-24% increased relative risk of falling between different activity levels, but only a ~6% increased relative risk of injuries due to falls. The lower group had a negligible decreased relative risk of falls and falls related injuries (2.7-3.9%) between activity levels.Discussion: Findings suggest fall risk is linked to physical capacity and activity levels. Residents with higher physical capacity can take more falls-free steps although their fall risk somewhat increases with activity; however, this has a limited increase on falls-related injuries. Comparatively, those with lower capacity have a higher baseline risk but are less affected by increased activity. Additionally, despite staff perceptions that cognitive impairment is linked to substantial risk of falling, no associations were found between cognition and falls. This challenges the practice of restricting ambulatory activity in aged care to prevent falls, highlighting the need for tailored interventions.

P02-K-94 - A machine learning approach to predict future falls for older adults in care-homes across Japan: A collaborative study with a care company

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Background and Aim: Aging and declining population are the two major socio-economic problems in Japan currently and falls compound this challenge even more in elderly. A significant percentage of the Japanese elderly population reside in care-homes across the country and falls and related injuries are also quite common among the care-home residents. One of the main goals for this collaborative project is to predict the risk of future falls (in future residents) and to understand if some ergonomic or caregivers' training related changes need to be undertaken across the care-homes in Japan. Methods: We employed Decision trees, Random Forest, kNN, Naïve Bayes, Boosting and Light GBM algorithms for fall prediction using data for one year (August 2022-July 2023) from a large database, having data of multiple past years. The current study includes 9396 elderly residents aged 60 years or older. Common variables like fall history, age-groups, a variety of Activities of Daily Living (ADL) and others were used as predictors. All the categorical predictors (nominal and ordinal) in the dataset were one-hot encoded. Residents who had multiple falls were classified as fallers and those who did not fall at all were classified as non-fallers. 60% of the dataset was used for model training, 20% for validation and 20% was used for holdout testing. The algorithms were executed in Python, IBM SPSS Modeler and JASP to check for robustness of results. Finally, the open-source JASP results are reported here for simplicity.Results: The Random Forest (RF) with 100 trees gave consistent and robust predictions compared to the other algorithms. The total or averaged Area Under the Curve (AUC) was 0.74, accuracy was 0.67, sensitivity or recall was 0.67, specificity was 0.65, precision or positive predictive value was 0.67, negative predictive value was 0.66 and F1 score was 0.67. Most of these metrics are better than a likewise previous study using Decision trees (Makino et al., 2021) where the AUC was 0.7, accuracy was 0.65, sensitivity or recall was 0.62, precision or positive predictive value was 0.66 and negative predictive value was 0.64. Our overall validation accuracy was 0.69, test set accuracy was 0.67 and Out-Of-Bag (OOB) classification accuracy was 0.66 for both the validation and training sets. The confusion matrix of the test set, the AUC curve and the OOB classification accuracy plot are given in the additional pdf document.Conclusions: We have been able to make a better prospective fall prediction system using RF, compared to decision trees and now we are reducing the

total number of predictors so that we can achieve similar and robust model metrics and performance. This study gives useful information for the early screening of fall risk for incoming residents and provide opportunities to form strategies for fall prevention in care-homes, which can be generalized for community-dwelling and clinical settings in the future.Funding: SOMPO Care Inc.

P02-K-95 - Postural responses of older adults for arresting real-life forward falls

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BACKGROUND AND AIM: Up to 80% of traumatic brain injuries in older adults are caused by falls (Fu et al., 2017). Upper limb bracing is a common protective response for preventing head impact and injury, especially for falls in the forward direction (Hsiao & Robinovitch, 1998; Moon & Sosnoff, 2017). However, upper limb bracing is demanding in its speed, strength and flexibility requirements, and not always effective for older adults in preventing head impact (Robinovitch et al., 2022). We analyzed video footage of real-life forward falls in older adults, to identify the biomechanical factors that separated falls where the head did versus did not impact the ground.METHODS: Videos of real-life falls by older adults (aged 83 years; SD 7.6) in long-term care were digitized using Kinovea software. Linear mixed models were used to compare falls with head impact (n = 9) to falls without head impact (n = 9). Kinematic variables of interest included values before, during and after hand impact of trunk velocity and arm angle (angle from the horizontal of the line connecting the shoulder and wrist).RESULTS: When compared to falls without head impact, falls with head impact involved larger trunk horizontal velocity just before hand impact (mean = 2.1 m/s (SD = 1.4) versus 1.7 m/s (0.9); p = 0.026). There were no differences in trunk vertical velocity (p = 0.710) and arm angle (p = 0.067). However, there was a significant interaction between head impact and timing during the fall for arm angle (p = 0.035). There was no difference between falls with and without head impact in arm angle just before hand impact (79.9° (12.9) versus 74.5° (9.5), p =1.000). In falls with head impact, arm angles were larger after hand impact than before hand impact (mean = 111.4° (SD = 30.0) versus 79.9° (12.9), p = 0.004), reflecting movement of the wrist into a position inferior to the shoulder. In contrast, in falls without head impact, arm angles were similar before and after hand impact (74.5° (9.5) versus 75.9° (26.2), p = 1.000), reflecting that the hands were maintained superior to the shoulders throughout the impact event.CONCLUSIONS: Our results imply that older adults experienced head impact during forward falls due to a combination of arm collapse, and high horizontal velocity causing toppling of the torso over the body.ACKNOWLEDGEMENTS AND FUNDING: Supported by operating grants from the Canadian Institutes of Health Research (AMG-100487, TIR-103945, and TEI-138295) and the AGE-WELL National Centre for Excellence (AW CRP 2015-WP5.2, AWCRP-2020–04).

P02-L-96 - Effects of real-time feedback-induced attenuation of postural sway on postural control in patients with spinocerebellar degeneration

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BACKGROUND AND AIM: Spinocerebellar degeneration (SCD) is a progressive neurological disorder characterized by cerebellar atrophy and degeneration of associated fiber tracts, often leading to postural instability. This instability is thought to arise not only from ataxia-related pathology but also from compensatory mechanisms, such as excessive muscle tone. Therefore, distinguishing between impairment-related and compensation-related components is crucial in physiotherapy assessment. This study investigated the effects of a system capable of attenuating center of pressure (CoP) sway in real time on postural control in individuals with SCD. METHODS: Fifty-five individuals with SCD (age: 64.1 ± 13.8 years; SARA: 13.8 ± 5.1; disease duration: 10.5 ± 7.3 years) and thirty healthy adults (age: 55.6 ± 22.4 years) participated. In addition to quiet standing, SCD patients performed a 30-second standing task under real-time CoP sway attenuation using a feedback device (BASYS, Tech Gihan Co., Ltd.), referred to as the feedback condition (FB). In the FB condition, anterior-posterior CoP displacements measured via a force plate were attenuated by synchronously shifting the support surface in the same direction. CoP data were obtained from a force plate, center of mass (CoM) coordinates from a depth camera, and muscle activity of the soleus (Sol) and tibialis anterior (TA) from surface electromyography, using the BASYS Body Tracking System (Creact Inc.). Outcome measures included the 95% confidence ellipse area and mean velocity of CoP sway, mean muscle activity, and the time lag of Sol response to CoM sway, assessed via cross-correlation analysis. Paired t-tests were used for group comparisons, and one-way ANOVA was applied to compare the three SCD standing conditions (Pre, FB, Post). Pearson's correlation coefficients were calculated to examine variable associations. RESULTS: Compared to healthy controls, SCD patients exhibited greater CoP sway, increased TA activity, and delayed Sol responses to CoM sway. In the SCD group, CoP sway significantly decreased during the FB condition compared to the Pre condition. Patients with greater sway area in the Pre condition showed larger reductions in sway during FB. Those with excessive CoP sway in the Pre condition showed significantly reduced sway in the Post condition. TA activity significantly decreased in both the FB and Post conditions compared to Pre. The Sol response time lag was significantly shorter in the FB condition than in Pre or Post. Patients with greater Sol delays in the Pre condition showed larger reductions in Sol delay in the FB and Post conditions. CONCLUSIONS: Real-time attenuation of CoP sway feedback effectively reduced excessive muscle activity and facilitated the Sol response to sway, thereby improving postural stability in individuals with SCD. This system shows promise as a novel intervention for individuals experiencing postural instability.

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P02-L-97 - Development and pilot testing of a digital physical activity intervention targeting daily walk time in people 50 years and over experiencing chronic low back pain

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Background and aims: Low back pain is the leading cause of disability worldwide, contributing to mobility problems such as falls in older people. Clinical guidelines recommend holistic, non-surgical management integrating education, exercise programs, and psychological therapy. This study co-designed and piloted a digital walking program integrated with a pain management program to boost adherence and physical activity in older people with chronic low back pain. Methods: Forty-two participants aged 50+ with low back pain for 3+ months were randomised to usual care (N=20) or intervention (N=22). The 15-week intervention included personalised and adaptive walking goals supported by a wrist-worn step tracker, and 2-5 coaching sessions focussing on habit formation through motivational interviewing, goal setting and reflection. Participants also completed an online and telephone-based psychological pain management intervention, which provided evidence-based cognitive behavioural strategies for managing pain and its impact on daily life and emotional well-being. Outcomes were assessed at baseline and 6 months and included daily walking duration (primary outcome) assessed via a back-worn activity monitor, quality of life, mental health, well-being, pain, exercise self-efficacy, weekly exercise, health behaviour, falls, acceptability, appropriateness and feasibility. Results: No intervention effects on walking duration were observed ($p = 0.87$), partly due to incomplete activity monitor data (54% missing). Walking goal adherence was 48.2%, rising from 43.8% to 58.3% by wave three as refinements were implemented. Participants with complete activity data (N=10) increased their step counts, with 63.6% exceeding 8000 steps daily by program end. Participant feedback supported the program's feasibility and acceptability. They reported a transformative shift in their approach to physical activity, moving away from goal-focused methods to habit-based strategies that seamlessly integrated walking into their daily lives. One participant noted, "But this missing part is there's actually a link that I can attach to my lifestyle... that's crucial I think," highlighting the importance of connecting physical activity with routine tasks to form sustainable habits. Others highlighted how the incremental approach supported adherence and led to functional improvements: "The incremental approach strengthened my legs and built my confidence without me even noticing." Conclusions: Our co-designed digital physical activity program was feasible

and well-received. While adherence and data completeness remain challenges, participant feedback underscores the program's potential to improve physical activity in older people with chronic low back pain. Future iterations will address these challenges by using consumer-grade activity monitors, better integration of duration goals alongside step counts, optimised motivational messaging and algorithmic adjustments for automatic regression.

P02-L-98 - Virtual outpatient rehabilitation: Co-design, development and initial user testing of a digital rehabilitation program for enhanced patient management and rehabilitation outcomes

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Background and aims: Mobility is essential to independence and the World Health Organization considers it one of the most important health indicators. Poor mobility following stroke often requires rehabilitation, where high doses of tailored exercise have been shown effective, especially within the first 6 months. However, limited healthcare system capacity hinders the feasibility of providing intensive programs. This study co-designed and developed a digital rehabilitation program that integrates a tailored high-dose exercise program and usual care for people recovering from stroke. Methods: We used an integrated knowledge translation approach, involving extensive stakeholder engagement to understand the needs, preferences, and priorities of stroke survivors and healthcare providers. This helped identify unmet clinical needs related to patient engagement, communication between care teams, and the potential of technologies to improve healthcare delivery. A total of 30 participants were included, spanning stroke survivors, hospital clinicians and administrators, community-based allied health professionals, and public health bodies. We then performed a 2-month feasibility study in a sample of 14 outpatients. Quantitative and qualitative outcomes were assessed at baseline and 2-months, and included adherence (defined as exercise minutes), usability, acceptability, appropriateness, and feasibility. Results: Stakeholders highlighted that while 'consistent exercise was critical for recovery', 'barriers to accessing care impact the rehabilitation received' and 'community services are not resourced to meet patient needs'. Stakeholders expressed that a digital rehabilitation program has potential 'to deliver improved care but must fit into clinical workflows and support daily patient engagement'. Based on total dose (680 min), which included a staggered bi-weekly increase from 40 min to 120 min by week 9, preliminary results show varying levels of engagement. Six participants, classified as non-users, completed a median of 0 minutes (IQR 0-0.2) over 2 months, citing barriers such as low motivation and digital literacy. Five

occasional users completed a median of 3.1 hours (IQR2.9-3.5) or 27% of the recommended dose, citing barriers such as time constraints or health challenges. Three motivated users completed a median of 11.2 hours (IQR 10.4-13.8) or 98% of the recommended dose, reporting improved mobility and high program satisfaction. Overall, participants rated the program as usable, acceptable and feasible. Conclusions: This study indicates a digital program could address key challenges in stroke recovery, providing an accessible, scalable solution for post-discharge rehabilitation. While engagement varied, the findings highlight the potential of digital programs to improve patient outcomes and support the integration of exercise into usual care, helping to meet the increased demand for rehabilitation services. Funding: UNSW CVMM theme, NSW ACI.

P02-L-99 - Exploring spinal reflex modulation in the pelvic floor muscles through sensory stimulation from the lower limb

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Background and aim: The pelvic floor muscles (PFM) are critical for maintaining continence and a potential target for rehabilitation strategies to help manage urinary dysfunction in neurological populations. While PFM training is a mainstay of treatment for incontinence in able-bodied populations, this form of physiotherapy relies on the ability to voluntarily contract the PFM. This would be challenging to perform by people with neurological impairments. There is a need to explore alternative ways to strengthen the PFM. The spinal segments mediating lower urinary tract function overlap with those controlling lower limb sensorimotor function. Studies in animals show electrical stimulation of the tibial nerve results in reflex relaxation of the detrusor muscle, thereby increasing bladder capacity. Tibial nerve stimulation can also evoke responses in the urethral and external anal sphincter muscles, which have the same nerve innervation and functional role as the PFM. Our recent studies in healthy adults show that the PFM are activated during walking and jogging, with greater activity seen during the stance phase. These studies suggest sensory inputs from the lower limb, either through direct stimulation to the nerve or from activating the muscles during walking, may affect the activity of PFM. Cutaneous reflexes have been used as a proxy to study how sensory inputs from the skin and muscle influence motoneuron excitability. Task-dependent cutaneous reflex modulation has been confirmed in the leg muscles, indicating sensory inputs around the foot influence the excitability of the muscles based on the functional goal of the task (e.g. sitting vs standing). To explore the idea of whether cutaneous reflexes in PFM could serve as a probe for understanding the control of PFM activity, this study explored: 1) the feasibility of eliciting cutaneous reflex responses in PFM and 2) whether this reflex response is modulated by task. Methods: Nine healthy young adults have been recruited so far. PFM and lower leg muscle electromyography were measured using surface electrodes. Cutaneous stimulation was delivered as a train of pulses to the

distal tibial nerve. Reflex responses in PFM were measured in sitting and standing positions with matched background muscle activity in soleus and PFM. Results: PFM reflex was observed 75-175ms following stimulation. Reflex amplitude was correlated with PFM background activity with greater facilitatory response at lower background activity. With matched PFM background activity, 7 of 9 participants showed greater reflex responses in standing compared to sitting, indicating possible task-dependent modulation. Conclusion: It seems feasible to elicit cutaneous reflex responses following distal tibial nerve stimulation in the PFM and this response may be modulated by posture. These results suggest that the neural circuits mediating sensorimotor function of the leg muscles interact with those that control urinary function.

P02-M-100 - Modulation of gait control under metronomic constraint assessed by long-range autocorrelations in healthy population and in Parkinson's disease

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Background: Gait variability of healthy adults displays Long-Range Autocorrelations (LRA), meaning that the stride interval at any time statistically depends on remote previous gait cycles. Clinically, the presence of LRA in stride series is often considered as a marker of health, while its alteration has been associated with pathological conditions such as Parkinson's disease. Previous works suggested that LRA may result from a selective regulation of stride length and duration while maintaining a constant target speed. In this framework, constraining the stride time with a metronome would impedes the flexible regulation of this gait parameter, leading to a decrease of LRA in series of stride durations. However, while the decrease in LRA when gait is guided with a metronome has been widely documented, transitions between walking with and without a metronome (and vice-versa) have not been measured. Methods: A total of 21 healthy volunteers were asked to walk overground during two conditions of 15 minutes in which a metronome was activated during either the first or second half of the session to test both transitions. Participants were explicitly asked to synchronize one foot with the metronome, set to their average spontaneous pace. The LRA was assessed with the Adaptive Fractal Analysis and this method was applied over a sliding window on the stride series to outline its evolution. Our analyses were reproduced with a computational model allowing to relate sudden changes in movement parameters to the LRA, which is typically measured over longer timescales. In the light of current theories associating the basal ganglia with a representation of motor costs, we are currently applying the same protocol involving patients with Parkinson's disease and age-matched healthy adults in order to interpret their adaptation within the same framework. Results: In healthy participants, results showed a clear transition in both conditions, with LRA of the series of stride duration gradually reduced when the metronome was turned on and recovered when it was turned off. In contrast, the task instruction had little impact on the standard deviation of the same series. In both conditions, the change in LRA could be reproduced

in the model by an instantaneous switching of the control policy, gait guided with a metronome being modelled by adding a term regulating asynchrony between the metronome beat and heel strike. The same analyses will be conducted on patients' data and presented in detail. Preliminary results showed a significant decrease in LRA with the metronome, despite greater heterogeneity across patients compared to age-matched controls.Conclusions: Our results validate the hypothesis that LRA emerge from a flexible control strategy that rapidly regulates timing and amplitude parameters according to task requirements and provide a complementary methodology to investigate the effect of task instruction to assess gait in healthy and clinical population.

P02-M-101 - From posture to core: Estimating spine deformation from dorsal shape in adolescent Idiopathic Scoliosis

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Background and Aim:Adolescent Idiopathic Scoliosis (AIS) is a 3D spinal deformity affecting up to 4% of adolescents, diagnosed primarily through radiographic Cobb angle measurements. Frequent radiographic monitoring presents significant radiation exposure risks. ScolioSIM, a module of the ScolioMedIS system, offers a non-invasive, radiation-free alternative for 3D spinal alignment assessment. This study validates ScolioSIM's capability to assess spinal deformities by comparing its results with gold-standard radiographic measurements.Methods:The study involved 30 AIS participants (mean age: 18.1±3.5 years) who underwent biplanar radiographic imaging and optical 3D back scans in standardized postures. The ScolioSIM process integrated anatomical landmarks, external spinal alignment, and X-ray-derived internal alignment to generate patient-specific 3D spine models and deformity parameters. ScolioSIM-derived Cobb angles (SCA) were compared against manually measured Cobb angles (CA) and sterEOS software-calculated angles (ECA) using Pearson correlation coefficients, mean absolute differences (MADs), and regression analysis.Results:ScolioSIM successfully measured 80 deformity curves, yielding a mean SCA of 24.9±14.3°. Strong to excellent correlations were observed between SCA and CA (thoracic R^2=0.957, lumbar R^2=0.928, combined R^2=0.934, $p<0.001$). MADs ranged from 0.3° to 4.9°, with the smallest differences in thoracic curves. Regression analysis confirmed ScolioSIM's high predictive reliability for both CA (R^2=0.873) and ECA (R^2=0.858).Conclusions:ScolioSIM demonstrates high accuracy and reliability in assessing spinal alignment and deformities in AIS, correlating strongly with traditional radiographic methods while avoiding radiation exposure. Its potential for longitudinal monitoring and treatment evaluation establishes ScolioSIM as a promising tool for personalized scoliosis management. Future developments aim to enhance its automation and accessibility for broader clinical applications.Acknowledgements:This project was funded through the EU's H2020 MSCA grant No.892729 and Innosuisse grant 47195.1 IP-LS.

P02-M-102 - Standing stability is achieved by keeping feedback gains near critical levels

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Background and aim Stabilizing feedback control of standing is reflected by strong correlations between neuromuscular responses (i.e., muscle activity and joint moments) and deviations in center of mass (COM) kinematics after perturbations. Since any stabilizing control will ultimately be reflected in the ground reaction forces (GRFs), we here propose a simple feedback model assuming that unperturbed standing is stabilized by generating corrective ground reaction forces based on preceding COM position and velocity information. We asked whether differences in balance-demand and intrinsic stiffness between postures would lead to differences in feedback gains.MethodsWe first tested the model's validity by simulating an IP model with various input intrinsic and feedback parameters and with continuous or intermittent control, to see whether corrective ground forces could be well reconstructed and whether feedback gains can be estimated. Next, we fitted this model to human experimental data obtained from normal standing, unipedal standing and step posture. Results Simulation results demonstrated good reconstruction of corrective forces from COM information (R^2: 0.50~0.99), and estimated feedback parameters were closely correlated to the actual values with standardized regression coefficients higher than 0.74. Human experimental results showed good model fits with R^2 ranging from 0.76 to 0.99 across postures of all subjects. Feedback delays varied among postures, with normal standing showing a significantly longer delay (246±21ms), and step posture the shortest delay (193±29ms, delay for unipedal standing was 204±24ms). Strikingly, the position and velocity gains remained similar across postures, with the position gains slightly above the critical stiffness, even when changing from bipedal to unipedal stance. Conclusions In conclusion, our model can be used to characterize feedback control of unperturbed standing, based on preceding COM information. Notably, our results indicated that the central nervous system achieves standing stability by maintaining consistent near-critical feedback gains, which could reflect an energy-efficient strategy in human postural control.

P02-N-103 - Increased fall-related injuries in central body parts among individuals with Parkinson’s disease: A secondary cross-sectional analysis of the retrace database

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Background and aim:Falls in individuals with Parkinson's disease (PD) involve reduced balance recovery responses as well as a stiffer posture with increased muscular co-contraction. Consequently, these altered fall mechanisms might lead to different injuries. Therefore, we aimed to determine whether, among individuals visiting the emergency department (ED) in a hospital in Luxembourg with an injury after a fall, the proportion of individuals with central body injuries (head, trunk, hip) is higher for individuals with PD than for those without.Methods: We analysed 8404 fall-related ED visits by individuals aged 60+ in Luxembourg in 2018 using RETRACE data, an ED Injury Database in Luxembourg. This anonymous routine data was collected in ED and encoded according to the European Injury Database methodology. In addition to a Chi-squared test comparing the proportion of individuals with and without PD experiencing central body injuries, we used multiple logistic regression to regress the binary outcome « central body region (head, trunk, hip) of the injury vs extremities (arm, leg) » on PD-status, adjusting for age and sex.Results:104 (1.2%) individuals with PD were identified via ICD-10-code or full text search of the narratives. Among individuals with PD, 76.9% (80) had central body injuries (head, trunk, hip), 17.3% (18) extremity injuries (arm, leg) and 5.8% (6) unknown or multiple body parts injured. Among the 8300 individuals without PD, only 55.8% (4635) had central body injuries, while 38.2% (3167) had extremity injuries and 498 had unknown, other or multiple body parts injured (6.0%).Figure 1. Higher proportion of individuals with PD visiting an emergency department after a fall with an injury in central body regions than for individuals without PDAs illustrated in Figure 1, individuals with PD visiting the ED after a fall were significantly more likely to suffer central body injuries than individuals without PD (Chi-squared test: $\chi2$ (1) = 18.95, $p < .001$). According to the multiple logistic regression analysis, individuals with PD visiting the ED after a fall had 2.6 times the odds (95%CI [1.6, 4.5], $p < .001$) of experiencing a fall-related central body injury compared to those without PD, increasing with age and lower among women. Additionally, individuals with PD visiting the ED with a fracture after a fall were significantly more likely to suffer central body fractures than individuals without PD (Chi-squared test: $\chi2$ (1) = 10.15, $p = .001$).Conclusions:While previous research mainly focused on falls-prevention, we advocate for additional research on protective interventions for fall-related injuries in people with PD that particularly focus on head, trunk and hip protection.

P02-N-104 - A novel approach to study structural and functional correlates of gait in Parkinson's disease

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Background and Aim: Postural instability and gait disturbance (PIGD) is one of the most debilitating symptoms in advanced Parkinson's Disease (PD), occurring in over 60% of patients. Degeneration in subcortical structures and changes in neuronal activity in the subthalamic nucleus (STN) during gait have been proposed as key determinants to understand patient heterogeneity in PIGD. The development of new imaging technologies provides the opportunity to test these hypotheses for the first time. Particularly, Deep Brain Stimulation (DBS) sensing technology allows for the measurement of Local Field Potentials in the STN whilst the person with PD performs activities such as walking in a naturalistic environment. Furthermore, Quantitative Susceptibility Mapping (QSM) allows for the identification and assessment of neurodegeneration in small subcortical structures. In this study, we assessed how PIGD gait markers are correlated with degeneration in subcortical structures such as the substantia nigra (SN) and the pedunculopontine nucleus (PPN), as well as with pathological brain activity measured through LFP in the STN, during active gait. Methods: An MRI scan was completed prior to surgery to obtain Quantitative Susceptibility Mapping (QSM), Diffusion Tensor Imaging (DTI) and structural (T1) images of the brain. After surgery, once participants had recovered and the DBS was switched on, different tasks were performed on and off medication (walking, resting, standing with eyes open and standing with eyes closed). During these tasks participants wore a motion tracking suit (XSens Link, Movella) and Local Field Potentials (LFP) were recorded from the brain (Medtronic DBS sensing) during the completion of the tasks. Radiomics was used to index degeneration in subcortical structures. Xsens gait analysis software was used to extract spatiotemporal gait metrics. Beta activity was extracted from the Local Field Potentials on the STN. Correlations were performed between degeneration metrics in subcortical structures, gait parameters and pathological beta activity in the STN recording during resting and gait. Results: As expected, preliminary analysis showed several correlations between pathological activity measured in the STN during the different tasks, MRI makers of neurodegeneration and the rest of the measured parameters. Particularly, this analysis revealed that using radiomics was a more sensitive measure of degeneration which was able to show the relationship between subcortical structure health and the other parameters of interest in the study. Conclusions: This is the first study to combine QSM and DBS sensing to provide novel insights into the heterogeneity of PIGD symptoms in Parkinson's. The ability to index neurodegeneration in small subcortical structures involved in PIGD, such as the PPN, could result in great advances in our understanding of these symptoms and their treatment. Acknowledgments and funding This research was funded by the Medical Research Council

P02-N-105 - CuePD: Personalised gait retraining via a smartphone app

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Background and aimWith an ageing population, there is an increasing prevalence of age and neurological-related falls which can lead to injuries and decline in wellbeing.

Disturbances in gait are linked to fall risk e.g., increased stride variability. Gait retraining via metronome or music cueing has shown effectiveness in improving gait and reducing fall risk. However, current music-based approaches lack personalisation to an individual's condition and are not scalable, limiting routine use. CuePD is a smartphone-based app designed to assess gait in near real-time and deliver personalised music cues to retrain gait. This study aims to show the validity and efficacy of CuePD in older adults and people with Parkinson's disease (PwPD).MethodsThirty/30 adults (9M:21F, 61.3 ± 8.8years, 72.5 ± 14.3kg, 165.4 ± 10.2cm) and 2 PwPD (2M, 72.5 ± 4.5years, 91.6 ± 3.0kg, 177.5 ± 0.5cm) performed a series of 1-minute walks that included one at a natural pace (baseline) and three walks with personalised auditory cues: metronome (ME), instrumental music (IM), and vocal music (VM). Auditory cues were set at +10% above baseline cadence to increase gait speed, stride length, and reduce stride variability. Music cue tempo was adjusted using a time-shifting algorithm to preserve original pitch of the music. The smartphone, positioned on the lower back (Figure 1a), used embedded accelerometer signals and validated algorithms to measure 14 gait characteristics. Validity was assessed using intra-class correlation coefficients (ICC) by comparing CuePD derived gait characteristics to gold-standard wearables (Opal, APDM). Gait response/efficacy to CuePD was assessed by contrasting changes in cadence, stride length, gait speed, and stride variability from baseline to cued walks.ResultsIn older adults, CuePD showed excellent validity with strong agreement in mean gait characteristics, with ICC values ranging from 0.865 to 0.997. Variability metrics showed ICC values ranging from poor to strong, spanning from -0.109 to 0.868, while asymmetry metrics also varied, ICC values ranging from -0.023 to 0.823. VM was the most effective (+8%) to achieve the +10% cadence target. Accordingly, VM indicated improved gait by effectively increasing (i) stride length (+7.22cm, standardised response mean, SRM: 0.91), (ii) gait +0.11 m/s (SRM: 1.22) and (iii) decreasing stride time variability by 0.6% (SRM: -0.56), Figure 1b-d. Preliminary results for PwPD also demonstrate valid gait characteristics and VM efficacy, with +3.3cm in stride length, +0.05 m/s in gait speed, and -0.79% in stride time variability. All participants found VM more engaging and easier to regulate their gait during walking compared to ME cueing.ConclusionsThis study demonstrates the potential of a smartphone-based app (CuePD) as a scalable solution for gait assessment and retraining in older adults and PwPD. By effectively administering personalised auditory cues, CuePD increased cadence, stride length and gait speed while reducing variability. To date, VM has demonstrated the largest effect while offering an engaging alternative to a metronome-based approach. Ongoing work comprises the recruitment of more PwPD (n=60) to thoroughly examine validity and efficacy within that group.Acknowledgements and FundingThe authors would like to thank all who volunteered for the study. This research is co-funded by a grant from the National Institute of Health Research (NIHR) Applied Research Collaboration (ARC) North East and North Cumbria (NENC). This research is also co-funded by the Faculty of Environment and Engineering at Northumbria University.

P02-N-106 - Social support levels may not impact physical function following a tango or walking intervention in people with Parkinson's disease: An exploratory analysis of a randomized controlled trial

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Background and aim: People with Parkinson's disease (PD) with mobility limitations are at risk of low social connectedness and tend to have poorer health outcomes. Physical function can be improved through exercise, but whether social support influences intervention responsiveness is unclear. This study aimed to 1) examine the influence of 12 weeks of group exercise (tango or walking) on physical function in people with PD who reported low versus high baseline social support, and 2) determine the influence of intervention type on social support effects. Methods: This exploratory analysis of an ongoing assessor-blinded randomized controlled trial (1:1) [NCT04122690] included 40 participants with PD (69.24±7.73 years; 26.3% female; Hoehn & Yahr: 2.28±0.58). We used the Multidimensional Scale of Perceived Social Support to categorize participants into high or low support groups. Participants were assessed OFF medication at baseline and 12 weeks with the timed-up-and-go test, 360-degree turn test, forward, backward, and fast gait speed, 6-minute walk test, chair stand test, tandem stance, and body position spatial task. Participants were randomized into tango (n=20) or walking (n=20) groups and completed 20 sessions within 12 weeks. Results: Left foot tandem stance trended towards improvement regardless of social support (p=0.06). An interaction among time, support, and intervention indicated that participants with low social support in the walking group improved more than participants with high social support in the walking group or participants in the tango group on the chair stand test (p=0.03). Exercise adherence was high for both walking (95.5±19.9%) and tango (97.2±6.88%) interventions. No adverse intervention-related events occurred. Conclusions: People with PD in high and low social support groups exhibited similar improvements in physical function following a 12-week tango or walking intervention, with a possible advantage of the walking program for individuals with low social support. While the dose, volume, frequency, and intensity of exercise were similar in the walking and tango interventions and led by the same intervention staff, differences in the level of social engagement may explain these findings. More specifically, the topics of discussion may have been centered largely on problem-solving when learning new dance moves during the tango program, and socially engaging topics of their choice during the walking program, which may have influenced motivation. Therapeutic intervention targeting physical function regardless of social network in people with PD is important. Given the broader relationship between social network and future health outcomes, clinicians should still monitor people with PD who have low social support even if they respond similarly to intervention.Acknowledgments and Funding: The PAIRED trial is funded by a United States Department of Veterans Affairs Merit Award (I01 RX002967).

P02-N-107 - Effectiveness of combined TDCS and exercise on gait asymmetry in Parkinson's disease: A randomized sham-controlled study

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BACKGROUND AND AIM: Asymmetry is a notable and debilitating factor in gait impairment among individuals with Parkinson's disease (pwPD). Nearly half of pwPD exhibit discrepancies in step length between their right and left sides. Gait asymmetry (GA) is directly associated with more severe gait impairments, including falls, which occur in 70% of pwPD. Consequently, there is a need to refine rehabilitation strategies that promote symmetry in mobility has the potential to reduce the incidence of falls and the associated costs, while simultaneously improving patient well-being. Transcranial direct current stimulation (tDCS) and exercise have been proposed as potential methods to reduce GA in pwPD. While exercise can be used to modify gait by requiring individuals to adapt their spatial-temporal gait parameters, tDCS can be utilized to modulate excitability between the brain hemispheres. A combination of tDCS and exercise can potentialize the effects on GA in pwPD. Thus, this study aimed to investigate the long-term effects of a combined tDCS and exercise rehabilitation on GA in pwPD. METHODS: Twenty-four pwPD were tested in a randomized, double-blind, parallel-arm and sham-controlled study (ReBEC - RBR-10v4dxgm). Participants were randomly assigned to two groups: active tDCS (3 women, 68±4 years old, 1.63±0.13m, 69.4±10.3kg, MDS-UPDRS-III=28.9±4.7pts) and sham tDCS (3 women, 69±2 years old, 1.66±0.11m, 73.3±12.4kg, MDS-UPDRS-III=30.9±9.1pts) groups. Participants attended six tDCS sessions, with a 48-hour interval between each session in each intervention type. The tDCS was applied at 2mA for 20min (active group) or 10s (sham group) during gait exercise. The anode was positioned over the motor cortex contralateral to the most affected side, while the cathode was placed over the contralateral supraorbital. Gait exercises involved walking along an 18-m circuit under two conditions: increased arm swing amplitude (10min) and arm swing speed (10min). The gait exercise protocol was performed identically for both groups. Gait parameters were assessed using the GaitRite system and the symmetry index was calculated before and after the rehabilitation protocol. RESULTS: The two-way ANOVA (group: active/sham tDCS; period: before/after intervention) indicated no significant main effect of group (Figure 1). However, a significant main effect of period was observed, with reductions in step length asymmetry (51%, $p<0.01$) and step time asymmetry (57.4%, $p<0.001$) after the rehabilitation protocol. In addition, a significant group*period interaction was found, suggesting that the sham tDCS group increased stance time asymmetry (>300%, $p<0.05$) after the rehabilitation protocol, while no significant changes were observed in the active tDCS group. CONCLUSIONS: Gait exercise reduced GA in pwPD, but tDCS did not enhance the benefits of gait exercise on GA in pwPD.

P02-N-108 - Exploring the longitudinal changes in digital rest-activity and sleep outcomes in inpatients with Parkinson's, with and without delirium

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Background/AimsDelirium is an acute neuropsychiatric syndrome associated with altered levels of consciousness, confusion, impaired attention and sleep-wake-cycle disruption. Delirium is common in Parkinson's disease (PD) and is associated with an increased risk of mortality and dementia [1]. Most clinical tools only provide information for a snapshot of time, which fails to show fluctuating delirium symptoms. This study aimed to explore the changes in digital rest-activity and sleep measures in PD inpatients with and without delirium and between delirium subtypes over the hospital admission.MethodsIn parallel to longitudinal delirium assessments based on the DSM-5 criteria, participants wore an Axivity AX6 device on their wrist for up to seven days. Delirium subtypes were based on validated criteria (DMSS-4) and classified over the hospital stay. Open-source software (GGIR) was used for data processing [2]. Seventeen digital measures were included, representing daytime activity, daytime rest, sleep fragmentation and night-to-day variability (Figure 1). Linear mixed-effects modelling identified changes ($p<.05$) in the digital outcomes over the hospital admission. ResultsDigital measures were derived for 52 participant admissions (34-delirium; n=6 hyperactive, n=8 hypoactive, n=20 mixed). Daytime activity declined during the hospital stay in delirium and all delirium subtypes compared to cases without delirium ($p<0.05$). Daytime rest increased over time in cases of hypoactive delirium compared to those without delirium ($\beta=0.43, p=0.040$) and mixed-delirium ($\beta=0.44, p=0.039$). Night-time wake duration (sleep fragmentation) increased in those with mixed-delirium compared to those without delirium ($\beta=18.08, p=0.005$) or hyperactive-delirium ($\beta=24.12, p=0.031$); no further significant changes were found ($p>0.05$ for all). ConclusionDigital daytime activity measures can identify change over time in inpatients with PD and delirium. Daytime rest and sleep fragmentation measures may have clinical utility for monitoring change in subgroups of delirium. Results are exploratory, and replication in a larger study is required.REFERENCES:[1] Gerakios et al, 2024, Age Ageing, Mar 1;53(3):afae046.[2] van Hees VT, 2015, PLOS ONE, 10(11), p. e0142533.

P02-N-109 - Turning heads: does head motion during turning in people with Parkinson's disease correlate with clinical measures?

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Background: Turning is essential to mobility, constituting 35-45% of all daily steps. [1] Turning is a common cause of falls [2] and falls during a turning task are 7.9 times more likely to result in hip fracture [2]. Alterations to segmental axial rotation in turning tasks have been previously identified in people with Parkinson's Disease (PwP) [4]. It is not well understood how these changes in movement strategies are related to patient and clinician reported measures of function. There is also emerging evidence of vestibular dysfunction related to Parkinson's Disease (PD) and it is unclear how this affects turning performance [5]. Aims: 1) Identify differences in head motion during turning task between older adults and PwP. 2) Understand which head motion variables in turning are associated with clinical outcome measures for PwP. 3) Determine if turning behaviour in PwP is typically above or below threshold for reliance on vestibuloccular reflex. Methods: 36 PwP completed an intermittent walking task with 180 degree turns (ICICLE-Gait). An inertial measurement unit attached to the head evaluated head rotations (>30 degrees). Turning features were extracted using a validated algorithm. Spatiotemporal (duration, velocity) and signal-based features reflecting movement intensity (root mean square [RMS] in the mediolateral [ML], anterior-posterior [AP] and vertical [VT] planes from the gyroscope) were extracted. Relationships between turning and clinical measures (Activities of Balance confidence (ABC), Mini Mental State Exam (MMSE), Unified Parkinson's Disease Rating Scale (MDS-UPDRS) II and III, Levodopa Equivalent Daily Dose (LEDD)) were evaluated using Spearman's rho. Peak turn head velocity of participants turning above and below vestibular threshold [6] was identified. Results: There were 2/6 spatiotemporal and 13/25 signal features with weak-to-moderate correlations with clinical measures. Lower cognition and reduced balance confidence were associated with slower head rotations (rho=0.416-465, p<.05) and lower head movement intensity (lower rms: rho="0.340," p<0.05). higher disease severity (higher mds updrs-ii, iii scores) was associated with slower rotations (rho="-0.322:-0.436," p<0.05) increased LEDD greater head movement intensity. PwP predominately turned below vestibular threshold (71% rho = 0.435, p=0.007) compare with controls (31%, rho = 0.186, p=0.183) see Fig 1. Conclusion: Rotational head velocity is an important feature of turning that correlates with clinical outcomes. Turning places a demand on sensory, cognitive and motor systems which is affected in PD. Future research should assess vestibular function and impact on turning behaviour. References: [1] Glaister et al 2007 PMID: 16730441 [2] Robinovitch et al 2013 PMID:23083889 [3] Cumming & Klineberg 1994 PMID: 8014355 [4] Lebel et al 2018 PMID: 29434569 [5] Venhovens et al 2016 PMID: 27062368 [6] Vital et al 2010 PMID: 20644064

P02-N-110 - Digital technology-based assessment of gait, posture, and upper Limb Bradykinesia in Parkinson's disease: Response to subthalamic deep brain stimulation and levodopa

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Background and aimDeep brain stimulation of the subthalamic nucleus (STN-DBS) is a well-established therapeutic treatment for Parkinson's disease (PD), providing improvement of symptoms such as tremor, rigidity, and bradykinesia. Understanding the distinct impact of stimulation and levodopa on gait and postural features is crucial to optimize personalized therapeutic approaches. In addition to clinical rating scales, cutting-edge wearable sensors can be used to assess the effectiveness of pharmacological and surgical treatments, both in clinical settings and real-life environments. This study uses wearable sensors and digital technology to evaluate gait, posture, and upper limb bradykinesia responsiveness to STN-DBS and levodopa. MethodsThirty-three persons with PD were evaluated before (pre-DBS) and six months after (post-DBS) bilateral STN-DBS. They performed a comprehensive motor protocol (including Timed Up and Go, 18-m walk test, full 360° turn in place, and postural sway) monitored by wearable inertial sensors placed on the lower back and the feet (mTest, mHealth Technologies srl), automatically measuring spatiotemporal gait parameters. A finger-tapping test was performed using a tablet, tracking the number of times the person could alternately tap two buttons 20 cm apart in 60 s with the most affected hand. In the pre-DBS, tasks were performed before (med-OFF) and 60 minutes after levodopa intake (med-ON). Post-DBS patients were evaluated in different stimulation and medication conditions (med-OFF/stim-ON, med-OFF/stim-OFF, med-ON/stim-OFF, med-ON/stim-ON). Gait tasks were performed in both in single- and dual-task (counting backwards) modes, while postural sway was performed twice with open and closed eyes, respectively. The study evaluated clinical and instrumental motor outcomes before and after STN-DBS, comparing each medication condition before DBS to the corresponding condition after DBS with stimulation ON. The responsiveness of gait and posture to treatments was evaluated post-DBS by computing standardized response mean values, with the med-OFF/stim-OFF condition as the baseline.ResultsThe comparison of the sensor-based motor parameters before the levodopa intake (med-OFF in pre-DBS and med-OFF/stim-ON in post-DBS) revealed a significant improvement in gait parameters (e.g., gait speed, stride length, and turning velocity) following STN-DBS surgery. In contrast, postural parameters exhibited minimal change. The alternate finger-tapping test significantly improved post-DBS ($p<0.001$). Six months after the surgical procedure, gait speed was significantly enhanced in stim-ON conditions ($p<0.001$).ConclusionsSTN-DBS significantly improved upper limb bradykinesia and spatiotemporal gait parameters, thereby supporting the efficacy of STN-DBS surgery on motor outcomes, gait, and axial features. Further research is needed to explore the long-term effects of STN-DBS, especially in real-world conditions using wearable sensors.

P02-N-111 - Does motor fluctuations affect gait and turns in daily life in people with Parkinson's disease?

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BACKGROUND AND AIM: People with Parkinson's disease (PwPD) often spend less time engaging in physical activity, due to persisting motor symptoms and from medication-induced motor fluctuations (MF). The degree of MF has commonly been evaluated using patient-reported outcome measures. Recently, wearable inertial sensors have been used as an alternative method to monitor mobility in real-life settings. The aim of this study was to investigate the impact of MF on gait and turning during daily mobility. We hypothesize that those experiencing MF would show impaired gait and turning compared to those not experiencing MF. METHODS: 79 PwPD (69.3 ± 6.9 yrs) were included in the analysis. Participants wore inertial sensors on each foot and on the waist for 7 days, at an average of 8 hours per day (Opals, APDM Wearable Technologies, a Clario company). Wearable sensor data were used to calculate gait and turn metrics. We first assessed whether MF were associated with gait measures (i.e., mean and coefficient of variation (CV) of gait speed, pitch at toe-off, and double support proportion) and with turn measures (i.e., mean and CV of turn angle, turn duration, and peak turn velocity). The presence and severity of MF were measured using both the total score of UPDRS-IV and each item score. Linear regression analyses were performed with age, motor symptoms (measured by the total score of UPDRS-III), and MF as independent variables, and gait and turn measures as dependent variables. Separate models were used for each dependent variable. Secondly, we compared the effect of levodopa intake on gait speed and peak turn velocity from 1 hour before to 3 hours after levodopa intake. These measures were averaged over 15-minute intervals across a 4-hour period, and ensemble averages were calculated over the reported medication times and across participants. Participants were categorized into two groups: those experiencing functional impact from motor fluctuation (UPDRS item 4.4>0) and those without such impact (UPDRS item 4.4=0). RESULTS: UPDRS-IV total score was not significantly associated with gait measures [gait speed (mean: p=0.59, CV: p=0.88), pitch at toe-off (mean: p=0.65, CV: p=0.48), double support proportion (mean: p=0.82, CV: p=0.24)] or turn measures [turn angle (mean: p=0.95, CV: p=0.16), turn duration (mean: p=0.19, CV: p=0.19), peak turn velocity (mean: p=0.74, CV: p=0.47)] during daily mobility. Similar results were seen with individual item scores. In addition, levodopa intake had similar group effects on gait speed and peak turn velocity regardless of being impacted by MF (Fig. 1). We will examine the pattern of gait fluctuations for each individual. CONCLUSIONS: Our preliminary results showed lack of associations between the presence and severity of self-perceived MF and objective gait and turn measures during daily life mobility. These results suggest that patient-reported outcomes of MF might not affect gait and turning in daily mobility.

P02-N-112 - Neural correlates of concern about falling in Multiple Sclerosis: Resting-state functional connectivity between the Amygdala, Hippocampus, and Cerebellum

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Background & Aim: Concern about falling (CAF) is a common and debilitating issue in individuals with multiple sclerosis (MS), contributing to poor health outcomes and diminished quality of life. While CAF is related to poor motor functioning, cognition, and emotional well-being, the underlying neural correlates remain unknown. Given the multifactorial nature of CAF, we hypothesized that neural correlates may involve interactions between core brain regions involved in emotional processing (e.g., the amygdala) and those involved in motor (e.g., cerebellar) and cognitive functions (e.g., hippocampus). This study aimed to examine associations between CAF and resting-state functional connectivity (FC) in the amygdala-hippocampal and amygdala-cerebellar circuits in individuals with MS.Methods: Participants with relapsing-remitting MS completed the Falls Efficacy Scale-International to assess CAF, followed by a functional MRI scan using a multi-echo multi-band sequence. Region of interest (ROI)-to-ROI analyses were used to examine associations between CAF and FC within the amygdala-hippocampal and amygdala-cerebellar circuits. Significant connections were identified using false discovery rate (FDR) correction at $p < .05$. Results: Forty-one individuals (33 females, aged 31-65, mean = 47.56, SD = 10.17) participated in our study. CAF was significantly associated with greater amygdala-hippocampal FC (L amygdala – L hippocampus: $T(39) = 5.88$, p-FDR < .001; L amygdala – R hippocampus: $T(39) = 7.27$, p-FDR < .001; R amygdala – R hippocampus: $T(39) = 6.97$, p-FDR < .001; R amygdala – L hippocampus: $T(39) = 3.76$, p-FDR = .001) and lower amygdala-cerebellar FC (L amygdala – L cerebellum: $T(39) = -2.77$, p-FDR = .016; L amygdala – R cerebellum: $T(39) = -2.52$, p-FDR =.026).Conclusions: These findings highlight the neural correlates of CAF in MS, revealing distinct patterns of resting-state FC in circuits relevant to motor, cognitive, and emotional processes. Higher CAF was associated with greater connectivity between the amygdala and hippocampus, suggesting that neural circuits underlying fear-related memories and emotional processing may play a crucial role in perceived fall risk. In contrast, lower amygdala-cerebellar connectivity in individuals with greater CAF may reflect diminished integration of emotional and motor responses, potentially compromising environmental assessment and fall-related hazard recognition. Gaining further insights into the neural underpinnings of CAF could identify specific brain regions and circuits that may benefit from targeted interventions aimed at mitigating CAF and its negative consequences in MS.Acknowledgements & funding: This study was funded by the National Institutes of Health (F31HD116491; R21HD106133).

P02-N-113 - The process of establishing a multidisciplinary research agenda for understanding physical activity in people with Parkinson's disease in Sweden

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BackgroundPeople with Parkinson's disease (PwPD) have much to gain from being physically active. Despite the benefits, PwPD are generally less physically active than healthy people of similar age. Today, there is a lack of knowledge about physical activity (PA) in PwPD and the factors influencing their ability to be physically active. To fill this knowledge gap, the aim of this project was to describe the establishment of a national, multistakeholder expert panel and define a prioritized research agenda to better understand which factors may influence PA behavior in PwPD in Sweden for future fit-for-purpose interventions.MethodsThe Nominal Group Technique (NGT) was used in a national multistakeholder expert panel, to generate research ideas on what influences the ability to be physically active in PwPD. Data were collected over two NGT workshops, with one conducted digitally via MS Teams and the other in-person. Each workshop had a particular focus. In workshop 1 (WS1), ideas were generated and shared in the larger group and then ranked based on their importance to physical activity. A ≥70% level of agreement was decided, in line with recommendations for consensus-reaching methodologies, for an item to be considered for final inclusion.Workshop 2 focused on methodological considerations for the assessment of PA based on the previously defined (from WS1) explanatory variables. Data collection, outcome measures, and instruments for the range of variables were discussed. Similarly agreement had to be reached on the nominated measures.ResultsThe multistakeholder expert panel consisted of people from diverse geographical regions in Sweden and included PwPD, representatives from a patient organization, healthcare professionals and researchers within the field of Parkinson's and/or PA. From WS1, the factors ranked highest (≥88% agreement) were self-efficacy, patient preferences and motivation and apathy. The second highest ranked (80-87%) were fear of falling, history of PA, social support, safe environment for PA, information/prescription of PA from health care and motor symptoms. Thirdly ranked (70-79%) were equity factors, depression and anxiety, fatigue, pain, cognition, availability of health care facilities and resources and team around people with PD. In workshop 2, measurements (clinical tests and questionnaires) and self-made questions for each factor were proposed, discussed and decided on. Further, frequency of data collection and administration of measurement were discussed. Where possible, psychometrically sound measures were preferred.ConclusionsThe findings from the NGT, used in a national multistakeholder expert panel to explore factors influencing PA in PwPD, revealed variables and factors from a biopsychosocial perspective, highlighting the need to understand the role of contextual factors in a complex behavior such as PA.Acknowledgements and fundingNo acknowledgements or funding sources to declare.

P02-N-114 - Supporting gait and balance rehabilitation in people with Multiple Sclerosis: Usability and preliminary efficacy of a biofeedback-enabled crutch in continuity of care

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Background and Aim: People with multiple sclerosis (PwMS) are at high risk of falls due to impairments in strength, coordination, balance, and gait, often requiring walking aids such as canes or crutches. However, traditional aids may not fully address their balance and gait needs, particularly during independent use. We investigated the usability and preliminary efficacy of an engineered crutch (FBKEIN) with real-time feedback on exerted load to improve walking safety and efficiency in PwMS.Methods: FBKEIN integrates an accelerometer, a uniaxial load cell, and local memory for data collection. Twenty-two PwMS using walking aids (15 females; mean age: 58.6±9.8 years; disease duration: 14.9±12.9 years; all Expanded Disability Status Scale=6) used FBKEIN over an extended period while participating in two 20-session rehabilitation programs (REHAB1 and REHAB2), separated by a waiting-list period. Eleven participants (bioFB group) received real-time biofeedback through a vibration or a buzzer depending on whether the load exerted on the aid was above or below an individual threshold determined by the therapist and were instructed to adjust their posture accordingly. Usability and satisfaction were evaluated through an interview designed to gather comprehensive insight on user experience and perceived benefits and using the Assistive Technology Usability Questionnaire (NATU) and Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST). Preliminary efficacy was assessed using the Timed 25-Foot Walk Test (T25FW), Timed Up and Go Test (TUG), and Modified Fatigue Impact Scale (MFIS).Results: Overall, FBKEIN's perceived impact on walking improvement (6.7±2.3/10) and willingness for future use (8.1±2.2/10) were moderate to high. Improvements were most frequently reported in coordination (55%) and balance (50%), while gait speed improvement was noted by 15%. The bioFB group reported higher perceived benefits compared to conventional aids (8.1±2.2/10 vs. 5.2±4.1/10) and demonstrated changes in load exertion and posture. NATU and QUEST service satisfaction scores were high across both groups, though product satisfaction scores indicated bioFB perceived FBKEIN as slightly less durable and harder to use. Fatigue reduction was observed in both groups post-REHAB1 ($p=0.05$). Biofeedback enhanced walking ability (better bioFB performance at T25FW post-REHAB1: $p=0.02$ and post-REHAB2: $p=0.05$) and dynamic balance (better bioFB performance at TUG post-REHAB1: $p=0.04$).Conclusions: FBKEIN, particularly with real-time biofeedback, shows potential as a tailored assistive device to improve gait, balance, and safety for PwMS. Its ability to provide personalized feedback during independent use highlights its value in supporting continuity of care beyond supervised rehabilitation. Future optimization of the device should focus on enhancing usability and durability to maximize its impact on mobility and quality of life.

P02-N-115 - Post-stroke gait asymmetry: Differentiating pure impairments from compensatory strategies

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BACKGROUND AND AIMTemporal gait asymmetry (TGA) during comfortable walking in post-stroke individuals reflects a combination of pure impairments and compensatory strategies. Pure impairment in TGA indicates that symmetrical gait is unattainable due to functional limitations, whereas cases dominated by compensatory strategies may demonstrate asymmetrical gait at comfortable walking speed (CWS) while achieving symmetrical gait patterns under rhythmic auditory cueing (RAC). This study aimed to classify TGA in post-stroke individuals into two groups: those with pure impairments and those predominantly employing compensatory strategies. The clinical and gait characteristics of these groups were subsequently analyzed. METHODSThirty-nine post-subacute stroke patients (mean age: 70.4 ± 10.7 years; mean time since stroke onset: 78.8 ± 42.6 days) were evaluated using a randomized block design under two conditions: CWS and RAC. RAC was employed to experimentally control temporal gait symmetry. Gait evaluation included spatiotemporal parameters and trunk acceleration, while clinical evaluation assessed the severity of motor paralysis, sensory disturbances, spasticity, balance ability, and gait efficacy. Participants were classified into clusters using a Gaussian mixture model based on the symmetry index of single-leg stance time under the CWS and RAC conditions. RESULTSThe symmetry indices under the CWS and RAC conditions showed no significant association ($\rho = 0.062$, 95% CI [-0.258, 0.370], $p = 0.707$). Scatter plots revealed independent distributions of symmetry indices under the two conditions, with values being either low or high. Clustering based on the Gaussian mixture model identified four optimal clusters. Analysis of gait speed under CWS and RAC conditions revealed a significant main effect of cluster ($F(3,35) = 0.547$, $p = 0.002$, $\eta p^2 = 0.334$), but no significant main effect of condition ($F(1,35) = 0.916$, $p = 0.345$, $\eta p^2 = 0.026$) or interaction effect ($F(3,35) = 1.960$, $p = 0.138$, $\eta p^2 = 0.144$). Cadence showed no significant main effects or interactions. Clusters exhibiting asymmetry under both conditions demonstrated severe functional impairments, characterized by pronounced motor paralysis and higher spasticity scores. Conversely, clusters with asymmetry during CWS but symmetry under RAC displayed strong compensatory strategies, likely driven by reduced gait self-efficacy. CONCLUSIONSThis study identified distinct clusters of TGA in post-stroke patients under experimental gait conditions, emphasizing the necessity of decomposing TGA into components of impairments and compensatory strategies. These findings provide valuable insights for the development of personalized rehabilitation strategies, recognizing the varying severity of functional impairments and levels of gait self-efficacy among clusters. Future research should incorporate a broader range of variables to enhance understanding of temporal and spatial gait asymmetry impairments

and compensatory mechanisms. ACKNOWLEDGEMENTS AND FUNDINGWe thank the staff at Takarazuka Rehabilitation Hospital for their guidance and cooperation. This work was supported by JSPS KAKENHI grant numbers JP22K21255, JP23K16628. The funding bodies had no role in this study.

P02-N-116 - Perspectives of individuals with motor incomplete spinal cord injury on gait adaptability training during rehabilitation: A qualitative study

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Background: Gait adaptability, the ability to modify one's gait pattern in response to task or environmental demands, is critical for safe and independent walking. Following spinal cord injury or disease (SCI), gait adaptability is likely impaired. Despite rehabilitation, many individuals with SCI face ongoing walking challenges and view safe walking as an unmet goal. This study aims to explore the perceived importance and appropriateness of addressing gait adaptability during SCI rehabilitation from the perspectives of community-dwelling individuals with subacute SCI. Methods: A qualitative exploratory study using semi-structured interviews was conducted. The interview guide, informed by the COM-B model of behaviour change, focused on exploring the dynamic interplay between Capability (C), Opportunity (O), and Motivation (M) in shaping walking outcomes. Questions queried participants' perspectives on current rehabilitation practices aimed at improving gait adaptability. The study included community-dwelling individuals aged 18 years or older with subacute, motor incomplete SCI who had completed walking training during inpatient rehabilitation. Interviews were conducted 3-6 months post-hospital discharge, audio-recorded, transcribed verbatim and analyzed using interpretive description. Results: Ten individuals with SCI were interviewed (5 males, 5 females). Four key themes were identified. 1) Value of gait adaptability training: Participants emphasized its role in bridging the gap between clinical settings and unpredictable everyday environments, highlighting its real-world relevance and importance for safety and independence. 2) Factors influencing participation in gait adaptability training: Engagement was influenced by personal motivation, access to facilities and equipment, and social support from therapists and peers. 3) Current practices: Practices varied in timing, task difficulty, and outcome assessment, with delayed interventions and inadequately challenging tasks often limiting progress. Outcome measures were typically basic mobility assessments, with progress assessed informally. 4) Future directions for gait adaptability training: Participants advocated for incorporating higher-level challenges to better prepare individuals for real-world complexities and adopting patient-centred approaches tailored to individual needs and goals. Conclusions: This study highlights the importance of gait adaptability training for individuals with motor incomplete SCI, emphasizing its role in fostering confidence and independence post-discharge. While participants valued this training for its real-world relevance, progress is often informally assessed through therapist feedback. The findings highlight the need for personalized approaches to improve gait adaptability assessment and training and offer valuable insights for future research and strategies to optimize the implementation of gait adaptability training for this population. Acknowledgments: Neurosciences Division of the Canadian Physiotherapy Association and Canada Research Chairs program.

P02-N-117 - Can turning quality be improved by a novel turning intervention in people with Parkinson's disease? A preliminary analysis

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BACKGROUND AND AIM: Falls are common in people with Parkinson's disease (PD) and often occur during daily life while turning; this can lead to serious injuries such as hip fractures. It is unknown however, if a rehabilitation program can improve turning ability during daily life. Here, we have adapted our Agility Boot Camp program around the constraints of turning (TURN-IT) that people with PD experience (King et. al. 2022). We hypothesized that the TURN-IT program would improve turning performance during daily-life. The primary outcome measure is the change in variability (standard deviation) of the number of steps during turning, averaged over 7 days of daily monitoring. Secondary outcomes included other daily-life gait monitoring measures, as well as gait measures collected in the laboratory.METHODS: Participants had a diagnosis of PD and one or more falls in the previous year. They were randomized into the: 1) Control group or 2) Turning intervention group. The Control group received no intervention, and the Turning intervention group attended supervised, 1-hour classes, 3 times per week for 6 weeks, one-on-one with an exercise trainer, overseen by a physical therapist. Intervention participants spent 10-20 minutes at each exercise station – warm-up walking, turning, axial rotation, and weight shifting. Exercises focused on the particular constraints of turning ability, including: narrow base of support, rigidity, bradykinesia, impaired sensory integration, reduced attention, and inflexible set-switching. Pre- and post-6 week testing included wearing instrumented socks with inertial sensors for 7 days and a laboratory visit with gait, balance and clinical assessments. Registered in clinicaltrials.gov (#NCT04897256).RESULTS: Preliminary results are presented here as Groups A and B. We will have the intervention completed in the Spring to present results from the full, unblinded-dataset at this conference. Thus far, we have randomized 49 participants with 2 participants currently progress. We had 5 drop-out/early terminations in Group A and 6 in Group B. Group A includes 19 participants (W/M 8/11; Age 70.63 ± 7.01; UPDRS, III 37.32 ± 9.30; H&Y 2.14 ± 0.35), and Group B has 17 (W/M 6/11; Age 68.90 ± 5.30; UPDRS, III 40.14 ± 12.46; H&Y 210 ± 0.31). We measured the intervention effect using standardized response means (SRM) for the Groups. Our primary outcome measure (variability in number of steps/turn) had a SRM of 0.37 in Group A (worsen) and 0.02 in Group B. However, one turning quality measure (Average Turn Angle per step, -0.43) and

two gait quality measures (Double Support Time, -0.66 and Variability in Stride Duration, -0.43) improved in Group B. CONCLUSION: Our preliminary analysis showed Group B, but not Group A, with some improvements in turning and gait during daily life, specifically Average Turn Angle per step, Double Support Time and Stride Duration. This exploratory, pilot study will help determine which, specific characteristics of turning quality in daily life are most sensitive to rehabilitation focused on improving turning in people with PD and how many subjects would be needed for a future, clinical trial.Reference: King LA, Carlson-Kuhta P, Wilhelm JL, Lapidus JA, Dale ML, Talman LS, Barlow N, Mancini M, Horak FB. TURN-IT: a novel turning intervention program to improve quality of turning in daily life in people with Parkinson's disease. BMC Neurol. 2022 Nov 28;22(1):442. doi: 10.1186/s12883-022-02934-5. PMC9703770ACKNOWLEDGEMENTS AND FUNDING: Grant support NIH grants R01 HD100383 and UL1TR002369.

P02-N-118 - Cortical Activity during standing balance in Parkinson's disease, older adults and young adults

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Background Balance impairments are hallmark symptoms of Parkinson’s disease (PD), contributing to heightened risk of falls and significantly reducing quality of life. Balance impairments are highly variable, highlighting the heterogeneous nature of PD. Balance deficits are associated with ageing and neurological impairment, as older adults (OA) also commonly experience balance issues. Previous research has suggested cortical activity changes with age and PD during motor tasks1. However, little is known about the real-time cortical control of balance in these populations. This study aims to investigate cortical activity during standing across different sensory conditions (eyes open/closed on firm/foam surface) and between groups: young and older adults and people with PD.MethodsA total of 124 people with PD aged 69.44 (7.71), (H&Y stage 1 N=20, 2 N=70, 3 N=30), 21 older adults (OA) aged 69.76 (7.82) and 17 younger adults (YA) aged 25.88 (4.35) were recruited. Participants performed four different standing tasks (eyes open/closed on firm surface and eyes open/closed on foam surface), each lasting two minutes. Mobile electroencephalography (EEG, 32 channel) measured cortical activity throughout each task. Additionally, balance performance was recorded using six wearable inertial measurement units (IMUs). EEGLAB software was used to process EEG signals and the independent component (IC) clusters, including their power spectral densities (PSD); Delta (δ:1-4Hz), Theta (θ:4-8Hz), Alpha (α:8-13Hz), Beta (β:13-30Hz) and Gamma (γ:30-50Hz) band. We identified 1356 independent components and formed 10 clusters with sources located in the frontal, parietal, and occipital cortices.ResultsSignificant differences in group (PD, OA, YA) performance were found for sway area (p=.043), sway velocity (p=.019), and root mean square (p=.002). Specifically,

PD had significantly increased sway velocity compared to OA (p=.031), during the eyes open firm surface condition. Root mean square (RMS) was also significantly higher for PD compared to older adults during the eyes open firm surface condition (p=.036). Sway frequency was higher in PD compared to OA during the eyes closed on foam (p=.039) and compared to YA during the eyes closed firm surface condition (p=.036). During the eyes open foam surface condition, PD also had significantly higher RMS compared to OA (p=.023) and YA (p=.003).EEG analysis showed that cortical activity differed significantly between groups within specific regions under different standing conditions. PD had greater Alpha and Gamma-band PSD in the left pre-frontal cortex (PFC) than both OA and YA (p<.001) during both firm surface conditions. Higher gamma PSD was found in the M1 during all conditions in PD compared to both other groups (p<.001). In the occipital region, significantly higher PSD was found in PD during the eyes closed conditions compared to both other groups (p<.001). Specifically, in the gamma band during the standing with eyes closed on a firm surface, and both in the beta and gamma band during the eyes closed foam condition. This may indicate that people with PD have reduced cognitive processing (increased alpha) and increased sensorimotor processing (increased beta and gamma) in selective brain regions compared to controls during balance tasks. ConclusionsThese preliminary findings suggest maintenance of standing balance under different conditions requires cortical activity in specific regions (occipital, M1, PFC) in PD compared to OA and YA. Differences in cortical activity may underpin balance impairments associated with age and neurological deficits. 1. Stuart S, Vitorio R, Morris R, Martini DN, Fino PC, Mancini M. Cortical activity during walking and balance tasks in older adults and in people with Parkinson's disease: A structured review. Maturitas. Jul 2018;113:53-72. doi:10.1016/j.maturitas.2018.04.011

P02-N-119 - Dynamic postural reactions in individuals with chronic inflammatory demyelinating polyradiculoneuropathy at different stages of immunomodulatory treatment

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BACKGROUND AND AIM: Chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) affects distal and proximal nerves leading to progressive loss of strength, sensation, and reflex responses. CIDP impairs postural performance on clinical balance and gait tasks, though some improvements are observed with immunosuppressive treatment (e.g intravenous immunoglobulin; IVIg). However, no research to date has investigated how dynamic reactive balance is affected in individuals with CIDP at different stages of immunosuppression treatment. This study aimed to determine if/how treatment affects reactive balance control in CIDP using unpredictable, multi-directional support surface rotations.METHODS: 10 individuals with CIDP and receiving regular IVIg

treatments, and 10 healthy age-matched controls (HC) were recruited. Two testing sessions were scheduled to correspond with end-cycle and mid-cycle of their regular IVig treatment. During each session, participants stood on a rotational platform that delivered rapid, transient perturbations in the pitch and roll planes (7.5 deg at 50 deg/s). Two blocks were performed during each visit (eyes open and eyes closed), with 6 perturbations pseudorandomly presented in 4 directions. Surface electromyography was recorded bilaterally from tibialis anterior, medial gastrocnemius, and soleus and unilaterally from vastus lateralis. Onset latencies and amplitudes of balance correcting responses (BCRs) were calculated offline and pooled across vision blocks. Group effects were examined using independent sample t-tests; treatment effects were examined using paired t-tests (alpha=0.05).RESULTS: BCR onset latencies were significantly delayed in CIDP compared to HC for all muscles, with delays ranging on average between 20-40 ms. Significant decreases in BCR amplitudes were observed in the CIDP group compared to HC for soleus and medial gastrocnemius. There was no effect of immunosuppression treatment on either onset latencies or amplitudes of BCRs.CONCLUSION: This novel study demonstrated significant deficits in timing and magnitude of dynamic postural reactions with CIDP. The observed BCR delays with CIDP (with distal and proximal sensory loss) supports the important contribution of proximal proprioceptive inputs to trigger whole-body postural synergies. The decreased amplitude of BCRs is consistent with prior evidence in patients with distal and proximal sensory loss and supports proprioceptive modulation of BCRs. Unlike improved performance on clinical balance tasks, no changes in postural reactions were observed at different stages of IVig cycle for pitch plane perturbations. Therefore, IVIg effects on balance may be attributed to improved strength or reduced fatigue as opposed to altered spinal and supra-spinal reflex pathways that underpin dynamic postural reactions. Alternatively, it reflects a level of clinical stability can be reached through long-term IVig treatment of CIDP.FUNDING: Muscular Dystrophy Canada

P02-N-120 - Digital cueing with laser shoes does not improve walking in Parkinson's disease: Evidence across disease severity and freezing status

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Background: Gait impairment in Parkinson's disease (PD) occurs early and pharmaceutical interventions do not fully restore this function. Visual cues are traditionally taped lines on the floor, fixed in areas that are difficult for patients to navigate. Visual cueing has been shown to improve gait in PD and may be most beneficial in advanced disease stage or for alleviating freezing of gait (FOG). Technological development of digital laser shoe visual cues now allows for visual cues to be used continuously when walking. Subjective video rating has shown that laser shoes may

reduce FOG episodes in PD. However, objective measurement of gait during the use of laser shoes has not been systematically examined in PD, or their impact on gait across disease severity or FOG status. This study aimed to investigate the immediate effects of laser shoe cueing on gait in people with PD across different disease severity (i.e., Hoehn & Yahr (H&Y) stages I-III) and FOG status. Methods: Eighty people with PD (H&YI=20, H&YII=30 [15 FOG, 15 noFOG], H&YIII=30 [15 FOG, 15 noFOG]) walked a 10m straight path (back and forth) self-paced for 80 seconds without and then with laser shoe cues (participants were allowed 1-2 walks to familiarise with the cues). Inertial sensors were used to measure gait metrics. Laser cue line was set to usual step length for individuals based on their usual walk data from the inertial sensors. Linear mixed-effects models were used to examine gait changes with cueing across disease severity (while controlling for FOG) and FOG groups. Results: Laser shoe cueing did not improve gait in PD regardless of disease severity or FOG status, with no significant differences in gait with cues in different H&Y or FOG groups. Across all groups, participants decreased gait speed ($p<0.001$), cadence ($p<0.001$), arm range of motion ($p<0.005$) and arm swing velocity ($p<0.001$), and increased stride time, double support time ($p<0.001$), elevation at midswing ($p<0.001$) and gait (stride time, step time, double support time, elevation at midswing) variability (all $p<0.001$) while walking with the laser shoes compared to their usual walking. This may be due to either a more cautious gait pattern with cues, early motor learning with the cues or impaired gait with cues that may increase falls risk. Conclusion: Visual cueing with laser shoes does not improve gait in people with PD across disease severity stage or FOG status at early exposure. Further investigation is required to examine different cue settings (i.e., longer than usual step length) or exposure periods (i.e., over days/weeks), as well as the specific mechanisms underpinning cue response to allow development of more effective and targeted intervention. Funding: PF-CRA-2073 (PI: Stuart)

P02-N-121 - Enhancing balance and mobility: The role of exercise in postural and dynamic stability for Parkinson’s disease

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BACKGROUND AND AIMParkinson’s disease (PD) negatively affects balance, gait, and overall quality of life, while also increases the fall risk. Although levodopa remains the most effective treatment for alleviating motor symptoms, its influence on postural instability is limited, and long-term use can result in complications like motor fluctuations and dyskinesia. Consequently, complementary interventions such as exercise programs are gaining attention for their potential benefits.This study investigated the impact of supervised aerobic-strength exercise training on postural stability and gait in individuals with PD, focusing on differences between ON and OFF medication states.

Additionally, it explored the relationship between standing balance and dynamic balance during walking, providing insights into the effects of physical activity as an adjunct to pharmacotherapy in both medication states.METHODSFifteen PD patients (11 males, aged 65.5±6.8 yrs) participated in a supervised 4-month exercise program tailored to their physical fitness levels. The training regimen included two 1-h sessions per week focusing on strength and aerobic exercises, as well as one 1-h session dedicated to aerobic coordination. Assessments were conducted before and after the exercise intervention to evaluate changes in stance and gait performance in both ON (with antiparkinsonian medication) and OFF (12-24 hours without medication) states.Static balance was measured using 2 accelerometric sensors attached to the upper and lower trunk in 4 conditions: standing on a firm or foam surface with eyes open or closed. For each condition and sensor location, sway area, sway path, mean frequency, and sway jerkiness were calculated. Dynamic balance during normal and dual-task walking was analyzed by a markerless motion capture system with step length, stance time and walking speed determined. Clinical evaluations included the MDS-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) and Berg Balance Scale (BBS). The Wilcoxon paired test was applied to determine the effects of the exercise intervention.RESULTSFollowing the 4-month aerobic-strength training program, significant improvements were observed in motor function and postural stability. Motor MDS-UPDRS scores improved notably in both medication states, with more pronounced gains in the OFF state. BBS scores also increased significantly, reflecting enhanced overall balance. In the OFF state, several postural parameters were reduced, particularly while standing on foam. Moreover, decreased stance time in both medication states in dual-task condition was found, while walking speed increased only in the ON state. Changes in trunk sway significantly correlated with intervention-induced changes of stance time during dual-task walking, indicating enhanced trunk stability. The lack of correlations between postural and gait changes during normal walking underscores the task-specific effects of the exercise intervention.CONCLUSIONSConsistent physical activity has been shown to enhance motor functions like gait, balance, and coordination, which are commonly impaired in PD. By targeting these deficits, exercise may serve as an effective complement to levodopa therapy, offering improvements in mobility and stability that are particularly important in managing the disease's complex symptoms across various treatment stages.ACKNOWLEDGEMENTS AND FUNDINGWe thank all the participants for their help and cooperation.Supported by VEGA 2/0076/22, VEGA 2/0098/25, APVV-20-0420, APVV-20-0466.

P02-N-122 - Deep brain stimulation improves gait initiation anticipatory postural adjustments in Parkinson's disease

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Background: People with Parkinson's disease (PD) often have impaired anticipatory postural adjustments (APAs) during gait initiation [1,2]. During gait initiation, an APA typically consists of loading and unloading the stepping and stance legs, respectively, while the center of pressure (COP) moves posterior and laterally toward the stepping leg; this serves to propel the center of mass over the stance leg and then forward for walking [3]. In PD, impaired APAs may be responsive to levodopa treatment prior to deep brain stimulation (DBS) surgery, but post-surgery, may become intractable to medications, globus pallidus (GP) DBS, and subthalamic nucleus DBS [4]. Here, we investigated how GP DBS may alter the magnitudes and timings of the APA and first and second steps.Methods: While OFF medications, 8 participants (2 female; mean ± standard deviation: age 62.9 ± 8.9, 10.0 ± 1.9 years since diagnosis) with bilateral (n = 7) or unilateral (n = 1) DBS electrodes implanted in the GP, completed two visits with stimulation randomly assigned to OFF (1 hour wash-out) or ON clinical DBS parameters. Participants and investigators were blinded to stimulation setting. Participants performed 12 trials of uncued (self-initiated) gait initiation (6 trials each leg). Participants were instructed to wait 3-5 s after hearing the instruction “anytime” before quickly walking forward starting with the specified leg (block randomized). APA magnitudes, timings, and time to toe off, were calculated from a force plate data collected under each foot (Kistler, Inc.). Results: Linear mixed effects ANOVAs showed significant effects of DBS setting ($p < 0.05$, p-values FDR-corrected for multiple comparisons), for all the APA magnitudes (step loading, stance unloading, COP shifts in AP and ML directions), and some of the timing measures (time to the ML COP shift and first and second toe off) (see Figure). Post-hoc comparisons demonstrated that GP DBS improved APAs by increasing magnitudes and decreasing these timings. Improvements were observed irrespective of preferred vs. non-preferred, step vs. stance leg, or hemisphere stimulated. However, it is noteworthy that there was considerable variability in the response to DBS across participants. 5 of 8 participants (62%) experienced a clear improvement in APA measures. Conclusion: Contrary to previous studies of the effects of DBS on APAs steps [4], these findings demonstrate that GP DBS can improve the transition between standing to walking. Differences in GP DBS electrode location and clinical stimulation parameters may explain, in part, the difference between studies. An increased understanding the regions and pathways activated by GP DBS that improve APAs may lead to more consistent and efficacious outcomes.Acknowledgements and Funding: We'd like to thank the participants and our funding: P50 NS09857, P50 NS123109-03.References[1] A. Burleigh-Jacobs, F.B. Horak, J.G. Nutt, J.A. Obeso, Step initiation in Parkinson's disease: Influence of levodopa and external sensory triggers, Movement Disorders 12 (1997) 206–215. https://doi.org/10.1002/mds.870120211.[2] C. Lu, S.L. Amundsen Huffmaster, P.J. Tuite, J.M.. Vachon, C.D. MacKinnon, Effect of Cue Timing and Modality on Gait Initiation in Parkinson Disease With Freezing of Gait, Arch Phys Med Rehabil 98 (2017) 1291-1299.e1. https://doi.org/10.1016/j.apmr.2017.01.009.[3] Y. Brenière, M. Cuong Do, S. Bouisset, Are Dynamic Phenomena Prior to Stepping Essential to Walking?, J Mot Behav 19 (1987) 62–76. https://doi.org/10.1080/00222895.1987.10735400.[4] L.

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P02-N-123 - Capturing ataxic gait with or without shoes? A question of sensitivity versus relevance to everyday life

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BACKGROUND AND AIM:The comparability of gait analysis studies may depend on several factors, such as the length of the pathway and whether the assessment was performed with or without shoes. With disease-modifying drugs for degenerative ataxias on the horizon, these environmental changes need to be controlled in multicentre clinical trials before extracting digital performance markers. The aim of this study is to investigate the extent to which ataxia-related gait measures, which have been shown in previous studies to be sensitive to the severity of ataxia, differ between walking with and without shoes. We hypothesize that ataxic subjects will adapt their foot placement to walking without shoes, resulting in larger differences in gait compared to age-matched control subjects.METHODS:We assessed gait changes in 30 subjects with degenerative cerebellar disease (SARA: 7.2 ± 5.2, age: 49.4 ± 12.9) from three sites (Tübingen n=15, Chicago n=10, Portland n=5) and 13 age-matched healthy controls from Tübingen. Gait was quantified using 3 body-worn, inertial sensors under 2 conditions: self-paced walking 2 minutes over 10 metres (1) barefoot and (2) with shoes. Movement analysis focused on measures of spatio-temporal variability sensitive to ataxia: stride duration variability (SDcv), lateral step deviation (LSD) and toe out angle standard deviation (TOAstd). In addition, the pitch angle of the foot at initial contact (FPic) and at toe-off (FPto), the toe out angle (TOA) as well as the gait speed (GS) were examined.RESULTS:All foot angles and gait speed differed significantly in subjects with ataxia when walking with versus without shoes with high effect sizes (FPic r=-0.93, FPto r=-0.88, TOA r=0.69, GS r=-0.94). In addition, measures of spatio-temporal variability showed moderate effect sizes (TOAstd r=0.52, SDcv r=0.51, LSD r=0.48). Healthy controls indicated similar effects in foot pitch angles and gait speed (FPic r=-1.00, FPto r=-1.00, GS r=-0.93) but no significant change in ataxia-sensitive measures (SDcv, LSD, TOAstd). Furthermore, group analyses comparing gait measures between healthy controls and a mild cohort (n=13, SARA<7.5) revealed higher effect sizes without shoes (TOAstd: r_mild = 0.48) compared to shoes (TOAstd: r_mild = 0.34).CONCLUSIONS:In this study, we observed a significant dependence of ataxic gait quality on foot wear. When walking without shoes, the subjects

showed slower speed, less foot dorsiflexion and a greater external rotation of the feet, as well as an increase in ataxia-specific spatial-temporal variability (SDcv, LSD, TOAstd) than with shoes. Therefore, walking barefoot can increase the sensitivity of the gait examination, especially in the very early stages of the disease. However, gait measurements with shoes may be more relevant for functional ability in everyday life. Since wearing shoes significantly improves ataxia-specific parameters, patients should be advised to wear shoes for greater stability in everyday life.

P02-N-124 - Classification of medication states in Parkinson's disease patients through gait analysis

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Parkinson's disease (PD) patients commonly often experience motor fluctuations, alternating between the "ON state," where medication is effective, and the "OFF state," where its effects are minimal. During the OFF state, PD patients present more severe motor impairment which leads to an increased risk of falls and injuries. Monitoring and understanding these transitions are essential to manage the medication frequency intake and improve the patient's quality of life. Wearable sensors can be used to monitor gait and provide further analysis in the medication states. This study aims to classify medication states in PD patients using both spatio-temporal features (such as step length and cadence) and signal processing features (including harmonic ratio, gait symmetry index, and frequency-related parameters) through machine learning techniques.Thirty-three people with PD (age: 68 ± 7 years) walked at their normal speed for 2 minutes over a 10-meter distance while wearing a lower-back inertial sensor (Opal from APDM Wearable Technologies at lumbar L5). Total of 130 digital gait measures were derived from the 2-minute walk test. 70% of the training dataset was used for feature selection, and the remaining 30% of data was used as a test dataset. Different machine learning models (Random Forest, Logistic Regression, and Extra trees) were applied for the classification and interpretation of gait characteristics. The model's performance was assessed by the accuracy on the validation dataset. Models' accuracy (validation dataset) ranged between 80% -85% after applying feature selection (five features). The most influential characteristics in the classification models were related to the signal's frequency (range, integrated and mean power frequency). Specifically, frequency range was significantly smaller in people with OFF state compared to ON state. The density of the top five features is in the attached figure, showing the differences between both states.The results highlight the potential of gait analysis to classify and understand medication states in PD patients. This study shows that wearable sensors and gait characteristics, especially frequency-related features, can help identify differences between ON and OFF states. This could lead to improved methods for monitoring motor fluctuations and managing medication in future clinical trials and patient care.

P02-N-125 - Effects of a novel turning intervention on prefrontal cortex activity during walking in Parkinson's disease: An exploratory analysis

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Background and Aim: People with Parkinson's disease (PD) increasingly rely on executive control, as indicated by elevated prefrontal cortex (PFC) activation, to maintain walking stability. This compensatory mechanism can exacerbate mobility challenges under complex conditions. Rehabilitation interventions aimed at improving gait and turning automaticity may alleviate these challenges, reduce executive compensation, and enhance safety. This study conducted a secondary analysis to explore whether a novel turning intervention (TURN-IT) could reduce reliance on executive resources during walking. Methods: A total of 49 participants with PD were randomized to intervention or control groups, with 6 dropouts after randomization. This preliminary analysis includes 23 in Group A (13 men, 10 women; mean age=71; mean UPDRS-III=38; Hoehn & Yahr Stage=2) and 20 participants in Group B (13 men, 7 women; mean age=69; mean UPDRS-III=40; Hoehn & Yahr Stage=2). Participants completed 2-minute single-task (ST) and dual-task (DT) walking tests before (baseline) and after 6 weeks of intervention or control activities (6-weeks). During DT trials, participants recited digit spans matched to cognitive capacity. PFC activity was measured using functional near-infrared spectroscopy (fNIRS), and wearable sensors quantified gait metrics. To measure effect size, the standardized response means were calculated for each group. Results: Preliminary analyses using Standardized Response Mean (SRM) revealed distinct patterns of change in prefrontal cortex (PFC) activation between Group A and Group B. During single-task (ST) walking, Group B demonstrated a moderate reduction in PFC activity while walking (SRM = -0.430) at 6-weeks compared to baseline assessment. In contrast, Group A showed negligible change in PFC activation during ST walking (SRM = 0.006) at 6-weeks compared to baseline. Under dual-task (DT) walking conditions, both groups exhibited small reductions in PFC activation, with SRMs of -0.184 and -0.167 for Group A and Group B respectively. Conclusions: These preliminary findings indicate that Group B may show a reduced cognitive demand and enhance gait automaticity during walking at weeks 6 compared to baseline. However, participant enrollment is ongoing, and the intervention is still being implemented. By the time of the conference, we anticipate presenting a comprehensive dataset with fully unblinded analyses, offering deeper insights into the effects of the intervention on cognitive-motor interference and gait automaticity.

P02-N-126 - Consistency of daily gait fluctuations in Parkinson's disease: Insights from real-world data

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Backgrounds and Aim Assessing real-world gait to evaluate motor symptom severity is an important area of research in people with Parkinson's disease (PwP). Some gait outcomes (such as step length) are responsive to dopaminergic treatment [1]. With multiple doses of levodopa prescribed across the course of a day, optimising the timing of these doses is essential to alleviate motor symptoms and maintain improvements in function. Exploring fluctuations in symptoms following levodopa medication, in particular changes in gait, may help to optimise medication regimens. This study aims to explore the fluctuation (within a day) and consistency (across days) of gait, utilising the technique of statistical parametric mapping (SPM). Methods A convenience sample of 17 PwP (11 males, 68±8 years, median? Hoehn & Yahr stage II) were selected from a larger study, focusing on the use of wearable technology to monitor gait following medication intake [2]. Data was collected over 7 consecutive days from an inertial measurement unit (IMU; Axivity AX6) worn on the lower back. Validated algorithms quantified gait outcomes, focussing on velocity and length [3]. Daily time series, with 60-minute intervals, was constructed for step length and step velocity, with the derivative used to assess hourly fluctuations. Change in the daily time series across 7 days was assessed using a SPM t-test (α = 0.05) [4] to determine the consistencies and changes in daily patterns. Results Hourly fluctuations were present in both step velocity and length, with a maximum change ranging from ±0.8m/s and ±0.4m respectively. As may be expected, the change for both followed the same direction (i.e., a decrease in step velocity was paired with a decrease in length). When looking across individual days, 9/17 participants showed a consistent pattern of change that was significant ($p<0.05$). An exemplar timeseries demonstrating consistent change in step velocity and step length is provided (Figure 1).ConclusionWe have demonstrated that SPM can be used to show fluctuations in gait across a day on an hourly basis. Our findings indicate that for some participants, step velocity and length change consistently at the same time of day across 7 days. These changes may relate to the timing of medication intake and as such may be a useful tool for evaluating medication response and optimising medication regimens. Further analysis will superimpose medication intake times onto the daily gait profiles to further explore the utility of this statistical method.References [1] Galna et al., Movement Disorders, 2015 [2] Packer E et al, BMJ Open, 2023 [3] Del Din S et al. J Gerontol A Biol Sci, 2019 [4] Pataky T. C. et al., J. Biomech, 2018.

P02-N-127 - Spontaneous outdoor cycling in Flanders: A Comparison between people with Parkinson's disease and healthy age-matched controls

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Background and aim: A primary goal for physical therapists is to activate people with Parkinson's disease (PD), who otherwise adopt a sedentary lifestyle. Uptake of spontaneous physical activity, however, is hampered in PD due to (non-)motor impairments, in particular gait and balance deficits. Cycling is an attractive form of physical activity for people with PD, who despite their impairments often have preserved cycling ability. Besides, it is an important form of transport and sports in Flanders. However, it is unclear how many people with PD in Flanders take up spontaneous outdoor cycling and we do not know if being a regularly cyclist provides benefits on certain (PD-specific) clinical parameters. Hence, this study aims to explore the participation rate of spontaneous outdoor cycling among people with PD compared to controls, and to examine differences in clinical parameters between cyclists and non-cyclists. Methods: Retrospective data of a convenience sample of 45 individuals with PD and 37 controls with a mean age of 65,95±7.6 and 65,6±6.5 years was examined. Participants completed a diary focusing on their sleeping schedule as part of a separate study, which included an item where the participants had to list their daily activities. They received no instructions on what type of activities to perform, making it a non-coercive collection of self-reported cycling. Additionally ANOVA statistics with cycling and a diagnosis of PD as grouping variables were used on demographics, cognitive scales (e.g., Verbal fluency), sleep questionnaires (e.g., Epworth Sleepiness Scale) and other PD-relevant metrics (e.g., motor scales, medication and disease duration) to compare between PD and controls. Results: Eleven out of 45 people with PD (24,4%) reported cycling at least once per week whereas 14 out of 37 controls (37,8%) reported this. The average number of weekly trips was 1.4 for the PD group and 2.18 in the controls. Both variables were not significantly different between PD and controls. No information on duration or purpose could be derived. When comparing for the clinical parameters, only one main group difference between cyclists and non-cyclists could be found for the verbal fluency animals test, an executive functioning test where participants listed as much animals as possible in one minute. Using a post hoc independent T test, the cycling group performed significantly higher ($p=0.006$, $t=2.82$, $d=0.68$). Conclusions: only a quarter of PD patients and less than half of the control group cycle at least once a week, which was remarkably not significantly different among both groups. The finding of an association between cycling and executive functioning in PD and healthy controls inform future studies to consider these variables when assessing cycling in both populations. The participants also wore an actigraphy watch, the data of which will be analyzed next to place the amount of cycling into context of overall physical activity levels.

P02-O-128 - How does the brain control a sudden loss of balance in ACL ruptured adult males pre- and post- reconstructive surgery: A 9-month EEG test-retest study

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Background: During a sudden and unexpected loss of balance, the ability of an anterior cruciate ligament (ACL) injured individual to react and maintain equilibrium may be compromised due to changes in corticomuscular reprogramming caused by injury and/or reconstruction. An ACL rupture damages key somatosensory feedback loops responsible for proprioception and afferent signalling, increasing the demands on attention to maintain stability and decreasing the ability to engage in secondary cognitive tasks. However, it remains unclear whether these dysfunctions lead to fundamentally altered brain activation patterns when faced with a sudden loss of balance, and whether these patterns change from pre- to post- reconstructive surgery. In healthy adults, a sudden loss of balance reliably evokes a large negative peak of electroencephalographic (EEG) activity across the sensorimotor cortex 100-200 ms after balance is challenged (termed the “balance N1”). This signal serves as an alarm, prompting the body to make quick postural adjustments to correct balance and prevent a fall. The balance N1 is typically larger when balance recovery is more challenging, reflecting a compensatory increase in cortical activity to prevent a fall. However, slower, and weaker N1 signals have been observed in balance impaired clinical populations and may reflect an inability to produce a suitable cortical response due to somatosensory dysfunction. Balance-evoked cortical responses may serve as valuable markers for corticomuscular rehabilitation after ACL injury, however they remain unreported in ACL populations. Aim: The aim of the present study is to provide the first longitudinal assessment of the cortical control of balance recovery in ACL ruptured adults from pre-surgery to 3-months, and 9-months post- surgical reconstruction. Methods:Twenty-five adult males (18-35 years) with a current diagnosed ACL rupture, due to undergo reconstructive surgery, and 25 healthy controls will attend three identical lab sessions over a period of 9-months. During each session, participants will be stood on a force-plate embedded treadmill whilst their brain activity (via EEG) and leg muscle activity (via surface electromyography; EMG) is recorded. The treadmill will then unexpectedly move forwards a short distance at two varying speeds (i.e., a discrete perturbation). Participants will face a total of 88 discrete perturbations, half of which will be performed whilst engaged in a secondary cognitive task (maximal digit span). Key Measures: Balance-evoked EEG responses will be assessed by the amplitude and latency of the balance N1, as well as spectral activities pre- and post-perturbation. Postural responses will be assessed by the latency and peak amplitude of both muscle activity and the centre of pressure. We will also record key anthropometric data and clinical measures of recovery. Results: This project is ongoing, but preliminary results will be processed and presented.

P02-O-129 - Effects of diaphragm function on iliopsoas activation in individuals with chronic ankle sprains

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[Background and Purpose] Chronic ankle sprains (CAS) are common musculoskeletal injuries that result in persistent ankle instability and altered neuromuscular control, often extending beyond the site of injury. Recent studies suggest that CAS affects not only the ankle but also proximal muscle groups and core stabilizing systems. Notably, the function of the diaphragm—the primary muscle responsible for inspiration—is often impaired in individuals with CAS. The diaphragm plays a critical role in trunk and pelvic stability through its anatomical and functional connections with deep core muscles and the pelvic floor. Its anatomical link to the iliopsoas, a key hip flexor, is particularly significant. Impaired diaphragm function may reduce iliopsoas activation, leading to altered neuromuscular control and stability issues in individuals with CAS. Understanding the interplay between diaphragm dysfunction and hip flexor muscle activity is essential for designing effective rehabilitation strategies that address both distal ankle injuries and proximal stability components affecting lower limb function. This study was performed to investigate the effect of diaphragm function on iliopsoas activity in individuals with unilateral CAS. Specifically, differences in maximal isometric hip flexion contractions were evaluated under three breath-holding conditions (end-expiration, end-inspiration, and mid-lung volume) between the injured and uninjured sides. [Methods] Eleven participants with unilateral CAS were recruited and confirmed to have ankle instability through standardized assessments. This study adhered to the Declaration of Helsinki and was approved by the Kanazawa Orthopedic Sports Medicine Clinic Ethics Committee (kanazawa-OSMC-2020-004). Surface electromyography (EMG) electrodes were placed bilaterally on the iliopsoas, rectus femoris, sartorius, and tensor fasciae latae muscles. Participants performed maximal isometric hip flexion contractions for 5 seconds under three breath-holding conditions: end-expiration, end-inspiration, and mid-lung volume. The conditions were randomized, with 3-minute rest intervals between trials to minimize fatigue and learning effects. The EMG data collected during the contractions were processed using root mean square (RMS) smoothing. To ensure consistency, the RMS values for each condition were normalized by setting the RMS value for the mid-lung volume condition to 100%. Torque generated during each contraction was also measured. Paired t-tests were used to compare EMG activity and torque between the injured and uninjured sides for each condition. [Results] Significant differences in iliopsoas EMG activity were observed during the end-inspiration condition. The uninjured side demonstrated significantly higher iliopsoas activation than the injured side ($p < 0.05$). However, no significant differences were found during the end-expiration or mid-lung volume conditions. Other hip flexor muscles, including the rectus femoris, sartorius, and tensor fasciae latae, showed no significant side differences under any breathing condition. Torque measurements also revealed no differences between the injured and uninjured sides across all conditions. [Conclusion] Individuals with CAS exhibit reduced iliopsoas activation during maximal isometric hip flexion under inspiratory conditions, likely linked to impaired diaphragm function. The absence of torque differences between sides suggests that reduced EMG activity does not necessarily translate to diminished force production. These findings emphasize the importance of incorporating diaphragmatic breathing exercises and core stabilization strategies into rehabilitation programs for individuals with CAS.

P02-P-131 - Impaired ankle proprioception impacts postural stability in Parkinson's disease

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Introduction: Postural instability and falls are major factors impacting quality of life for people with Parkinson's disease (PwP). Limits of stability (LOS) quantifies the functional sway area as a proxy for postural stability and is markedly smaller in PwP. Proprioception plays a critical role in maintaining postural control; however, it is impaired in PwP and likely exacerbates postural instability. Whether LOS outcomes are impacted by proprioceptive ability in PwP remains unexplored. This study aims to investigate ankle proprioception acuity and its influence on quiet stance LOS in both healthy controls (HC) and PwP. We hypothesize that PwP will exhibit greater proprioceptive error compared to HC, and that increased proprioceptive error will correlate with reduced LOS. Methods: To date, proprioception error and LOS has been measured in 14 PwP (68.7± yrs) and 6 age-matched HC (71.8±9.1 yrs). LOS were assessed during either standard or narrow stance, with eyes open or closed and on a firm or foam surface. Participants leaned as far as possible in the anterior/posterior (AP) and mediolateral (ML) directions without lifting their feet. Center of Pressure (COP) sway area, range and RMS were calculated and normalized to base of support. Each ankle's proprioception was assessed using a seated joint-matching task. Knee position was standardized between 95-100°. Each foot rested on independent rotating plates that were equipped with digital angle gauges (935 DAG, Klein Tools Inc.). Neutral was defined as 0° incline. The target foot was locked into one of three randomized positions (10° dorsiflexion,10° and 20° plantarflexion). Starting at neutral, the contralateral foot was passively moved towards the target. With eyes closed, participants verbally indicated when their ankle positions matched. Each position was assessed twice. Directional (DE), absolute (AE) and variable (VE) error were calculated for each foot and position. Results: No group effect was found for COP area or range, but AP COP RMS was significantly greater in PwP than HC ($F_{1,93}$ =10.7, p = 0.002). An interaction effect between groups and position were found for both DE ($F_{2,306}$ = 4.98, p =0.0074) and AE ($F_{2,306}$ = 4.42, p =0.013) while VE did not differ for either position or group (p>0.05). PwP had significantly more error at 20° plantarflexion than HC (p=0.021) by underestimating the position. No significant correlations between either COP range or RMS and proprioceptive error were found, although LOS area and AE are trending (r(20)=0.29, p=0.086) to date. Discussion: Currently, data suggests that impaired ankle proprioception could relate to greater instability in Parkinson's. Degraded joint position sense in PwP likely creates greater AP sway variability (COP RMS) while approaching their LOS, ultimately enhancing the risk of falls. Improving proprioceptive ability may be an appropriate target intervention for rehabilitative strategies to improvement balance and mobility in PwP.

P02-R-132 - Reactive balance deficits in acute and chronic mild traumatic brain injury

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Background and AimMild traumatic brain injury (mTBI) elicits acute self-reported symptoms including imbalance1. While symptoms can spontaneously resolve over time, 20-60% of the individuals report chronic, persisting symptoms three months after injury2. In addition to self-reported symptoms, patients with acute and chronic symptoms exhibit objective balance deficits during standing or walking tasks--3. However, the impact of mTBI on reactive balance (i.e., the ability to recover stability after a sudden postural disturbance) remains unclear because it is rarely assessed. The purpose of this study was to evaluate reactive balance in people with acute or chronic mTBI symptoms compared to healthy controls. Additionally, we explored the relationship between reactive balance deficits and patient-reported symptoms severity.MethodsA total of 88 individuals were enrolled and provided informed written consent for this IRB-approved study. Participants were recruited based on three groups: individuals with acute symptoms from an mTBI 4-14 days earlier (24, 9F, age: 31.2 (9.1)), individuals with chronic symptoms from an mTBI 3 months to 3 years earlier (22, 18F, age: 30.0 (9.1)), and healthy controls without mTBI (42, 25F, age: 28.6 (7.8)). We assessed reactive balance using the instrumented, modified Push and Release test4 under single-task (ST) and dual-task (DT) conditions. Patients wore four inertial measurement units (APDM Inc., Portland, OR, USA) on their bilateral feet, lumbar spine and sternum to obtain our primary outcome of time to stability (TTS), defined as the time from the release of support to stabilization. Participants also self-reported symptom severity (Neurobehavioral Symptom Inventory; NSI) and dizziness handicap (Dizziness Handicap Inventory; DHI). To assess differences in TTS between groups, we implemented linear regression models, adjusted for age and sex, and calculated pair-wise Hedges's g effect sizes between each mTBI group and the control group. We similarly explored the relationship between patient-reported outcomes and reactive balance across both mTBI groups using age- and sex-adjusted regression models.ResultsCompared to healthy controls, people with chronic mTBI had longer TTS (ST $p = 0.023$, $g = 0.75$, DT $p = 0.013$, $g = 0.88$), and those with acute mTBI had longer, but not statistically different, TTS (ST $p = 0.279$, $g = 0.23$, DT $p = 0.381$, $g = 0.10$). Across mTBI participants, higher DHI and NSI scores were associated with worse ST TTS ($p = 0.026$, $p = 0.024$, respectively) but not DT TTS. ConclusionsReactive balance is impaired after mTBI, especially in those with chronic and more severe symptoms. Incorporating reactive balance assessments after mTBI may complement existing balance assessments to better guide rehabilitation.References(1) Harmon et al. Clin J

Sport Med, 2019. (2) Boake et al. J Neurops Clin Neurosci, 2005. (3) Campbell et al. Front in Neurol, 2022. (4) Morris et al. J Sport Rehab, 2021.

P02-R-133 - The role of optic flow on muscle activity in the absence of overt movement in seated versus standing positions

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Background and Aims: Human locomotion and navigation involves a dynamic link between individuals, tasks and the environment (Gibson, Houghton Mifflin, 1966). Perception-Action (P-A) theory emphasizes the critical role of optic flow, providing feedforward information necessary for locomotor control and adaptation in constantly changing conditions (Warren, Psychol Rev, 2006). When base of support is challenged, visual input helps fine-tune postural control to maintain balance (Nam et al, J Korea Phys Ther, 2017). While P-A coupling has been previously studied, the nature of this relationship and its impact on movement control, particularly muscle activity, requires further investigation.Methods: Participants (N=24; 23±3.4 years, 12 male) were administered attention questionnaires, instrumented with markers (OptiTrack, 100Hz) and EMG electrodes (right leg; 1000Hz). Participants adopted three postures (sitting with feet planted and feet dangling, upright stance) while viewing three virtual optic flow fields (boardwalk, trail, hallway) in a block-randomized posture design. An initial 'No Visual' block was included for comparison. A weighted head, trunk and pelvis center of mass (COMHTP) was created; range of COMHTP displacement and acceleration were calculated and averaged across conditions. EMG signals were filtered, normalized to 'No Visual' condition and averaged across conditions using trapezoidal integration. Repeated measures ANOVAs (Kinematics: 4 vision*3 posture; EMG: 3 vision*3 posture) were conducted with Bonferroni pairwise comparisons, where appropriate. Results: A vision*posture interaction effect was observed for range ML COMHTP displacement. For both sexes, in standing Boardwalk>No Visual; for females, in standing Hall>No Visual ($p<0.05$). For range of AP COMHTP displacement in standing, all three vision conditions were different from No Visual for both sexes; for males in seated plant, Trail>Boardwalk and for seated dangle posture, Boardwalk>Trail and Boardwalk>Hall ($p<0.05$). A vision*posture interaction was observed for range of AP COMHTP acceleration in females; all three vision conditions were different from No Visual. No significant interactions were found for males or ML COMHTP acceleration.No interaction effects were found for integrated EMG however, posture main effects were observed. For males, gastrocnemius activation for stand>seated plant and for females, vastus lateralis activation for stand>seated plant ($p<0.05$). No significant effects were found for the biceps femoris or tibialis anterior muscles.Conclusions: COMHTP displacement was significantly higher for standing compared to seated with feet planted, and increased EMG was observed in the lower leg musculature. Collectively, these results show the importance of the visual environment in providing important stimulation in preparation

for movement control, while body posture affords preparatory actions for navigation. Funding: ON Grad Scholar (KDM); NSERC Discovery (LAV).

P02-R-134 - Reliability of short duration quiet standing balance testing in individuals endorsing neck and back pain: Assessing the utility of the modified clinical test of sensory integration and balance

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BACKGROUND AND AIMPostural control is compromised in chronic neck and back pain patients.1,2 Use of force plate derived center-of-pressure (COP) testing is the gold standard for testing balance during quiet stance. In addition, the modified clinical test of sensory integration and balance (mCTSIB) can be useful to isolate the systems contributing to balance control as it systematically challenges the different sensory systems.3 The reliability of the mCTSIB has not been established in this population. The purpose of this study was to probe the test-retest reliability and clinical feasibility of using short, 20-second trials of the mCTSIB with chronic spine pain patients. METHODSIndividuals reporting chronic (> 3-months) neck/back pain and/or headaches were recruited from 3 spine clinics. The inclusion criteria were: ability to stand unassisted for 30s, speak/read English and no narcotics/alcohol within the last 24 hours. Exclusion criteria were: medical conditions that would affect balance and to not have received spine treatment within 4-weeks. The mCTSIB consisted of 4 trials: eyes open-firm surface (Trial 1), eyes closed-firm (Trial 2), eyes open-foam surface (Trial 3) and eyes closed-foam (Trial 4). Participants performed the test by standing quietly on a portable force plate for 30s in each of the 4 conditions, twice, for a total of 8 trials. The last 20s of data for each trial were retained for analysis to allow for a settling-in period. Patients stood with hands on hips, in stocking/bare feet positioned hip-width apart on a portable force plate. The intraclass correlation coefficients (ICCs) were calculated for 7 variables: COP total path length (TPL), AP and ML range and root mean square (RMS), average velocity (Vel), and 95% confidence elliptical area (Area). The standard error of measurement (SEM) and minimal detectable change (MDC95) was determined for the TPL. RESULTSNinety-two patients (mean age = 40.6 ± 15.2 years, BMI = 27.2 ± 4.5 kg/m2, pain intensity = 5.1/10 and disability rating = 29.5 ±15.7%) were included. ICCs across the COP parameters showed that AP and ML range and RMS metrics had lower ICCs; whereas, TPL, Area, and Vel showed good-to-excellent reliability for all but Trial 1. For TPL, across sex, age and clinic locations, Trials 2-4 showed good-to-excellent reliability (ICCs = 0.75 - 0.95) and the TPL composite scores were universally excellent (ICCs > 0.9). The TPL SEM was 3.8, 4.0, 3.1, 9.8 and 11.3cm and the TPL MDC95 was 10.6, 11.1, 8.7, 27.0 and 31.3cm for Trials 1-4 and composite scores, respectively. CONCLUSIONSCOP metrics for short, 20s trial durations generally show moderate-to-excellent reliability (ICCs = 0.54 - 0.96) for TPL, Area, and Vel for all trials. Use of the mCTSIB under the conditions described may

offer a clinically feasible and rapid method of obtaining a functional performance outcome measure in chronic neck and back pain patients.ACKNOWLEDGEMENTS AND FUNDINGWe acknowledge CBP NonProfit for support.References1. Silva AG, et al. Physiother Theory Pract. 2013 Jan;29(1):1-18.2. Ruhe A, et al. Eur Spine J. 2011 Mar;20(3):358-68.3. Goble DJ, et al. Med Devices. 2021 Nov 15;14:355-361.

P02-R-135 - Dual-task interference of sensory integration for navigation after concussion

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Background and aim Dual-task effects in walking tasks have been extensively studied in healthy and clinically impaired populations, revealing larger effects following concussion. However, common tasks, such as walking with serial subtraction, often do not reflect everyday behavior. When walking, we control gait while updating our estimated position within the environment, yet balance control and spatial updating are often investigated separately. Sensory integration of vision, proprioception, and vestibular feedback supports both processes and is attentionally demanding, but it is unclear whether a dual-task effect occurs. Therefore, this study explored dual-task inference of sensory integration for navigation on gait and balance control in healthy controls and people with concussion using a virtual reality (VR) homing task.MethodsSeven healthy controls (MAge= 24.1, 3 Male, 4 Female) and four participants with recent concussion (MAge= 24.3, 1 Male, 2 Female, 1 Non-Binary) completed 40 trials in the VR homing task. Participants walked from a set point to three waypoints while visual landmarks were displayed in the background. Upon arrival at the third waypoint, the headset darkened for 10 s. Next, participants were instructed to walk to the first waypoint under four different conditions: Consistent self-motion and visual cues, where the landmarks remained unchanged; Conflicting self-motion and visual cues, where the landmarks shifted position during the blackout; Self-motion Only, where the landmarks did not re-appear; and Vision Only, where the participants were rotated during the blackout to prevent the use of vestibular or proprioceptive cues. During the homing period, kinematic lumbar and ankle data were recorded, and the average gait velocity and the mediolateral margin of stability (ML MoS) was calculated. Due to the small sample, we used descriptive statistics and effect sizes to explore the effect of condition (dual-task interference) and group (concussion effect).ResultsCompared to the Consistent condition (HC – 0.53 m/s, Conc – 0.49 m/s), both groups walked slower during the Vision Only condition (HC – 0.49 m/s, Conc– 0.46 m/s; $d > .298$), and the concussion group walked slower in the Self-Motion Only condition (HC – 0.54 m/s, Conc – 0.35 m/s; $d = 0.411$).Both groups also exhibited greater ML MoS variability during the Vision Only condition (HC – 0.111, Conc – 0.143) compared to the Consistent condition (HC – 0.095, Conc – 0.127; $d > 0.629$).ConclusionsThese preliminary data show that reducing cue availability affects gait, with slower velocity and greater ML MoS variability when only visual cues are present for navigation. Additionally, concussion may induce dual-task interference when relying on proprioceptive and vestibular cues. Data collection is ongoing, and further evidence is needed to determine how cue availability impacts sensory integration for dynamic mobility during navigation and how concussion impacts this process.

P02-R-136 - The effects of vibrotactile cueing of the foot sole on supplementary motor area activity during walking with and without arm swing

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Background and aimParkinson's Disease (PD) is a common neurodegenerative disorder, manifesting in motor and non-motor symptoms. A frequently observed motor symptom is Freezing of Gait (FOG), which is an episodic involuntary inability to move. Cueing is a behavioral strategy that can be used to ameliorate FOG. While vibrotactile cueing recently successfully reduced FOG, little is known about the underlying neurophysiological mechanisms. External cueing is associated with age-dependent gait improvements and altered cortical activity in healthy people and people with PD. During cued walking, increased sensorimotor activity in healthy people and people with PD, and stronger event-related synchronization/desynchronization alternations of sensorimotor brain regions in people with PD, were observed. Thus, cortical sensorimotor activity may be an important neurophysiological correlate that can enhance our understanding of cue-induced gait improvements. Less defined event-related brain dynamics of the supplementary motor area (SMA) were previously shown in people with PD, as well as in healthy age-matched controls when they walked without arm swing. Vibrotactile cueing might ameliorate such altered brain activity. To examine this hypothesis, we investigated the effects of vibrotactile cueing and arm swing on SMA activity during overground walking in healthy young and old adults. MethodsData of an ongoing study in 15 healthy younger (18-30 years) and 15 older (60-75 years) adults will be presented. Participants completed four 3-minute walking bouts: with and without arm swing, and with and without vibrotactile cueing applied to the foot soles through vibrating socks (Fig. 1A). 64-channel EEG data were recorded to assess event-related spectral perturbation (ERSP). Inertial measurement unit (IMU) data from sensors located at the shanks and wrists were collected to determine gait events and arm swing amplitude (Fig. 1B). ERSPs at the electrode over the SMA (i.e. FCz electrode) were computed relative to the IMU-derived heel strikes to evaluate the effects of vibrotactile cueing, arm swing, and age on brain dynamics of the SMA. Paired and unpaired nonparametric permutation tests were used to identify significant ERSP differences between conditions and age groups, respectively. ResultsAt the ISPGR conference we aim to present the ERSP plots of every walking condition (with vs. without cueing and with vs. without arm swing) in both age groups. Additionally, we aim to present differences between walking conditions and age groups.

ConclusionsThis study will provide insights into how vibrotactile cuing affects sensorimotor activity in healthy adults during walking, and how it is influenced by gait-related arm swing. These findings have the potential to improve the clinical application of vibrotactile cueing, particularly for individuals with PD. FundingThis is an EU-funded Interreg IV project (12078).

P02-S-137 - Validation of the a-gO system vs. VICON for nonlinear analysis of motor variability

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Background and Aim: Motor variability reflects the neuromuscular system's ability to adapt to constraints such as task complexity, environmental changes, and pathological conditions. This adaptability is essential for functional performance and relies on dynamic control mechanisms. Nonlinear measures, such as Lyapunov exponents, entropy, and detrended fluctuation analysis, offer advanced tools to capture the complexity of motor behavior, providing valuable insights into system flexibility and adaptability. Among motion capture technologies, VICON is recognized as one of the gold-standard for nonlinear analysis of human motion time series due to its accuracy and reliability. However, its high cost and lack of portability limit its accessibility, particularly in clinical settings. This study aims to validate the a-gO motion capture solution, an innovative and portable computer vision-based solution designed to overcome the limitations of traditional motion capture technologies. Specifically, we focus on time-series analysis of postural control and gait, emphasizing the potential added value of integrating biomarkers from nonlinear analysis into clinical practice to improve patient care and functional assessments.Methods: Twenty participants will perform locomotor tasks on a treadmill at varying speeds, normalized to their preferred walking speed. Motion will be recorded simultaneously by the a-gO system (three iPhones + one iPad) and the VICON system (13 infrared cameras). Both linear and nonlinear measures will be derived from spatiotemporal and kinematic gait parameters. Postural control will be assessed during standing tasks under different conditions, including eyes open, eyes closed, and dual-task scenarios. For posture, both linear and nonlinear variables will be extracted from the center of mass (CoM) and center of pressure (CoP). Agreement between systems will be assessed using intraclass correlation coefficients (ICC), Bland-Altman plots, standard error of measurement (SEM), and minimal detectable change (MDC).Results: Preliminary results suggest that the a-gO system will show strong reliability and agreement with the VICON system, with high ICC values across all measured variables, including gait and postural metrics. Bland-Altman analyses are excepted to reveal minimal bias between the systems, while SEM and MDC values will reflect the accuracy and reproducibility of the a-gO system.Conclusions: This study will

provide decisive evidence supporting the a-gO system as a portable, cost-effective, and reliable alternative to traditional motion capture systems such as VICON. By validating its accuracy, the a-gO system has the potential to make advanced linear and nonlinear movement analyses more accessible, enabling their integration into clinical practice and advancing the assessment and management of motor function impairments in diverse patient populations.

P02-S-139 - Video-based measures of balance during the fukuda stepping test in subjects with varying balance abilities

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BACKGROUND AND AIM: With a rise in the number of falls in our aging population, it has become increasingly important to develop accessible tools for assessing balance. OpenCap is a recently developed open-source platform that performs motion capture from smartphone video. Our goal is to use OpenCap to create a tool for quantifying balance performance and providing insight into mechanisms of stability. To achieve this, we used OpenCap to collect data from 138 individuals with a large variance of balance abilities performing a range of balance tasks. Here, we present preliminary work for the Fukuda stepping test, a clinical test for assessing vestibular disorders. In this test, the subject extends their arms and marches in place with their eyes closed for 50 steps. The examiner estimates their deviation from a floor grid, with a deviation greater than 30 degrees or 0.5 meters indicating a potential deficit. Our aim is to (1) use OpenCap to automatically compute deviations during the stepping test and (2) estimate whole-body angular momentum (H) and step width variability from video data to understand how biomechanical metrics of stability relate to Fukuda performance. METHODS: We had subjects (ages 18-85, ranging from professional ballet dancers to vestibular patients) perform the Fukuta test and we collected OpenCap video (3 iPhones) which provided 3D kinematic data. We segmented the 50 steps with each march cycle (right and left step) divided into 6 regions. To estimate the linear and rotational deviations, we computed the center of mass trajectory and pelvis rotation. We measured regulation of frontal-plane H and the step width variability. RESULTS: We found greater rotation and translation with increased age (Fig. 1a). 33 subjects rotated more than 30°, 64 subjects translated more than 0.5 m (without rotating > 30°), while only 41 subjects did not exceed those thresholds. We found a significant correlation between rotation and change in H (mean dH/dt normalized by time) across all single-leg stance (SLS) regions ($p<0.01$). In Region 2 (first-half of R SLS) and Region 6 (second-half of L SLS) the change in H increased with greater left rotation while Region 3 (second-half of R SLS) and Region 5 (first half of L SLS) showed greater change in H with increased right rotation (Fig. 1b). Step width variability was significantly higher in individuals who translated more than 0.5 m ($p<0.01$) or rotated more than 30°($p<0.01$) compared to those who did not deviate. CONCLUSIONS: From OpenCap, we were able to compute the results for the Fukuda balance test using

smartphone video. Beyond quantifying the stepping test outcomes, we demonstrated how control of H and step width variability relate to stepping test performance outcomes. These results show OpenCap as a promising balance assessment tool. ACKNOWLEDGEMENTS AND FUNDING: This project was supported by the Wu-Tsai Human Performance Alliance and the Natural Sciences and Engineering Research Council of Canada.

P02-S-140 - Reliability of virtual reality (VR) system compared to Techobody® in assessing postural stability in young healthy adults

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Balance is the coordination of several bodily systems, including vestibular, visual, auditory, motor, and higher-level premotor systems. To maintain the center of mass within a particular spatial range, it is essential to maintain postural stability. There is potential for virtual reality to be used as a tool for assessing balance and postural stability. In this study, a virtual reality-based tool is compared to the Prokin Technobody system for measuring postural stability and balance. A total of thirty healthy young adults were divided into two groups (VR-based group and Technobody group). Two sessions, one with closed eyes and one with open eyes, were conducted to compare variables such as head path length, ellipse area, and perimeter. There was good reliability (Intraclass Correlation Coefficient: 0.7-0.9) between the two devices in different testing sessions. As a result of this experiment, VR-based tools may be useful in assessing and measuring the postural stability of healthy young adults.

P02-S-141 - Using interactive ground projection mapping to assess motor-cognitive performance in young healthy adults

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Background & aim. Effective motor and cognitive screening is imperative in healthcare to determine whether a patient requires further assessment. Widely utilized fine or gross motor-cognitive screening instruments for suspected Mild Cognitive Impairment or Parkinson's Disease include the Trail Making Test or the Trail Walking Test (TWT, Schott, 2015). However, these instruments are crude measures of motor-cognitive function and cannot detect subtle but progressive impairments. Projecting tasks mapped onto the floor represents a novel approach that has been employed in clinical studies. A digital version of the TWT (including a condition to measure gross motor speed), the dTWT, has been developed (Retz et al. 2023). The aim of this study is to test the reliability, equivalence, and concordance of the TWT and dTWT. Methods. A total of 40 healthy subjects aged 18 to 30 years (19 men, 21 women; mean age 21.4, SD=2.59) completed three trials per TWT and dTWT condition. Part M involves the following of a predetermined route, whereas in part A, participants are required to walk to numbers in sequential order that are randomly dispersed throughout the room, and in part B, they are tasked with walking alternating between numbers and letters (1-A-2-B-3-C...). With the dTWT, variables such as the time spent in and between each circle, the number and duration of breaks, and the length of the distance traveled by the participant can be collected for a more detailed analysis (Park & Schott, 2021). Results. Walking times in the dTWT increased significantly with increasing cognitive load; this is particularly evident between conditions M (41.4 ± 9.93) and A (43.6 ± 7.02) compared to B (54.4 ± 9.78), F(2,76) = 40.6, p < .001, h2p = .517. While there was a significant increase in time in the circles with increasing cognitive load (F(2,76) = 12.5, p < .001, h2p = .248), there was no significant difference in time between the circles (p = .328). There were no significant differences between men and women for the various parameters. Our findings indicated that the TWT performance on the two different modalities correlated significantly (r =.42 – 62). The reliability tests estimated using Cronbach's Alpha obtained an overall value of 0.753, indicating that the dTWT is reproducible and consistent. Conclusions. This study underscores the promise of interactive ground projection mapping in evaluating motor-cognitive parameters. Sensor-derived motion data has the potential to be utilized for the classification and quantification of disease status across a range of neurological conditions. Although still in its early stages, digital motor-cognitive assessment is poised to assume a significant role in the future, particularly in screening for and monitoring motor and/or cognitive performance in children and older adults.

P02-S-142 - Effect of trial length and stitching on fractal analysis of gait

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BACKGROUND AND AIM: Non-linear analyses such as detrended fluctuation analysis (DFA) have gained popularity in posture and gait research. By its nature, DFA requires relatively large amounts of data [1] and as such, may not be ideal for populations unable or uncomfortable performing tasks for long durations. Some research has explored the efficacy of combining ("stitching") several shorter trials together [2, 3]. The aim of the current research is to explore whether multiple shorter walking tests when combined can yield results comparable to those of a single long test. The results will help inform our planned projects being designed to examine the effects of cooling the feet and maintaining the effect for up to 15 minutes of walking. We anticipated there would be no differences in DFA output between long trials, individual short trials, and stitched trials.METHODS: Six healthy young adults (age 24 ± 3.08 years; 3F/3M) performed four treadmill walking trials at their preferred walking speed (PWS). PWS was determined by gradually increasing from a slow pace until the participant reported comfort, then decreasing from a fast pace until comfort was reported again. The average of these two speeds was recorded as PWS. Participants completed three 5-minute walking trials (A, B, C) and one 15-minute walking trial, in randomized order. A retro-reflective marker was placed on participants' shoes over the posterior aspect of the heels, and their 3D positions were recorded using a Vicon motion capture system. Inter-stride intervals (ISI) were calculated using the anterior/posterior heel positional data, and DFA was used to calculate the fractal scaling index (FSI). Next, the 15-minute trial was "split" into first (X), middle (Y), and final (Z) equal-length 5-minute segments, and FSI was calculated for each segment. The A, B, and C trials were stitched together into their six 15-minute permutations and the FSI was calculated for each. A repeated measures ANOVA (α=0.05) was performed to examine the effects of trial length, splitting, and stitching as outlined in Table 1.PRELIMINARY RESULTS: The ANOVA resulted in a P-value of 0.53, indicating no statistically significant difference between FSI values of the original trials (i.e. no effect from trial length) and the created trials (i.e. no effect from splitting or stitching).CONCLUSION: This preliminary testing suggests that three 5-minute walking tests can produce comparable FSI values to one 15-minute walking test. Given the small sample size of six participants, further testing is required to confirm these results and enhance their generalizability. However, the initial finding of this study is potentially relevant for populations unable to perform prolonged walking tests or in situations where a longer test may introduce confounding factors.REFERENCES: [1] Marmelat & Meidinger (2019) Gait and Posture; [2] Kirchner et al. (2014) PLoS ONE; [3] Marmelat et al. (2018) Frontiers in Physiology

P02-S-143 - Learning to navigate a virtual reality maze requiring obstacle clearance skills in older and young healthy adults

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BackgroundSpatial navigation abilities are needed to perform a wide range of daily activities. Being able to navigate in a novel environment relies on skills in various interacting domains including cognitive, sensory integration, processing speed,mobility skills, etc. all of which can decline with aging. In addition, aging may impair motor learning as indicated by reduced adaptation rates when repeatedly navigating a new environment. In this pilot project, the impact of aging on the ability to navigate a novel virtual reality (VR) maze while clearing obstacles is investigated.Methods Nine older adults (N=9, 33% male; mean age 63 +- 6 years) and five younger adults (N=5, 20% male; mean age 23 +- 5 years) completed the MObility Standard Test in virtual reality (MOST VR). Participants were equipped with an HTC Vive Pro Eye Head Mounted Display and four HTC Vive Trackers and were instructed to follow a unique path through a maze to a goal displayed on the ground. Each session included 5 training trials (the focus of the present analysis) conducted in a well-lit VR environment, followed by 20 minutes of dark adaptation and 18 test trials, with 6 light levels from dim to bright, each one performed in monocular (left and right) and binocular conditions. The mobility course configuration was randomized for each training/testing trial. The completion time of each trial was recorded and used as the primary outcome variable. Here results of the training trials are reported to address the primary goal of this present analysis, i.e. the impact of aging on the ability to navigate a novel environment. A mixed linear model was usedto determine the impact of age group (young/older), training test trial number (1-5) and their interaction on trial completion time. Subject nested within group was used as a random effect. Significance was set at 0.05.ResultsAge group (p=0.03, F-ratio: 6.2), training test trial number (p<0.0001, F-ratio=11.2) and their interaction effect (p=0.005, F-ratio: 4.3) had a statistically significant effect on the time to complete the navigation task (Figure 1). Asanticipated, older adults took longer to complete the navigation task and repeated exposure improved performance. Inaddition, post-hoc student's t- test comparisons revealed that older participants learned to navigate the VR environment at a slower rate than their younger counterparts. Specifically, older adults exhibited a statistically significant learningeffect (with respect to Training Trial 1) only in Training Trial 5, compared to Training Trial 2 in the young group.ConclusionsThis is the first study investigating motor learning using a VR navigation task involving obstacle clearancerequirements in the MOST VR setup. This novel task proved to be sensitive in detecting navigation declines related to aging. The findings warrant further research into the use of the MOST VR to assess spatial navigation abilities and related adaptation skills in older adults.

P02-S-144 - A lab-based, multi-task fatigue protocol for older adults and stroke survivors: Development and pilot results

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Background and AimFatigue is a prevalent and functionally limiting issue in older adults and individuals post-stroke. In the WHO's Healthy Ageing framework, it is recognized as a key attribute of an individual's vitality capacity—a core element of physical and mental resources for daily life. Fatigue may be general or activity-based, and its multidimensional nature complicates objective assessment. Current protocols often use isolated, repetitive tasks that lack ecological validity. This study aims to iteratively develop and validate a lab-based protocol that reliably induces fatigue in a standardized yet meaningful way. Success criteria are: (1) participants experience progressive fatigue, and (2) severe fatigue is reached within one hour.MethodsA user-centered, iterative design approach was used, incorporating input from healthy older adults, older adults with mobility impairments, and stroke survivors. Task selection was guided by focus group discussions identifying fatiguing and challenging daily activities. The protocol integrates the five key elements known to influence real-world walking: speed, slopes/steps, surface, directional changes, and cognitive demand. Participants perform a continuous sequence of challenging tasks at a self-selected pace, ending when they (i) reach a fatigue level >7 on the modified Borg scale ("very hard exertion"), (ii) stop voluntarily, or (iii) reach the one-hour limit. Individual adaptations (e.g., mobility aids) accommodate varying abilities. Feedback on fatigue, realism, and safety informs iterative protocol refinements between sessions.ResultsEleven participants contributed to the refinement of the protocol: 3 healthy older adults (1M/2F, age: 65–89), 3 older adults with mobility limitations (1M/2F, age: 80–89), and 5 chronic stroke survivors (4M/1F, age: 35–69; Functional Ambulation Categories: 3–5). One healthy participant showed plateaued exertion scores and was stopped after approximately one hour (Fig1A). In response, subject-driven adjustments enabled the remaining healthy participants to experience progressive fatigue within the timeframe. Other participants consistently reported increasing exertion (Fig.1B–C), with task durations ranging from 10:50 to 51:41 minutes (Fig.1D). Feedback confirmed the protocol's realism and safety.ConclusionPreliminary findings support the protocol's potential to elicit progressive, real-life fatigue through ecologically valid tasks. Future steps include validation in larger cohorts and collection of normative data. This protocol may help standardize fatigue assessment and support evaluation of interventions—such as lower-limb exoskeletons—designed to mitigate fatigue in daily life.Acknowledgements and FundingThis research was supported by the FWO SBO project RevalExo (S001024N). Elissa Embrechts is a Junior Postdoctoral Fellow (FWO, 1232425N), and Benjamin Filtjens is supported by the University of Toronto's Data Sciences Institute (DSI-PDFY3R1P13).

P02-S-145 - Let's rock - classification of balance recovery steps in the wild: Application to punk rock concerts

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Background and AimDense crowds are challenging environments in which individuals may experience external perturbations from multiple directions. These interactions may result in loss of standing balance, triggering recovery strategies. Since the risk of falling in dense crowds is a key element in crowd studies, understanding the motion induced by contacts and pushes in such situations is crucial. In this study, we present a novel classification method to label stepping recovery strategies following external perturbation. This approach does not require information regarding the perturbations, hence allowed us to investigate recovery strategies in an ecological crowded environment involving physical interactions: punk rock concert crowds.MethodsThis work includes two main components. We first developed a novel Unified method to label recovery strategies. Unlike previous methods, this approach enables the classification of recovery steps without prior information about the perturbation itself. This method was first tested on a push-recovery dataset including more that 1400 recording of 21 healthy young adults undergoing perturbations from 5 different directions. We then propose an experimental protocol that allowed the recording of recovery strategies in a crowded environment using an IMU-based motion capture system. We used this protocol to create a proof of concept in which 147 recovery strategies of three participants were recorded during punk rock concerts. This proof of concept enables the comparison of recovery strategies recorded in real-world settings with observations collected during previous laboratory experiments. ResultsSeveral results emerged from this study. First, despite the inherent polarization of the concert crowd, perturbations were estimated to originate from all possible directions. The majority of recovery strategies used by participants were similar to those observed in laboratory experiments under comparable conditions. However, the characteristics of recovery steps appear to be different compared to laboratory experiments. Participants in the concert crowd tend to use smaller and faster recovery steps compared to participants in laboratory experiments for comparable perturbations. ConclusionsThis study presents a novel classification method for labeling recovery steps following external perturbation. This method does not rely on prior information about perturbations, enabling investigations in real-world settings. We then combined this approach with a novel experimental paradigm to create a proof of concept within a crowded environment. This enabled us to compare field observations to previous laboratory experiments and to suggest that recovery strategies in concert crowds are comparable to what was observed in laboratory experiments, despite differences in the characteristics of the recovery steps. Acknowledgements and FundingThis project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 899739 (CrowdDNA)

P02-T-146 - The temporal dynamics of standing balance in patients with bilateral vestibulopathy

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Introduction: Patients with bilateral vestibulopathy (BVP), characterized by impairments of both the left and right vestibular apparatus, exhibit impaired postural stability. Many studies utilizing force platform analysis have that BVP patients differed from healthy controls in linear parameters of standing sway (e.g., area, amplitude, velocity). Detrended Fluctuation Analysis (DFA) is a non-linear analysis capturing fluctuations over time. It is a validated method for assessing the temporal characteristics of time-series data and has been applied to various biological signals, including postural kinematics. This study offers the first assessment of standing body sway in patients with BVP (and healthy controls) in terms of non-linear analysis with DFA.Methods: Thirty-four patients with BVP and 30 healthy controls matched for sex, age, and educational level performed two 60-second static standing balance tests on a force platform (sampled at 100Hz) with eyes open and eyes closed. Separately for center of pressure positions in the anteriorposterior (AP) and mediolateral (ML) planes, we calculated short- and long-term DFA α exponents, as well as the box size of the crossover between these exponents. Linear mixed models were employed for statistical analysis. DFA parameters were optimized according to Phinyomark, 2020. Results: We observed significant group effects for the short-term DFA α exponent in both the ML and AP planes. BVP patients exhibited lower α exponents compared to controls in the AP ($p = .01$) and ML ($p < .01$) planes. Regarding the box size of crossover between short- and long-term DFA α exponents, a significant Group × Condition interaction ($p < .05$) was observed for the ML plane, and main effects of Group ($p < .05$) and Condition ($p < .001$) were noted for the AP plane. BVP patients demonstrated larger crossover box sizes compared to controls, and both groups exhibiting larger box sizes under the eyes-closed condition. Discussion: Our assessment of non-linear parameters of standing sway yielded novel findings, demonstrating that BVP leads to changes in temporal structure of sway. Short-term DFA α exponents differed between BVP patients and healthy controls, particularly in smaller box sizes, indicating that reflexive mechanisms for balance maintenance were altered. Long-term DFA α exponents, linked to voluntary and controlled balance strategies, were also impacted. Similarly, crossover box size was larger in BVP patients, especially in the AP plane. The novelty of these results complicates interpretation but provides a clear motivation for future research into the temporal dynamics of movement in BVP patients. These results highlight the role of vestibular function in maintaining the temporal organization of postural control and underscore the potential of DFA as a tool to evaluate vestibular function in balance.

P02-T-147 - Impaired vestibulo-ocular reflex precision observed bilaterally within subjects with unilateral vestibular schwannoma

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Impaired vestibulo-ocular reflex precision observed bilaterally within subjects with unilateral vestibular schwannomaCaroline M. Hardin, DPT,1 Andrew J. Kittelson, PT, PhD,1,2 Angela R. Weston, PT, PhD,3 Leland E. Dibble, PT, PhD,4 Andrew R. Wagner, PT, PhD,5 Brian J. Loyd, PT, PhD 1,2 1School of Integrative Physiology and Athletic Training, University of Montana, Missoula, MT; 2School of Physical Therapy and Rehabilitation Science, University of Montana, Missoula, MT; 3Army Baylor University Doctoral Program in Physical Therapy, U.S. Army Medical Center of Excellence, San Antonio, Texas; 4School of Pharmacy and Health Professions, Department of Physical Therapy, Creighton University, Omaha, NE; 5Department of Physical Therapy and Athletic Training, University of Utah, Salt Lake City, UT Background/Aim: The presence of a vestibular schwannoma (VS), has been shown to increase ipsilesional yaw-axis vestibulo-ocular reflex (VOR) variability when compared to vestibular healthy controls. The purpose of this paper is to examine yaw-axis VOR precision and accuracy between ipsilesional and contralesional head thrusts in people with vestibular schwannoma and healthy controls.Methods:

Participants with unilateral VS (n=15; mean age 46.1714.19y) and controls (n=12; mean age: 35.6710.05y) participated. Eye and head velocity were recorded during passive, high acceleration head on body yaw rotations [video head impulse test (vHIT), GN Otometrics System]. Raw data were processed using a custom written Matlab script to describe the accuracy (VOR gain) and precision of the yaw VOR during rotations toward the ipsilesional ear and contralesional ear. VOR precision was quantified across trials by calculating (a) the root mean square error (RMSE) of the horizontal slow phase eye velocity (SPEV) during a window of time defined by the yaw head velocity (20 to 150 deg/s) and (b) the coefficient of variation of the SPEV at the time when head velocity reached 90 deg/s (CoV90). T- tests (for repeated measures) were used to compare ears within subjects and linear regression models compared VS participants and controls while controlling for age. Results: RMSE of the yaw-axis VOR did not significantly differ (p=0.68) between thrusts toward the ipsilesional ear (mean RMSE=13.99, mean thrusts=12) and towards the contralesional ear (mean RMSE=11.91 , mean thrusts=12). RMSE significantly differed (p<0.001) with thrusts toward the ipsilesional ear when compared to controls (mean=9.427, mean thrusts bilaterally=13) and with thrusts towards contralesional ear when compared to controls (p<0.001). The CoV of the SPEV at 90 deg/sec did not differ with thrusts towards the ipsilesional ear (mean=0.236) and towards contralesional ear (mean=0.226; p=0.81). CoV significantly differed with thrusts towards the ipsilesional ear compared to controls (mean=0.115; p<0.001) and with thrusts towards the contralesional ear when compared to controls (p=0.001). Mean VOR gain significantly differed with head thrusts toward ipsilesional ear (mean=0.77) and towards the contralesional ear (mean=0.93; p=0.01). Gain significantly differed with thrusts towards the ipsilesional ear when compared to controls (mean=1.02; p<0.01) and with thrusts toward the contralesional ear when compared to controls (p=0.022).Conclusion: Participants with unilateral VS experience impaired VOR precision with both ipsilesional and contralesional yaw-axis rotations, while only demonstrating impaired accuracy of the VOR during ipsilesional yaw-axis rotations. Altered precision of the VOR during rotations both toward and away from the lesioned side may result from an increased noise-to-signal ratio due to the tumor's influence on vestibular sensory input to the central nervous system. Impaired precision of the VOR with contralateral yaw-axis rotations is a novel finding and implications of these findings are not yet known. Ongoing and future work will explore the impact of bilateral impaired VOR precision on gaze stability, postural stability, and other outcomes.Acknowledgements/FundingNIH Loan Repayment Program (PI: Loyd)Foundation for Physical Therapy Research New Investigator Fellowship Training Initiative (NIFTI) (PI: Loyd) References: King S, Dahlem K, Karmali F, Stankovic K M, Welling D B, Lewis R F. Imbalance and dizziness caused by unilateral vestibular schwannomas correlate with vestibulo-ocular reflex precision and bias. J Neurophysiol. 26 January 2022. 127:596-606. Doi: 10.1152/jn.00725.2020

P02-T-148 - Effects of the vestibulocochlear implant on balance and gait in bilateral vestibulopathy

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Background and aim: Bilateral vestibulopathy (BVP) often leads to, among many other symptoms, gait and balance issues and increased fall risk. The vestibulocochlear implant (VCI) is a neuroprosthesis that may offer a promising treatment for patients with severe BVP. This study aimed to explore the impact of different vestibular stimulation modes on gait and balance outcomes. Methods: The VertiGo! trial is a prospective, nonrandomized, single-center cohort study. The trial includes nine patients with severe BVP who demonstrated inadequate compensation despite conventional treatment. Nine patients received the VCI and were extensively tested in four testing weeks, the first providing reference data (no VCI stimulation) followed by three weeks each with different stimulation modes: (A) head motion-modulated stimulation with baseline stimulation, (B) head motion-modulated stimulation with reduced baseline stimulation, and (C) baseline stimulation without modulation. For the gait and balance assessments, patients walked at 0.6m/s, 0.8m/s, and 1.0m/s on an instrumented treadmill integrated in a 6-DoF motion platform (CAREN; Motek). Five walking conditions were evaluated: unperturbed walking in both lit and dark environments, along with three sizes of pseudorandom mediolateral platform sway perturbations. Coefficients of variation (CoV) were analyzed using 3D motion capture data for step time, step length, double support time and step width. Patients also completed the Mini-BESTest each week. Results: Step time, length and double support time CoV consistently reduced with increasing walking speeds across all walking conditions whereas step width CoV increased with increasing walking speeds across all walking conditions. Larger perturbations increased CoV consistently. The CoV in the reference mode and stimulation modes A, B and C varied across patients for all gait parameters with no consistent effect for any one stimulation mode (e.g., 5 of 9 patients had lower step time CoV and step length CoV for one stimulation mode but these did not always align with the modes with lower CoVs in the other parameters and the stimulation mode that benefited one patient was often not the mode that benefited another patient). Darkness usually increased CoV but no clear effect of a specific stimulation mode in darkness was found. In the Mini-BESTest, at least one stimulation condition total score was higher than the reference total score for 6 of 9 patients but these were distributed across the different stimulation modes.Conclusions: Walking speed, perturbations and stimulation modes can influence gait variability and balance performance. While specific stimulation modes may provide slight advantages during acute stimulation, individual responses exhibit considerable variability. The findings emphasize the importance of further investigating tailored stimulation. Investigation into potential differences between acute stimulation and ongoing stimulation is needed.

P02-T-149 - Prefrontal cortex activity during the clinical test of sensory integration on balance in post-concussion syndrome patients

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Prefrontal Cortex activity during the Clinical Test of Sensory Integration on Balance in Post-Concussion Syndrome patientsDang N1, Mochizuki G11School of Kinesiology and Health Science, York University, Toronto, CanadaIntroduction: A sub-population of concussion patients experience Post-Concussion Syndrome (PCS) marked by prolonged recovery and persistent post-concussion symptoms (PPCS) for months post-injury. Previous studies have found decreased prefrontal cortex (PFC) activation, sensory reweighting, and balance deficits in patients endorsing PPCS. Objective characterization of functional neural correlates is lacking as PCS diagnosis is rooted in reporting of subjective symptoms. This study probes the use of Functional Near-Infrared Spectroscopy (fNIRS) and the Clinical Test of Sensory Integration on Balance (CTSIB) as objective measures of neural activity and balance in PCS patients.Methods: The current work presents a preliminary analysis of cortical activity and CTSIB performance in individuals with PCS (n=2, age 24-28, 1 male) and age and sex-matched healthy controls (n=2, 1 male). fNIRS (8 channel) was used to measure blood oxygenation in the PFC during the CTSIB. Each quiet standing condition lasted 30 seconds and were scored out of 30. Each trial was performed on a force-plate to collect centre-of-pressure (COP) data. Conditions were eyes-open (EO), eyes-closed (EC) and Visual-Conflict Dome (VCD). Each condition was performed on a firm and foam surface for 6 conditions total. The Sport Concussion Assessment Tool 6 (SCAT6) symptom inventory was administered at the time of collection. The PCS group was expected to endorse greater symptom number and severity than the healthy controls. It was hypothesized that the PCS group would exhibit decreased cortical activity, lower CTSIB, and higher COP dispersion.Results: Vestibular-related concussion symptoms were more severe in PCS than healthy controls. Total number of symptoms and symptom severity on the SCAT6 were 12-16/132 and 15-22/132, respectively for those with PCS and 3-4/22 and 4-5/132 for controls. Despite endorsing elevated symptom burden, PCS participants were variable in PFC activity and COP excursion across conditions (elevated or reduced PFC activity and COP dispersion) in comparison to controls. These preliminary results may reflect the use of different strategies in performing the balance tasks in individuals with persistent symptoms and reinforce previous reports of a disconnect between subjective symptom reporting and objective measures of balance in individuals with concussion. Conclusion: These initial results show different patterns of balance behaviour and brain activity in healthy individuals and those with PCS that warrant further investigation. The results point to the potential of fNIRS to reveal different brain activation patterns in individuals with persistent concussion symptoms and the engagement of different balance strategies that concussed and PCS individuals may use to maintain balance post-injury. These results will inform ongoing work monitoring brain activity of acutely concussed and PCS

individuals over time. Funding: Funding was provided from departmental start-up funding (GM).

P02-T-150 - Vestibular control of balance and oculomotor systems during sit-to-stand transitions

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Background: The vestibular system provides essential cues about head motion and orientation, shaping self-motion perception and spatial awareness to ensure rapid adaptation to changing contexts. For instance, when transitioning from standing to walking, the brain suppresses balance-correcting responses from the vestibular system since they would otherwise impede the initiation of locomotion. It remains unclear, however, whether this vestibular suppression is specific to balance or extends to other vestibulomotor functions. To address this, we examined vestibulomotor responses in the balance and oculomotor systems during a sit-to-stand task, given the different role these systems play in executing this common movement.Methods: We conducted two experiments where participants performed sit-to-stand movements while exposed to stochastic (±4 mA) electrical vestibular stimulation. In our first experiment (N=10), EMG recordings from back and lower limb muscles, along with ground reaction forces under the feet and seat, were used to estimate vestibular contributions to balance. In our second experiment, we also measured eye movements in a new group of participants (N=8) to estimate the vestibular influence on oculomotor control. For both experiments, we used time-frequency gain and coherence analysis to estimate vestibular contributions to each system.Results: In our first experiment, we found that vestibular influences on balance responses, including muscle activity and ground reaction forces, decreased to near zero ~0.5-1 s before changes in loading forces signalled the initiation of movement. Shortly after this initiation (~0.5-1 s), vestibular contributions to balance responses re-emerged, peaking around the completion of standing (~2-2.5 s). In our second experiment, we replicated the inhibition of balance responses preceding the movement, but found that vestibular-evoked torsional eye movements were unmodified until the transition onset. Throughout the movement, the vestibular-evoked eye movements decreased by ~60% but only when the eye was moving and returned to normal levels when the eye was stationary.Conclusions: Together, our experiments demonstrate that vestibulomotor suppression is localized to specific sensorimotor processes. During sit-to-stand movements, vestibular signals supporting postural control are suppressed in anticipation of movement, accommodating transition between postural control and movement states. In contrast, vestibular signals for oculomotor control remain active throughout this transition phase and are only partially suppressed only when the eyes must redirect their orientation to maintain a visual target. This

distinction highlights the brain's ability to selectively modulate vestibular input based on the demands of specific tasks, ensuring that critical functions like gaze stability are preserved even as others, such as balance corrections, are dynamically adjusted.

P02-T-151 - Individuals with superior canal dehiscence syndrome have altered gait kinematics

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BACKGROUND AND AIM: Superior canal dehiscence syndrome (SCDS) is caused by an abnormal opening in the bone that covers the superior semicircular canal of the vestibular organ, and results in sound or pressure-induced vertigo and nystagmus in the affected canal plane. Patients may experience dizziness, oscillopsia, autophony, and chronic imbalance, yet association between SCDS and gait alterations is not well understood. Thus, here we explored whether gait kinematics differ in SCDS and healthy individuals. We specifically hypothesized head kinematics in the pitch and vertical axes would be the most affected during gait, as these axes correspond to the activation plane of impaired superior canal. METHODS: 16 individuals with unilateral SCDS (identified with unilateral symptoms based on the Bárány Society criteria; age:46.8±11 years; 7 female) and 16 healthy controls (age:47±11 years; 7 female) participated in this study. Participants were asked to perform 10 tasks of the Functional Gait Assessment scale (FGA) while inertial measurement units (IMU) were attached to their head, upper and lower back, ankles, and dominant wrist. Accordingly, gait cycles were identified, data were low pass filtered at 25Hz, and range and variability of 3D rotational and 3D linear kinematic measures and gait cycle duration and step time asymmetry were calculated. RESULTS: FGA scores were significantly lower in SCDS group ($p<0.001$). Patients also exhibited significantly slower gait cycles compared to controls in 8/10 tasks ($p<0.05$), with no significant differences in step time asymmetry ($p>0.05$). Most significant changes were observed in head and ankles kinematics. In 7/10 tasks, patients showed a significantly reduced range of vertical head acceleration compared to controls ($p<0.05$), as well as significantly greater variability in vertical head acceleration during gait with vertical head turns, gait with eyes closed, and backward walking ($p<0.01$). In 4/10 tasks, SCDS group showed a significantly reduced range of head pitch velocity compared to controls ($p<0.05$), and greater variability in head pitch velocity during gait with horizontal head turns, gait with eyes closed, and backward walking ($p<0.05$). SCDS group also showed reduced ipsilesional-ankle range of vertical acceleration and pitch velocity in 5/10 tasks ($p<0.05$). Across all IMUs, gait with eyes closed, backward walking, and negotiating stairs revealed the most significant between-group differences. CONCLUSIONS: Gait kinematics are altered in SCDS, especially for more challenging tasks and/or when visual feedback is reduced. Slow walking and reduced vertical

acceleration may act as a compensatory strategy to minimize the transfer and impact of vertical movements on the head, and thereby on the impaired semicircular canal, to alleviate bothersome vestibular and auditory symptoms of SCDS. Our unique kinematic findings provide clinically relevant measures with implications for pre-surgical rehabilitation of SCDS.

Poster session 3

P03-A-01 - Questionable feasibility of longitudinal real-world gait data collection in individuals undergoing knee arthroplasty

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BACKGROUND AND AIMRemote monitoring enhances ecological validity of gait assessments, but introduces challenges with prolonged, unsupervised use. Single sensors (e.g. on the back or wrist) seem optimal for feasibility, but sensors on the feet are preferred when gait speed is the outcome of interest. Sensors on the feet are, however, in a more vulnerable location, and require synchronization between sensors. Moreover, gait bouts of adequate length are necessary to obtain representative values for gait speed, which can be a challenge for inactive people. Here, we tested the feasibility of a 3-sensor setup for real-world gait monitoring in people with knee osteoarthritis (OA) before and after knee arthroplasty.METHODSTwenty-five individuals with end-stage knee OA undergoing knee arthroplasty (14 women, 68 ± 8 years) participated. Participants were assessed before surgery (T0), and at 3 (T1) and 6 months (T2) after surgery. Real-world gait data were collected with sensors on the feet and lower back during 4 consecutive days at each time point. From sensor data, gait bouts were identified and steps per bout were counted. The number of bouts of adequate length for gait speed (set at ≥30 steps) was calculated per participant per time point. Dropouts, reasons for dropouts and missing data, and the number of people with analyzable gait data and gait speed outcomes were reported per time point. Pain data were also collected via ecological momentary assessment using a mobile app, but are not discussed here.RESULTSAn overview of data availability is shown in Figure 1. Ten of 25 participants dropped out between T0 and T2. Seven of the dropouts were unwilling to proceed in the study, of whom 3 were due to issues with the mobile app. Across time points, data in 12/59 observations were missing due to unsynchronized sensors or recording failures (e.g. sensors were switched off). Individuals with data had a median of 19 (T0), 12 (T1) and 23 (T2) bouts of sufficient length to determine gait speed. Overall, 9/25 individuals had gait speed data available at all time points..CONCLUSIONSUnwillingness to participate led to substantial drop out, but this was only partly due to unwillingness to wear the sensors. Only 2/3 of people participating until the end of the study provided sufficient data to analyze gait speed pre- to post-TKA. In this study, participants were responsible to synchronize and start data collection each day. A technical solution to remove this burden likely improves the currently questionable feasibility.

P03-A-02 - Mobile Spatiotemporal Gait Segmentation using an ear-worn motion sensor and deep learning

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Background and Aim: Mobile health technologies enable real-world, quantitative gait assessment to support early diagnosis of gait disorders, disease monitoring, and fall prevention. Traditional methods often rely on body-worn sensors placed on the trunk or feet. The ear, however, presents a promising alternative measurement site, offering several advantages: seamless integration with existing assistive devices (e.g., eyeglass frames, hearing aids) and the concurrent, reliable measurement of vital parameters (pulse, oxygen saturation, temperature) using optical sensors in the inner ear. In this study, we evaluated the potential of an ear-worn motion sensor, combined with a deep-learning algorithm (mEar), for accurate spatiotemporal gait segmentation. Methods: Data were collected from 53 healthy adults walking at slow, preferred, and fast speeds. 3D acceleration profiles were recorded using a triaxial accelerometer integrated into an in-ear sensor and synchronized with a pressure-sensitive gait mat (GAITRite). A temporal convolutional network (TCN) was trained to detect initial and final contacts (ICs and FCs, Figure 1A) and estimate spatial characteristics, including stride length and width (Figure 1B). Results: The mEar algorithm achieved high accuracy for detecting temporal gait events (IC: Precision 0.993, F1 = 0.994, FC: Precision = 0.849, F1 = 0.914). Temporal parameters, including stride time (R = 0.999, ICC = 0.999), swing time (R = 0.968, ICC = 0.960), and double support time (R = 0.953, ICC 0.944), demonstrated excellent agreement with the gold standard. Stride length showed good accuracy (R = 0.867, ICC = 0.843), while stride width had lower precision (R = 0.321, ICC = 0.27). It enables the determination of temporal and spatial gait cycle characteristics (among others, stride time and stride length) with good to excellent validity at a precision sufficient to monitor clinically relevant changes in walking speed, stride-to-stride variability, and side asymmetry. Performance remained consistent across walking speeds, highlighting the robustness of the approach. Conclusions: The ear-worn sensor, integrated with deep learning, enables precise temporal gait analysis and moderately accurate spatial measurements, offering a user-friendly, non-intrusive solution for continuous gait monitoring. Its integration with vital-sign monitoring holds potential for telemedical and rehabilitation applications, providing comprehensive mobility and health assessments in daily life. Acknowledgements and FundingNo additional acknowledgements are declared. No specific funding was received for this work.

P03-A-03 - Activity recognition across multiple daily activities using deep learning and wearable sensors: A proof-of-concept study

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BackgroundTraditional methods for evaluating mobility like the 6-minute walk test are limited in duration and lack real-world relevance. Wearable sensors, such as accelerometers, allow continuous monitoring, capturing diverse activities like walking

and sedentary behaviour[1]. However, existing algorithms target few activities and rely on manual feature engineering. Data-driven approaches capture intricate patterns and hierarchical representations in data, by classifying a window[2], which can introduce error when more than one activity exists within a window. As a solution, this study aims to classify daily-life activities from wearable sensors using a deep learning model that can classify an activity at each timepoint.MethodsA publicly available dataset[2] of 22 adults (25-68y), with accelerometer data recorded from the lower back and wrist was used. Nine activities (in Figure 1), annotated by video recordings, were classified using both sensors. Our model consists of a multi-layer 1D convolutional neural network (CNN) for spatial feature extraction across sensors, followed by a gated recurrent unit (GRU) to handle temporal dependencies, predicting activity at each timepoint. Generalizability of the model was evaluated using the leave-one-participant-out (LOPO) cross-validation. Precision, recall and F1 score, weighted to account for activity imbalance, were used to evaluate performance. The predictions and ground truth labels from each fold of the LOPO were aggregated to construct an overall confusion matrix.ResultsThe average F1 score was 86±14%. Precision and recall values were highest for activities like walking, running, standing, sitting, lying (>80%) and lowest for standing cycling (<70%). Satisfactory performances were observed for stair ascent/descent tasks (>70%). Figure 1 displays the confusion matrix ensembled from each fold of the LOPO.ConclusionDeep learning architecture can effectively capture both spatial and temporal dependencies from accelerometer data, outperforming traditional methods[2]. The high F1 scores for common daily activities reflect the model's ability to distinguish stable patterns, while reduced performance for activities like cycling suggests the need for more data to improve detection. The use of a CNN for spatial feature extraction combined with a GRU for sequential learning proved to be well-suited for this application, as it handles continuous data and temporal dependencies effectively at a granular level. The LOPO also demonstrated the model's strong generalization capability, making it a promising tool for real-world applications of long-term activity monitoring with wearable sensors. Future work will extend this analysis to a large comprehensive dataset of patients with movement disorders including additional activities, such as postural transitions, as well as exploring the use of an inertial measurement unit with embedded gyroscope for improved performance.Refs [1] Kirk 2024 PMID:38243008 [2] Lagacjov 2021 PMID: 34883863.

P03-A-04 - Understanding movement and activities in Parkinson’s via using wearable sensors embedded into clothing

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Wearable sensors embedded in clothing can provide insight into people’s postures and activities over the day. Our research goal is to enable a continuous assessment of mobility and movement for people with Parkinson’s in daily life by monitoring activities such as walking, standing, sitting, etc. Features from sensors in the clothing may allow activities to be identified and detailed measurements to be derived during these activities. By putting sensors into clothing, we have been able to collect more detailed data that should give more quantified information about movements outside the laboratory and hence a better insight into living with Parkinson's. Ten participants were recruited for this study, seven people with Parkinson's and three in control group. Participants visited the university campus and were asked to wear a prototype of sports leggings with 7 lightweight inertial measurement sensors embedded at approximately the top of the feet, mid-shanks, mid-thighs and waist. Data was collected in three environments: (1) in the lab, where participants completed five activities, i.e. walking, timed up-and-go (TUG), five times sit-to-stand on a lower chair and a higher chair, and 30 secs sit-to-stand. (2) around the university campus where participants visited a museum and had a drink at the museum café. The lab and campus visits were video recorded. (3) The participants continued wearing leggings with sensors for the rest of the day. Participants then wore the sensors for one more day of usual activities. The video was used to annotate the data from the lab and campus environment. Categories were sit-to-stand, stand-to-sit, sit, walk, turn, stand, sit with weight shift and stand with weight shift. Feature selection in Matlab helped to reduce the features to moving mean and variance of thigh accelerometer, moving mean and variance of all sensors gyroscope data with 0.2 and 1 second window sizes. Fine k-nearest neighbors classifier achieved 96-99% accuracy across different activities for person with Parkinson's labeled data with 5-fold cross validation. The exported model was used on participant home data that was unlabeled. The model has reflected expected activities on the home data. Figure 1 represents three segments of predicted data. The whole day includes a range of activities. We were expecting to see sitting and walking in the car data and the model picked sitting as the most performed activity and walking as the second. During lunch the participant was mostly sitting which was reflected on the model's prediction. This preliminary research has shown that it is possible to collect detailed data of an individual with Parkinson's disease during a typical day. A remaining challenge is to present data in a suitable form for the individual and their clinical team. This research project is funded by the Ministry of National Education, the Republic of Turkiye by means of a studentship. We thank KYMIRA Ltd for the use of leggings with sensors.

P03-B-05 - Reactivity of the autonomic nervous system during visual-physical incongruent walking conditions- a virtual reality study

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Background and aim: The force of gravity critically impacts locomotion regulation while walking on inclined surfaces. To construct an updated assessment about the gravitational consequences and modulate gait patterns accordingly, the central nervous system (CNS) integrates multiple sensorial cues including vestibular and proprioceptive (i.e., body-based cues) and visual cues. The initial reaction to a destabilizing event in locomotion regulation was explained by the indirect prediction (IP) model, which suggests that neural constructs trigger pre-programmed gait patterns following environmental changes detected by fast perceived cues (i.e., visual). Then after, an iterative recalibration process of the relative influence of all sensorial cues leads to gradual re-stabilization, as explained by the sensory reweighting (SR) mechanism. This functional architecture allows the system to engage adaptive behavior by balancing between priors and external stimulus to maintain postural stability. Although communications between the CNS and executing effectors are known to be mediated also through the autonomic nervous system (ANS), not much is known about the involvement of the ANS in locomotion regulation, especially when multiple types of sensorial cues are involved. Here we examine the responsiveness of the ANS, as reflected by cardiac reactivity e.g., heart rate (HR) and heart rate variability (HRV), to coherent versus non-coherent sensorimotor signaling (both in the IP and SR periods) and the associated locomotor response. Methods: Fourteen healthy young participants completed level, uphill and downhill self-paced walking trials in a virtual reality (VR) environment in which the inclination of the visual scene was either congruent or incongruent with the physical inclination of the walking surface. Based on congruent data, we calculated the HR to gait speed baseline relation (linear calibration) of each participant (Fig 1A). The difference between expected and measured HR (Fig 1B; left panel) and the root mean square of successive (heartbeat) differences (RMSSD; Fig 1B; right panel) were calculated.Results: We found that during level walking, incongruent visual cues (i.e., uphill/downhill scenery) triggered alterations in ANS balance, reflected in significant HRV decrease ($p<0.001$, $\eta P2=0.66$) and in a residual increase of HR ($p<0.001$, $\eta P2=0.73$) which lasted during both the IP and SR periods. Conclusion: Taken together, our results, with the fact that an ultimate change in gait patterns requires alterations in cardiac resources, we speculate that ANS function and its responsive modes of action are in fact facilitating adaptive behavior. The entrance of virtual reality paradigms to the behavioral neuroscience arena enables the delineation of integrative perception-action behaviors across functional domains.

P03-B-06 - Exploring gait automaticity and prefrontal brain activity during single and dual-task walking in aging and Parkinson's disease

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BACKGROUND AND AIM: Performing cognitive tasks while walking often leads to slower gait speed and increased gait variability. This effect is observed in both aging and in Parkinson's disease (PD). Dual-task (DT) impairments worsen with higher cognitive load and diminished executive function. These impairments suggest that normal gait requires significant attentional resources due to reduced automaticity. The prefrontal cortex (PFC) is crucial in DT performance. However, few studies link automaticity, performance, and cognitive capacity to PFC activity. This study aims to 1) examine the connection between PFC activity and step time variability as a measure of gait automaticity during walking with and without a DT and 2) explore connections between PFC activity and other measures of gait automaticity, prioritization, and cognitive capacity as a potential moderator.METHODS: Existing data was analysed from the ParkMOVE dataset (2021-2023, https://doi.org/10.48723/vscr-eq07). Data from two groups were used: 49 older adults (OA) (60-84 yrs, mean 68.7), and 42 people with PD (60-91 yrs, mean 69.4). Participants carried out a walking protocol containing blocks of walking with and without an auditory Stroop task. Gait variables were obtained via inertial measurement units and PFC activity with functional near-infrared spectroscopy (fNIRS). Data analysis was performed in the NIRS Brain AnalyzIR toolbox (v2022.4.26). Hemodynamic changes were obtained via a general linear model with autoregressive pre-whitening. On group level for aim 1, a linear regression model related step time variability to PFC activation, controlling for age and disease severity. For aim 2, secondary analyses explored relations to other measures of automaticity, prioritization, and if a measure of cognitive ability (trail making test (TMT) B) acts as moderator on the relationship between gait automaticity and PFC activity.RESULTS: DT effects are shown in fig 1. There was a significant positive relationship between step time variability and PFC activity for PD (β=8.12, T=6.26, p<.01) but not OA. For OA, there was instead a relation between age and PFC activity (β=20.6, T=2.35, p=.02). Secondary analyses revealed relationships between PFC activity and DT cost of gait speed (β=3.00, T=2.90, p=.03) and Stroop response time (β=2.73, T=3.10, p=.01) in PD, but not in OA.While there was a significant correlation of weak to moderate strength between TMT B completion time and walking speed dual-task cost in both OA (R=0.4, p <.01) and PD (R=0.34, p=.04), the moderation analysis detected no moderation effects. CONCLUSIONS: Loss of gait automaticity in PD is linked to increased PFC activity, possibly reflecting compensatory mechanisms. In older adults, PFC activity during walking and DT walking is mainly influenced by age.ACKNOWLEDGEMENTS AND FUNDING: Supported by Norrbacka-Eugenia foundation, Promobilia, ALF, Swedish Research Council, Swedish Parkinson Foundation, Karolinska Institutet.

P03-B-07 - Bilateral vestibulo-ocular reflex gain-down adaptation impairs rapid balance corrections for increased sway in healthy adults

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Background And AimBalance is a multisensory process influenced by contextually dependent weighting of vision, vestibular, and somatosensory inputs. Reduction in vestibular function (i.e. vestibular neuritis) often acutely leads to increased sway. Otolith signaling is considered a primary vestibular cue for balance. We recently demonstrated transient increased sway after unilateral vestibulo-ocular reflex (VOR) down adaptation. Here we investigate whether the rapid recovery of body sway is further disrupted after bilateral vestibulo-ocular reflex (VOR) gain down adaptation, simulating a mild age-related decline in peripheral vestibular hypofunction.MethodsHealthy adults (n = 10, nine female), mean age 27.6 (± 13.2), stood wearing an inertial measurement device (Opal, APDM Inc.) with their eyes closed on a foam cushion (Airex, Inc) before and after incremental VOR gain down adaptation (iGainDown) simulating mild bilateral vestibular neuritis. Three 30 second repetitions of sway area were recorded before and immediately after iGainDown. Active head impulse VOR gain was measured (EyeSeeCam, Micromedical, Inc) before and after iGainDown to ensure VOR gain reduced. Percentage change for VOR gain and sway area were determined. Three levels of sway area were defined for analysis: average sway area for the first 3 pre-tests (PRE), sway area for the first post-test (POST1), and average sway area for the last 2 post-tests (Post2). Percentage change for VOR gain and sway area were determined. Mixed models compared change in sway area was compared (PRE-POST1, POST1-POST2, PRE-POST2) controlling for age and sex.ResultsVOR gain significantly decreased bilaterally exceeding meaningful change values (average = -9.4% (SD 2.4), range [-5 – 13%]). Sway area was significantly greater immediately for POST1 compared to PRE (+3 degrees^2, p = 0.017) and remained significantly greater over the next two tests (POST2) compared to PRE (+2.6 degrees^2, p < 0.037).ConclusionsHere we demonstrate immediate worsening of balance in healthy adults after transient VOR adaptation. Unlike our previous study with unilateral VOR adaptation where the postural effects did not persist in POST2, bilateral VOR adaptation resulted in a more persistent disruption to body sway suggesting that corrective sensory weighting strategies were delayed. These results suggest that the ability to quickly compensate for a disruption in vestibular reflex pathways depends on intact contralateral vestibular signaling and has implications for sensory weighting capacity with increased age or in the presence of vestibular disease. ACKNOWLEDGEMENTS AND FUNDINGAcknowledgement: We thank Professor Americo A. Migliaccio and Mr. Christopher J. Todd from the Balance and Vision Laboratory, Neuroscience Research Australia, for building the StableEyes devices and related software used in this study.FUNDING SOURCE: Supported in part by NIDCD K23 DC018303 (E Anson).

P03-B-08 - Distinct effects of center of mass immobilization on fast and slow center of pressure dynamics

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BACKGROUND AND AIM: Recent evidence suggests that center of pressure (COP) sway may partly reflect exploratory behavior (Carpenter et al., 2010), with the central nervous system generating COP motion to gather sensory input from the environment. This idea has been supported by studies showing that immobilizing the center of mass (COM) increases COP displacement. Additionally, Zatsiorsky and Duarte (2000) proposed that the slow dynamic (Rambling) of sway may also represent exploration, while the fast dynamic (Trembling) ensures stability. However, the traditional Rambling-Trembling method relies on equilibrium points (F = 0) to interpolate the Rambling component, a requirement often unmet during immobilization due to large COP drifts, resulting in poor interpolation. This study adapts the Rambling-Trembling framework using a frequency-based approach to assess how COM immobilization affects COP dynamics. We hypothesized that immobilization would increase the slow dynamic, reflecting exploration, and reduce the fast dynamic due to the artificial stabilization. METHODS: Seventeen participants completed trials under open- and closed-eye conditions. They stood on a force platform, feet shoulder-width apart for approximately 165s. The COM immobilization occurred around 95s using two approaches: a full-body apparatus "locking" participants from calves to head, and a belt system restricting only the estimated COM location. To assess the slow dynamics of COP, we adapted the Rambling method by applying a low-pass filter at 0.5 Hz to approximate the slow dynamic component (Rambling-Approx), as pilot data from a standard quiet standing task showed that 95% of rambling power resides below this frequency. The fast dynamic component (Trembling-Approx) was obtained by subtracting the Rambling-Approx signal from the original COP signal, following the traditional Trembling method. Standard deviations of both components were compared across non-immobilization ("unlocked") and immobilization ("locked") phases using linear mixed models. RESULTS: Statistical analysis revealed that COM immobilization increased the slow dynamic displacement in the complete immobilization apparatus but decreased it in the partial immobilization apparatus. For the fast dynamic component, displacement was lower during the locked phase, in the open-eye condition, and during the complete immobilization. CONCLUSIONS: The results highlight that the increase in COP displacement observed during full-body immobilization is primarily due to the slow dynamic component, suggesting increased exploratory behavior. Conversely, the fast dynamic component diminishes, indicating reduced corrective movements. This finding supports the idea that immobilization promotes exploration (slow dynamics) while reducing the need for stability corrections (fast dynamics). ACKNOWLEDGEMENTS AND FUNDING: Primary author had the NSERC Postgraduate Scholarship.

P03-B-09 - Action simulation as an intervention to improve balance, mobility and gait in healthy older adults: A scoping review

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Background and aim: Falls in older adults are an important public health issue. To address fall risk, action simulation techniques (i.e., action observation and/or motor imagery) have been suggested as alternative/adjunct strategies to physical exercise. Action simulation interventions remove barriers associated with physical practice (e.g., anxiety regarding unsupervised exercise) while targeting key cognitive factors contributing to fall risk (e.g., deficits in motor planning). This is important due to postural control becoming less automatic and more cognitively demanding as we age. This scoping review aimed to explore how action simulation techniques have been applied and evaluated in healthy older adults, as well as their effectiveness for improving measures of balance, mobility and gait. Methods: Following the PRISMA-ScR protocol, six databases/repositories were searched up to March 2024. Studies were included if they included healthy community-dwelling older adults, applied an action simulation intervention, and evaluated its impact on at least one measure of balance, mobility or gait. Two independent reviewers screened the studies, extracted data, and thematically charted the data. Results: Seventeen studies were included, including 464 participants, with a mean age ranging from 63.6 to 86 years, and baseline Timed up-and-Go completion times ranging from 6.47s to 16.17s. Most studies were RCTs (N=12; 71%). Across the 21 distinct interventions described, motor imagery was the most commonly used intervention (N=13; 76%), while eight studies (47%) combined action simulation with another co-intervention employing physical practice (e.g., tai chi). Intervention duration ranged from a single session (N=3; 18%) to 12 weeks (N=1; 6%), but only one study examined longer-term (1-month follow-up) effects. Studies examined a wide range of outcomes, including static and dynamic balance, gait, and mobility. Nine studies also examined various fall-related psychological and cognitive measures (e.g., falls efficacy). The interventions typically reported positive results for at least one movement outcome (N=15; 71%), but evidence was inconsistent across both movement and psychological outcome measures, as 10 interventions (48%) found mixed effects. The only study that examined long-term effects (at 1-month post-intervention) reported sustained positive effects for measures of gait and balance. Studies reported mixed findings on fall-related psychological measures: three (out of six) studies assessing balance confidence, and one (out of two) study assessing falls efficacy found positive effects of the intervention. For those few studies for which such data was available, studies reported common issues with recruitment, but excellent completion rate and adherence. Conclusions: Overall, this review shows some promising effects of action simulation on balance, mobility and gait in older adults. However, if action simulation techniques are to be adopted as a fall prevention strategy, more studies examining long-term effects, acceptability and transfer to real-world scenarios (i.e., actual fall reduction) are needed.

P03-B-10 - Gait adaptation and modulation deficits in older adults with and without cognitive impairments

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Motor-cognitive interactions are impaired in neurotypical aging and in individuals with mild cognitive impairments. We will discuss the results from recent and ongoing studies focusing on gait dysfunction and functional mobility deficits in older adults. The first study investigates locomotor adaptation in individuals with Alzheimer's Disease (AD) and mild cognitive impairment (MCI) compared to healthy older adults (HOA). Our results

indicated a significant decrease in locomotor adaptation and gait-cognitive dual-task capacity in older individuals with MCI and AD compared to HOA. Furthermore, we found an association between the magnitude locomotor adaptation and cognitive test scores, suggesting that greater cognitive impairment is associated with reduced walking adaptability in response to split-belt perturbations. The second study explores the effects of aging and MCI on the ability to modulate spatial, temporal, and spatiotemporal gait features during overground gait in older adults, in the context of music- and dance-based therapies. We compared gait performance during novel rhythmic movement sequences between HOA and MCI groups. We found that individuals with MCI showed reduced accuracy in spatiotemporal gait modifications compared to HOA. Additionally, exciting new results (unpublished) from our lab show differences between young and old adults in corticospinal excitability (measured using transcranial magnetic stimulation) during varying levels of balance and cognitive challenges, providing further support for a reorganization of attentional and motor cortical resource allocation in older adults without and with cognitive impairment. Overall, these studies highlight the link between cognitive impairments and gait / balance dysfunction in older adults, and suggest that improved understanding of these cognitive-motor impairments and their underlying neural mechanisms can aid early detection and inform intervention design to improve functional mobility in older adults with cognitive impairments.

P03-C-12 - Integrating margin of stability and physiologic profile assessment: A dynamic approach to fall risk prediction

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BACKGROUND AND AIM: The margin of stability in antero-posterior direction (MOSap), based on the inverted pendulum model, represents the shift of the whole-body center-of-mass state (XCoM) during movements [1]. Although MOSap reflects dynamic stability, its role in predicting fall risk alongside well-established clinical tools like the Physiological Profile Assessment (PPA) [2], which measures vision, proprioception, strength, and reaction time, remains underexplored. This study examines the relationships between MOSap and PPA z-scores, as well as between individual physiological factors and PPA z-scores. We hypothesize that higher MOSap values will correlate with lower PPA z-scores (H1); weaker physiological performance will correlate with higher PPA z-scores (H2). This study will help better connect biomechanics (MOSap) with clinical outcomes (fall risk), ultimately leading to more targeted fall risk assessments/ rehabilitation. METHODS: We performed a secondary analysis on data from nine participants (67±10 years, 55% female) in a community fall risk assessment program. Participants obtained a fall-risk score (PPA z-score) and performed three overground walking trials on a 20-ft pressure-sensitive walkway at their preferred speed.

MOSap (MOSap = Step length (SL)– XCoM) was calculated for the middle three steps at heel contact. Higher MOSap values indicate lower fall risk and vice versa. Spearman's coefficient was used to assess the correlation between MOSap and PPA z-scores. RESULTS: A significant weak negative correlation between MOSap and PPA z-score was noted (p=0.003; Table 1). Further, correlations were observed with balance measures, gait parameters, proprioception measures, cognitive functions, and visual functions (p<0.01; Table 1). Collectively, these results highlight the multi-domain nature of MOSap, emphasizing contributions from postural stability, gait, proprioception, vision, and cognitive function. CONCLUSION: Our study shows that MOSap is a comprehensive indicator of dynamic balance, linking fall risk to interplay between postural stability, mobility, sensory feedback, and cognitive function. Correlations between MOSap and balance measures emphasize the importance of dynamic stability for postural control, supporting its use in fall prevention. Additionally, correlations with proprioception, vision, and cognition show that MOSap integrates motor control with sensory and cognitive inputs, strengthening its role as a stability indicator. The negative correlation between MOSap and the PPA z-score suggests MOSap could complement clinical fall risk assessments. Weak correlations may be due to the small sample size of nine participants. These findings emphasize the need to consider multiple physiological factors in fall risk assessment, with MOSap and PPA enabling tailored interventions such as gait training, vision correction, or cognitive exercises. REFERENCES[1] Hoff et al. 2005. J Biomech. [2] Lord et al. 2003. Phys Ther. FUNDING: Project supported by Optima Health.

P03-C-13 - Examining gaze-driven postural adaptations in older adults with and without central visual field loss

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BACKGROUND AND AIM: Age-related macular degeneration (AMD) is the most common form of age-related visual impairment, causing central visual field loss (CFL). This leads to both reduced vision and alterations in oculomotor control, as individuals adopt eccentric viewing strategies to exploit their intact peripheral retina. Those with AMD experience mobility difficulties and greater fall risk, yet these issues remain poorly characterized, especially considering the combined effects of eccentric viewing, aging, and vision loss. Furthermore, successful fall risk interventions or rehabilitation protocols specifically aimed at improving mobility and postural control in this population are lacking. Studies in healthy young adults have shown that gaze orientation impacts body stabilization and control. Furthermore, whole-body adaptations occur to enhance gaze/body stability during visual tasks (e.g., reading, visual search). Given that those with binocular CFL often experience more unstable gaze and compromised visual search, exploiting ecological sensorimotor relationships could offer promising rehabilitation approaches to improve both gaze and whole-body stability, potentially leading to safer environmental interactions and greater autonomy. It remains unknown, however, whether gaze-driven postural adaptations persist in older age, given age-related sensorimotor dysfunctions. To address this gap, our study is designed to include healthy-sighted young and older adults, as well as older adults with CFL.METHODS: Preliminary data have been gathered for 9 participants (3F, age range: 31-82) including one older adult with CFL. Participants stepped in place on a force plate with and without a visual search task, their head, trunk and leg movements tracked with IMUs. Targets and distractors were projected on a screen (58°×48°) and participants reported the number of targets found during successive trials. Recordings lasted 30s and conditions were repeated 3 times.RESULTS: Preliminary data suggest that postural adaptations driven by the demands of the search task persist in older adults with and without CFL, though there exists some variability. We observe reductions in vertical head acceleration during the search task compared to baseline, but an increase in mediolateral acceleration. Interestingly, the older adults with CFL reduced head acceleration during the search task in all planes. Head velocity increased in yaw but reduced in roll. Participants also increased step width during the search task, presumably to improve stability via a larger base of support. CONCLUSIONS: While data collection and analysis are ongoing, we observe a preserved ability to adapt in older age. Should these observations persist in CFL, there may promising avenues for rehabilitation and training that exploit ecological relationships between sensorimotor systems.ACKNOWLEDGEMENTS AND FUNDING: This work was funded by NIH grant T32-EY-025201, the NIDILRR RERC Program grant 90REGE001, and the Smith-Kettlewell Eye Research Institute.

P03-C-14 - Augmented reality induced gait and postural balance perturbations in fallers and non-fallers, a multisensory approach

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Background and aimEveryday activities, like scanning for products at the grocery store, often involve head movements which could disrupt balance and sensory systems. These disruptions are more pronounced in older individuals, where age-related sensory decline may compromise adaptive balance strategies and gait function, increasing fall risk. This study aims to assess: (1) How head movements affect gait stability and postural balance in older adults with a history of falls compared to non-fallers, and (2) their correlation to sensory functions (vestibular, visual, and cervical sensorimotor control), considering frailty as an influencing factor. This abstract outlines the study protocol; results will be presented at the ISPGR 2025 conference if accepted.Methods A cross-sectional, case-control study will be carried out involving community-dwelling adults aged ≥65 years. Participants will be categorized as fallers (cases) if they experienced ≥2 fall incidents in the past 12 months. In case of 0 fall incidents and no identified fall risk on the Timed Up and Go test, they will be categorized as non-fallers and form the age and gender balanced

control group. Recruitment will take place in community centres, service flats and through 1st line practitioners until a sample size of 74 is reached. Data collection involves 3 main components: 1. 3D-Biomechanical Movement Analysis: Participants wear an augmented-reality set of goggles that projects a hologram moving in vertical (up, down) or horizontal (left, right) direction. This way evoking movement of the eyes and head by following the hologram while standing or walking. Gait stability and postural balance reactions (centre of mass, centre of pressure, margin of stability, reactive and anticipatory postural adjustments) will be mapped based on biomechanical marker data, force plate data and electromyography. 2. Frailty: Assessment using the Fried criteria. 3. Sensory function: (1) Cervical sensorimotor control measured through Head Repositioning Accuracy testing. (2) Vestibular function assessed through 3D-video Head Impulse Testing, examining the vestibulo-ocular reflex gain (and asymmetry). (3) Static and Dynamic Visual Acuity measured through functional Head Impulse Testing. Data processing will be performed using the software packages of Nexus (Vicon Motion Systems Ltd.), MATLAB and HITCAL. Statistical analysis will be conducted using RStudio. ResultsWe expect that head movements will induce a protective gait pattern and that sensory function and balance strategies during head motions are correlated both in fallers and non-fallers. We expect a poorer sensory function, higher frailty levels and slower, less efficient balance strategies as a response to head movements in fallers compared to non-fallers. ConclusionThis research, by introducing a head-motion perturbation into gait and balance assessment in combination with sensory function, offers a novel research method and framework to study fall mechanisms.

P03-C-15 - Predicting frailty status from six-minute overground walk IMU data using convolutional neural networks

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Background: Frailty is a multifactorial condition that affects both quality of life and overall health, often leading to an increased risk of falling. Current assessments often require multiple clinical tests that are inherently subjective and must be administered by a trained professional. This study aims to investigate whether deep learning models applied to inertial measurement unit (IMU) data collected during a six-minute overground walk can accurately predict frailty status using the Fried Frailty Phenotype (healthy, pre-frail, frail). Methods: Six-minute walk data were collected from 867 community-dwelling older adults (mean age 72 ± 6 years; 55% female) with IMU sensors attached to both feet and the pelvis, at their preferred walking speed along a hallway in a clinic. Time-series of acceleration and angular velocity signals were fed into a convolutional neural network (CNN). Models were trained to classify the older adults into three frailty categories, using bootstrapping to ensure robustness of the results. Performance of the model was evaluated by the area under the receiver operating characteristic curve (AUC), sensitivity and specificity. Results: Across five-fold cross-validation, the CNN models achieved moderate discrimination: mean AUC = 0.82, sensitivity = 76.23%, and specificity = 88.12% for classifying healthy, pre-frail and frail older adults. Bootstrapping with 100 resamples ensured the stability of the model, with a standard error for the AUC of approximately 0.05. Conclusion: Deep learning applied to IMU data from a simple six-minute walk test provides a scalable, ecologically valid approach for frailty assessment among older adults. By using overground walking data, rather than clinical functional assessments, this method can be used to facilitate community-based frailty monitoring for early intervention. Future work will explore other modeling techniques to further increase predictive accuracy. Acknowledgement: The research was conducted at the Future Health Technologies at the Singapore-ETH Centre, which was established collaboratively between ETH Zurich and the National Research Foundation Singapore. This research is supported by the National Research Foundation Singapore (NRF) under its Campus for Research Excellence and Technological Enterprise (CREATE) programme.

P03-C-16 - The impact of pain on falls in middle-aged and older people: Gait quality as a mediator in UK biobank data

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Background and Aim: Pain has been consistently identified as a fall risk factor. However, the mechanisms underpinning this relationship remain poorly understood. This study explored the pathways through which pain influences fall risk, focusing on the mediating roles of gait quality, depression, inflammation, physical activity and cognition.Methods: This cross-sectional study analysed data from 57,089 participants aged 40 to 69 years from the UK Biobank. Pain was assessed through self-reported chronic musculoskeletal pain affecting daily activities. Fall incidence was categorised as no, one or multiple falls in the past year. Gait quality was measured using a wrist-worn accelerometer, providing digital gait biomarkers such as step-to-step variability and walking speed. Depression was evaluated using self-reported depressive symptoms, and inflammation was assessed as high or low high-sensitivity C-reactive protein (CRP) levels. Structural Equation Modelling was used to examine pain's direct and indirect effects on falls. The study was preregistered on the Open Science Framework (OSF) [DOI: https://doi.org/10.17605/OSF.IO/G2EC9]. Initially, the literature-based model included latent variables for gait quality, physical activity, and cognition, with inflammation and depression as potential mediators. Early model iterations, where gait speed was part of gait quality and a cognition latent variable was used, yielded poor model fit. This led to refinements such as the separation of gait quality and walking speed, and the removal of cognition and physical activity, which were initially hypothesised to play a key role but were found to have a minor impact on falls.Results: The final model demonstrated a good fit (CFI = 0.976, TLI = 0.949, RMSEA = 0.05). Pain was shown to have both direct and

indirect effects on falls. Gait quality emerged as the strongest mediator, with reduced gait quality significantly, increasing fall risk. Gait speed was an independent contributor, with slower speeds associated with greater fall risk. Depression, influenced by pain, indirectly increased fall risk by impairing both gait quality and cognitive function. Inflammation mediated fall risk, likely through its impact on mobility and neuromuscular control. Sensitivity analyses confirmed that these pathways were consistent across various pain profiles, including back, knee, hip and shoulder/neck pain, as well as multisite pain.Conclusions: This study gives new insights into the complex pathways linking pain and falls, highlighting the role of gait quality alongside psychological and biological mediators. Pain increases fall risk through secondary effects on gait quality, gait speed, depression and inflammation. These findings showed the importance of a multifactorial approach to fall prevention, incorporating pain management, gait improvement, and strategies to address depression and systemic inflammation to manage fall risk in middle-aged and older people.

P03-C-17 - Mind the gap: Younger and older adults use different behavioural strategies to cross a path in virtual reality

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BACKGROUND: Crossing a path in dynamic environments requires pedestrians to adjust their speed as gaps shrink perpendicular to their trajectory. Appropriate speed adjustments rely on visuomotor integration (VMI), as pedestrians attend to their environment to make safe crossing decisions. While young adults (YA) typically adapt their speed effectively when navigating closing gaps (Cinelli et al., 2009), older adults (OA) are often reluctant to adjust their speed, possibly due to age-related VMI delays (Dommes et al., 2013). This study examined how aging affects one's ability to use VMI to accurately adjust walking speed and safely cross a path with a closing gap. We hypothesized that OA would be less effective at adjusting their speed in a timely manner and thus exhibit more conservative and variable adjustments due to VMI deficits.METHODS: Fifteen YA (21.6 +/-1.4 yrs) and fifteen OA (69.4 +/-3.8 yrs) completed a virtual path crossing task. Participants were instructed to walk along a path and cross an intersection while safely avoiding collisions with virtual pedestrians (VPs). VPs crossed from either side of the intersecting path at one of six speeds (0.7–1.2x participant's average walking speed). Each VP speed condition was repeated five times. Participants were immersed in the virtual environment with an HTC Vive Pro 2 head-mounted display, which also recorded positional data (90Hz).RESULTS: YA modulated the onset of their walking speed adjustment to that of the VP speeds; earlier for faster speeds ($\bar{x}$ = 2.2s prior to crossing) and later for slower speeds ($\bar{x}$ = 1.9s). However, OA maintained a consistent onset across all VP speeds ($\bar{x}$ = 2.1s). Magnitude of change in walking speed revealed significant main effects of VP speed ($p < .001$, np2 = .619) and group ($p = .006$, np2 = .240). Although both groups increased the magnitude of their speed

change as VP speed increased, OA's magnitudes were consistently larger (x̄ = 0.6m/s) compared to YA (x̄ = 0.4m/s). Finally, a significant VP speed x group interaction was found for time to reach maximum speed change (p = .019, np2 = .132; Figure 1). YA reached maximum speed quicker in the slower VP speeds (x̄ = 1.6s) and took longer in faster VP speeds (x̄ = 2.3s), while OA maintained a consistent time to reach maximum speed change regardless of VP speed (x̄ ≈ 2.1 - 2.2s).CONCLUSIONS: The current findings suggest that YA and OA use different strategies when adjusting their speed to pass through closing gaps. YA appear to modulate both the timing and magnitude of their speed adjustments based on the gap closing rate, demonstrating adaptive and efficient responses. In contrast, OA adopt a more rigid strategy, responding with more consistent timing and larger speed adjustments, regardless of gap closing rate. These patterns may reflect age-related changes in VMI, with OA potentially adopting a more fixed 'one solution fits all' strategy when navigating dynamic environments.FUNDING: NSERC

P03-C-18 - Movement specificity of balance recovery in older adults

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Background and aim: Falls are the second leading cause of injury-related deaths in older persons, and with an ageing global population, addressing fall risk has become paramount [1,2]. Balance ability decreases with age, impacting daily tasks [3]. Balance perturbations have been used to assess and improve balance recovery during destabilizing events during standing and walking, like tripping and slipping [4]. However, falls also often occur in movements other than walking, especially in frail older adults prone to falling [5,6]. Different daily movements pose distinct biomechanical challenges: walking involves forward momentum while turning demands lateral control. Assessment of balance recovery ability during these movements has not yet been investigated. Does balance recovery differ during different daily movements, including standing, walking, and turning, in younger and older adults? Methods: We so far measured 20 older adults (73±6 yrs) and 20 younger adults (25±3 yrs) for comparison. Participants were exposed to unexpected forward treadmill perturbations (Balance Tutor system) during standing, comfortable speed walking, and in-place turning. To assess recovery at the highest perturbation intensity individuals could handle without falling, the intensities were increased until they requested to stop or took more than 3 recovery steps. Full-body kinematics were recorded using an IMU suit (Xsens system). Balance recovery was evaluated as the difference in the Centre of Mass velocity, from the onset till the end of the perturbation, between the lowest and the highest perturbation intensities of each individual. Friedman rank tests were conducted to investigate if individuals changed ranking between different movements within their age group.Results: For context, because older adults reached lower perturbation magnitudes for all movements (p(two-sample t-test) <0.001, Fig. 1B), there was no difference between young and old in balance recovery ability. While, visually older participants performed differently between tasks (

wider spread) but no significance (p(levene's)=0.122, Fig. 1C). There was no significant change in the ranking of individuals in their balance ability between movements within each group (Friedman p(young)=0.5, p(old)= 0.7).Conclusion: This is the first study to explore balance recovery at individual limits in older adults during daily movements. It provides insight into balance (problems) during different fall-inducing movements. Since, the measurements are ongoing only turning was included from the daily movements and pre-liminary balance metric was computed for quantification. Further analysis will include whole-body angular momentum metric, anticipatory balance analysis, and additional daily living tasks.Acknowledgments and funding: EPP funding of State of Baden-Württemberg foundation, GermanyReferences: [1] WHO (2021)[2] United Nations, World Population Prospects 2022: Summary of Results, 2022.[3] Rubenstein et al. (2002), Clin Geriatr Med[4] McCrum et al(2022), Front. Sports Active Living[5] Robinovitch et al (2013), Lancet[6]] Bartosch et al (2020), Aging Clin Exp

P03-C-19 - Relationship between respiratory muscle strength and dynamic balance in older persons requiring care or support: Focusing on the maximal single step length test and maximal double step length test as dynamic balance indices

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BACKGROUND and AIM: Falls are a major health problem among older people, representing a leading cause of disability and long-term care needs. Dynamic balance, assessed using tests such as the maximal single step length test (MSL) and the maximal double step length test (MDST), plays a critical role in fall prevention. However, the relationship between these dynamic balance indices and respiratory muscle strength, including maximal inspiratory pressure (PImax) and maximal expiratory pressure (PEmax), remains poorly understood in older people requiring long-term care or support. Understanding this relationship may contribute to the development of targeted interventions to prevent falls. The aim of this study was to determine the relationship between respiratory muscle strength and the MDST and MSL in community-dwelling older people requiring long-term care or support. METHODS: This was a cross-sectional study performed at a single day care center. All participants were informed of the study details orally and in writing, and their consent was obtained in writing. This study was performed in accordance with the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Kanazawa Orthopedic and Sports Medicine Clinic (kanazawa-OSMC2023–003). Thirty-nine Japanese community-dwelling older people (17 men and 22 women) aged ≥ 65 years who were attending a single day care center were included in this study. The participants were certified as requiring long-term care or support under the Japanese long-term care insurance system. The participants' PImax, PEmax, MSL, and MDST results were recorded. The relationship between the dynamic balance indices, MDST and MSL, and respiratory muscle strength was examined

using Pearson's correlation coefficient and multiple regression analysis. RESULTS: Table 1 shows the basic characteristics and measurement values of the study participants. Pearson's correlation coefficient analysis revealed a positive correlation between MDST and PImax ($r = 0.430$, $p = 0.006$) but not between MDST and PEmax ($r = 0.287$, $p = 0.076$). No correlation was found between MSL and PImax ($r = 0.293$, $p = 0.070$) and MSL and PEmax ($r = 0.189$, $p = 0.249$). There was a positive correlation between MDST and MSL ($r = 0.851$, $p < 0.001$). Multiple regression analysis indicated that both PImax ($p = 0.027$) and MSL ($p < 0.001$) were significant explanatory variables for MDST, with an adjusted R^2 of 0.746. CONCLUSIONS: In this study, we found that MDST, which requires more dynamic balance ability than that for the MSL, was associated with inspiratory muscle strength in community-dwelling older people who required long-term care or support. Adding inspiratory muscle strength and MDST assessment to long-term care or support for older people could contribute to reducing the number of falls in older people with frailty.ACKNOWLEDGEMENTS AND FUNDING: This work was not funded.

P03-C-20 - Identifying the factors that contribute to gait efficacy in people with Parkinson's disease

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Background and aim: Self-efficacy refers to an individual's confidence in his or her ability to complete a task successfully and is crucial when considering mobility. Low gait self-efficacy may lead older adults to limit their walking and the environments in which they walk, regardless of their actual walking capability. This may manifest itself as lower Gait Efficacy (GE), a measure that can be assessed using the modified Gait Efficacy Scale (mGES) (Newell et al., 2012). Older adults may also reduce their activity due to fear of falling (FOF), which can be measured by the Activities-specific Balance Confidence-Scale (ABC) and Falls- Efficacy Scale-International (FES-I), which asking about challenging physical tasks requiring balance. Information about GE and its relationships with FOF, disease severity, and other potential contributing factors is lacking among people with PD. We aimed to address this gap.Methods: Fifty-seven patients with PD completed questionnaires and tests during a single visit. GE was evaluated using the mGES. The MDS-UPDRS part III assessed disease severity. Other potential contributing-factors included: age, sex, disease duration, the FES-I, ABC, 6 Minute Walk Test (6MWT) distance, The Timed Up and Go (TUG), and the Short Physical Performance Battery (SPPB).Results: The mGES was negatively correlated with disease duration, age, and FES-I, and mGES was positively correlated with ABC (Table 1, Figure 1a), SPPB, and 6MWT. mGES was not significantly correlated with TUG or sex. Multiple regression analysis showed that mGES remained significantly associated with FES-I after adjusting for age, disease duration, MDS-UPDRS-III, gender, and education ($F(6, 50) = 21.45$, $p <$

.001, R^2 = .720, Adjusted R^2 = .687). FES-I was found to be the strongest predictor (β = -.731, p < .001) of mGES, with age showing a modest negative effect (β = -.176, p = .034). A second regression model adjusting for FES-I, 6MWT, age, education, gender, disease duration, and MDS-UPDRS-III was also significant (F(7, 49) = 20.39, p < .001, R^2 = .744, Adjusted R^2 = .708). FES-I remained the strongest predictor of mGES (β = -.653, p < .001). Finally, stepwise regression identified ABC, FES-I, and age as significant independent predictors of mGES, explaining 81.5% of its variance (Figure 1b).Conclusions: Fear of falling, self-efficacy related to balance, performance on mobility tests, and age were found to be related to gait efficacy in individuals with PD. Interventions to improve gait efficacy in PD should target both psychological and physical factors to improve gait self-efficacy.

P03-C-21 - 10 minutes in virtual reality is insufficient for gait adaptation to occur in young and older adults

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Introduction: Recently, virtual reality (VR) garnered substantial interest for gait protocols. However, most VR applications for gait protocols were conducted on systems that combined semi-immersive VR devices (ex: displays on screens) and treadmills. Such setups alter gait from its nominal overground pattern. Advancements in VR head mounted displays (HMD) may overcome these limitations by creating fully immersive environments for overground navigation. However, the altered visual input of the VR-HMD may require an adaptation period.Research Question: Does gait adaptation occur for young and older adults in 10 minutes of overground walking in VR? Methods: Sixteen older adults (66.4 ± 4.3yrs, 73.6 ± 9.7kg, 1.7±0.8m) and fifteen young adults (26.5 ± 2.6yrs, 67.1 ± 14.9kg, 1.7 ± 1.0m) walked along a 12m path for a minimum of 5 trials without VR. Afterward, participants completed 10min of continuous overground walking in a to-scale, VR copy of the laboratory with the Meta Quest 2. A 16-camera Vicon Motion Capture System (Oxford, England) collected full-body motion at 120Hz. Data were extracted at baseline and the VR first and last minutes. Averages and standard deviations for stride time and length, step width, and peak trunk velocity in the sagittal and frontal planes were assessed. A mixed ANOVA, with Bonferroni correction, assessed group and condition differences. Results: No walking speed differences occurred. Average stride time decreased (F(2,29) = 8.80, p < .001) from baseline to the first VR minute, but increased from the first to last VR minute. Average step width (F(2,29) = 6.89, p < .002) was narrower in the last VR minute than in baseline. Step width variability (F(2,29) = 12.38, p < .001) was lower in baseline than both VR minutes. Average trunk velocity in the sagittal (F(2,29) = 5.08, p < .009) and frontal planes (F(2,29) = 10.57, p = .002) were lower during the first VR minute than baseline. During the last VR minute, average frontal plane trunk velocity (F(2,29) = 9.30, p < .001) was lower than in baseline. Frontal plane trunk velocity variability

(F(2,29) = 11.79, p < .001) was higher during both VR minutes than baseline. Discussion: Walking with a VR-HMD perturbs postural control in both planes. Indeed, frontal plane trunk variability increased during both VR minutes than in baseline. Further, sagittal plane trunk velocity decreased from baseline despite the faster steps in the first VR minute reflecting an initial incongruency between trunk motion and the stepping action. To compensate, participants increased step width variability, reduced trunk frontal plane velocity, and took narrower steps to maintain the upper body in the mediolateral base of support. Finally, the slower steps in the first than last VR minute allowed more time for the loading leg to accept the upper body's full weight at initial contact. Overall, 10min is insufficient for adaptation to occur when using a VR-HMD.Funding: SP19-004, FTI23-G-016, FO999898083

P03-C-22 - Cultural adaptation and validation of the Arabic short version of the Iconographical Falls Efficacy Scale (Icon-FES): Assessing concern about falling among older adults

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Background Concern about falling is a significant issue among older adults, affecting their quality of life and functional independence. Culturally adapted and validated assessment tools are essential for accurately evaluating concern about falling. This study aimed to translate, cross-culturally adapt, and validate the Arabic short version of the Iconographical Falls Efficacy Scale (Icon-FES).Methods The translation and cultural adaptation process followed established guidelines. Structural validity was assessed using exploratory factor analysis (EFA). Internal consistency reliability, test–retest reliability, convergent validity, and known-groups validity of the scale were evaluated.Results A total of 123 community-dwelling older adults (mean age 69.54±3.48 years; 53.7% male) participated. The Arabic short version of Icon-FES demonstrated strong structural validity, with EFA supporting a unidimensional structure accounting for 73.47% of the variance. It exhibited high internal consistency (Cronbach's α = 0.95) and excellent test–retest reliability (ICC = 0.97). Convergent validity was confirmed through significant correlations with the Arabic Falls Efficacy Scale-International (FES-I; rs = 0.73, p < 0.001), Single Leg Stance (SLS; rs = − 0.34, p < 0.001), and Five Times Sit-to-Stand Test (5TSTS; rs = 0.44, p < 0.001). Known-groups validity showed higher scores in females, those with lower education, and a history of falls.Conclusions The Arabic short version of Icon-FES is a reliable and valid tool for assessing concern about falling among community-dwelling older adults. It offers an innovative approach through culturally adapted visual elements that could enhance applicability, enabling accurate assessment and supporting targeted interventions among Arabic-speaking older adults.

P03-C-23 - Differences in localized ground reaction forces between older fallers and non-fallers using a shoe sensor system

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BACKGROUND AND AIM:Falls are a serious concern among older adults, highlighting the importance of early detection of people at risk of falls. Ground reaction forces (GRFs), which are kinetic measures, are considered useful for assessing fall risk; however, their measurement requires a force plate, which has limits testing environment and data collection from large samples. Furthermore, the differences in time-series changes in GRFs between fallers and non-fallers remain unclear. To address these challenges, we developed a shoe sensor system equipped with high-capacity three-axis force sensors at four locations on the sole: the heel, first and fifth metatarsal heads, and toe [1]. This system enables continuous GRFs measurement during walking. In this study, we aimed to examine the difference in the time-series changes in GRFs during straight walking between older adults with and without a history of falls using the shoe sensor system.METHODS:A total of 807 older adults (mean age= 76.3 ± 6.2 years, 66.2% of female) participated in this study and were analyzed. They were instructed to wear the shoe sensor system and walk straight line of 11 meters at their preferred walking speed. We also assessed fall experience within a year, and participants were then classified as fallers (167 individuals) or non-fallers (640 individuals). Time-series localized GRFs data at each sensor location and resultant GRFs from four sensors during a stance phase (0%–100%) for multiple gait cycles during a 5-meter walk were compared between fallers and non-fallers using unpaired t-test statistical parametric mapping [2]. All GRF data were averaged across the left and right feet.RESULTS:No significant differences were observed in the resultant GRFs from four sensors in any direction between fallers and non-fallers. Localized GRFs in the mediolateral and the anteroposterior (AP) directions at the first metatarsal head were significantly greater in fallers than in non-fallers during 91%–93% ($p < 0.05$, Fig. 1(a)) and 72%–81% ($p < 0.05$, Fig. 1(b)) of the stance phase, respectively. In contrast, localized GRFs in the AP direction at the toe were significantly lower in fallers than non-fallers during 98%–99% of the stance phase ($p < 0.05$, Fig. 1(c)).CONCLUSIONS:Differences related to fall experience were observed in the mid- and late-stance phases. Our results suggest that GRFs were lower in fallers during the stepping-off phase, potentially leading to a compensatory increase in GRFs at the first metatarsal head during mid-stance. The inability to push off the ground with the toes firmly may be a distinguishing characteristic of fallers' gait.REFERENCE:[1] Matsumoto, H., et al., Comparing the GRFs, Toe Clearances, and Stride Lengths of Young and Older Adults Using a Novel Shoe Sensor System, Sensors, Vol.24, No.21 (2024), 6871.[2] Pataky, T. C., Generalized n-dimensional biomechanical field analysis using statistical parametric mapping, Journal of Biomechanics, Vol.43, No.10(2010), pp.1976-1982.

P03-D-24 - Higher cortical demand in more challenging walking tasks: Insights from fNIRS

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Background and Aim: The primary goal of this study was to identify the cortical circuits involved in walking in people with multiple sclerosis (PwMS) using functional Near-InfraRed Spectroscopy (fNIRS). Although there are several studies on motor rehabilitation at the behavioral level, few have investigated the neural correlates [1-2], and none have simultaneously examined the frontal, sensorimotor, and parietal areas. Furthermore, this study aimed to compare two types of walking, along linear and curvilinear trajectories, to determine whether different walking scenarios, with varying levels of complexity and realism, activate cortical regions differently. Methods: Nineteen PwMS (age: mean ± SD = 59.74 ± 9.52 years; 12 females) were recruited for this study. All PwMS had an Expanded Disability Status Scale score of 6, indicating the need of a crutch to walk. They were asked to walk along two different paths: one straight (Linear condition) and one curved in a figure-eight shape (Curvilinear condition). The order of conditions was randomized to minimize potential order effects. Each condition included 8 trials, with each trial consisting of 30 seconds of walking followed by 30 seconds of rest. During the rest phase, participants were instructed to stand as still as possible. To prevent fatigue, participants were allowed to sit and rest for a few minutes after every four trials. Throughout the experiment, fNIRS was used to record cortical activity. For each condition and Brodmann area (BA), the change in oxygenated hemoglobin concentration was calculated. Results: The analysis of the fNIRS signal indicated that walking in PwMS elicited the activation of the prefrontal, sensorimotor, and parietal cortical areas. Furthermore, the changes in oxygenated hemoglobin concentration resulted to be significantly different between the two conditions: the prefrontal areas were significantly more active in the Curvilinear condition than in the Linear condition (Linear vs. Curvilinear: central BA10: 0.118 vs. 0.207 μM, $p < 0.001$; central BA8: 0.047 vs. 0.092 μM, $p = 0.028$; central BA6: 0.016 vs. 0.095 μM, $p <0.001$; and right BA8: 0.005 vs. 0.068 μM, $p = 0.003$). Conclusion: This study confirms that fNIRS is a valid tool for studying gait in multiple sclerosis. Moreover, it reveals that various cortical areas are active during walking in this population, including prefrontal, sensorimotor, and parietal regions. The differences observed in cortical activity between different types of walking highlight the importance of considering the nature of the walking task in motor rehabilitation. Incorporating more realistic and complex walking scenarios, such as curvilinear paths, could enhance rehabilitation programs by better addressing the everyday needs of patients. [1] Kupchenko, Y., et al. (2023). European Journal of Physical and Rehabilitation Medicine, 59(2), 164.[2] Santinelli, F. B., et al. (2024). Neurorehabilitation and Neural Repair, 15459683241279066.

P03-D-25 - The neural correlates of gait and executive function deficits in fragile x-associated tremor/ataxia syndrome (FXTAS): A preliminary study

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Background & Aims: Gait and executive function (EF) impairments in FXTAS—a neurodegenerative disorder characterized by cerebellar ataxia, tremor, and cognitive dysfunction—negatively affect mobility, increase fall risk, and reduce quality of life. The neural mechanisms underlying these cognitive-motor relationships are largely undescribed. We aimed to examine the 1) cortical control of gait and EF in FXTAS during simple and complex gait tasks and EF assessments, and 2) structural grey matter volume (GMV) and white matter integrity (WMI) changes in frontal-cerebellar pathways that may underlie gait and EF deficits in FXTAS.Methods: 10 participants with FXTAS (69.7±6.4 years; 70% men) and 7 controls (66.7±6.7 years; 57% men) performed gait testing under single task (ST), fast-paced, dual task, and obstacle navigation conditions, then completed an extensive EF test battery. Simultaneous functional near-infrared spectroscopy (fNIRS) data was collected from the dorsolateral prefrontal cortex (DLPFC), premotor cortex (PMC), and supplementary motor area (SMA) during all assessments. T1-weighted MRI and T2-weighted DWI scans were collected from all participants. GMV of the DLPFC, combined PMC/SMA, and cerebellum, and DTI measures of WMI of the middle cerebellar peduncles (MCP), superior cerebellar peduncles (SCP), and cerebellar white matter were obtained.Results: A trend of increased DLPFC activation was observed in FXTAS participants vs. controls under the ST gait condition (p=0.091). When analyzing cortical activation during the first and second halves of each gait task, the FXTAS group exhibited significantly greater DLPFC activation (p=0.042) and also a trend of increased PMC/SMA activation (p=0.093) compared to controls during the first half of ST gait. The FXTAS group demonstrated significantly reduced DLPFC activation during an information processing speed test (p=0.020) and a trend of reduced activation during a verbal fluency test (p=0.087). An interim analysis of 6 FXTAS and 6 control participants revealed no significant differences in GMV of the DLPFC, combined PMC/SMA, or cerebellum. However, several DTI measures were abnormally elevated in FXTAS participants, including MCP mean and axial diffusivities (p=0.019 and 0.004), SCP mean, axial, and radial diffusivities (p=0.010–0.041), and axial diffusivity of cerebellar white matter (p=0.0043).Conclusions: Individuals with FXTAS over-recruit the DLPFC and PMC/SMA during simple gait, particularly during its initiation, perhaps to compensate for decreased gait automaticity. Reduced FXTAS DLPFC activation during EF tasks suggest lower maximum recruitment capabilities due to ceiling effects. Several WMI abnormalities were revealed in the SCP, MCP and cerebellum in FXTAS. These functional and structural alterations in frontal-cerebellar circuits may underlie gait and EF deficits in FXTAS, making them potential targets for therapeutic interventions.

P03-D-26 - Brain imaging of whole body movement

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Background and aim:Understanding how the brain supports naturalistic, whole-body movement requires neuroimaging methods that can capture dynamic brain activity without constraining the body. Recent advances in wearable optically pumped magnetoencephalography (OP-MEG) provide a promising solution, enabling non-invasive, high-resolution imaging during natural movement.Methods:I will introduce this novel imaging modality and describe how it enables source-localised brain imaging during naturalistic, whole-body actions. I will outline the experimental paradigms used to acquire OP-MEG data during visually guided stepping and dance, and explain how these recordings are used to reconstruct the spatial and temporal dynamics of cortical activity.Results:I will present evidence of robust, movement-related neural activity localised to primary motor and sensorimotor regions during both stepping and multi-limb dance. These results demonstrate the viability of reconstructing cortical sources during complex, dynamic behaviour using OP-MEG. I will also discuss ongoing methodological challenges, including movement-related artefact rejection and the integration of behavioural state information with neural data in naturalistic contexts.Conclusions:These advances highlight the potential of OP-MEG as a high-fidelity method for capturing the spatial and temporal dynamics of brain activity during natural movement. This opens new avenues for studying motor control in ecologically valid contexts, with broad applications across neuroscience and clinical research.Acknowledgements and funding:This work was funded by a Wellcome Technology Development Grant and supported by the Discovery Research Platform for Naturalistic Neuroimaging funded by the Wellcome.

P03-D-27 - Speed and handrail use shape cortical activity during treadmill walking: Implications for rehabilitation programs

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Walking on the treadmill is often used in gait rehabilitation. The use of treadmill handrails is debated, since it induces bad posture and prevents the natural stride, however it has been studied only from a behavioral view. In order to give new hints in this frame, we explored the cortical correlates of treadmill walking at different speeds, holding or not onto the handrails. Cortical activity was assessed with fNIRS in 24 healthy participants (27.0±6.3 y, 13 F). A box-car paradigm was designed, with 30 s of walking on a treadmill and 30 s of rest in an upright position. Participants walked in 4 randomized conditions (8 times each): the speed was set at 3 km/h or 5 km/h, and they kept their hands on the handrails (V3_HOLD and V5_HOLD conditions, respectively) or walked with a spontaneous swing of the arms (V3_no-HOLD and V5_no-HOLD conditions, respectively). During the rest blocks, they were asked to keep their hands on the handrails

or their arms along the body, according to the related task condition. Sixteen sources and 16 detectors formed 44 standard channels (3 cm) covering frontal, prefrontal, sensorimotor and parietal areas. In addition, 8 short-separation (SS) channels (8 mm) were used. Pre-processing of the fNIRS signal was performed through custom scripts based on Homer3 (spline and wavelet motion correction techniques; band-pass filter (0.01-3 Hz)). A General Linear Model was applied, regressing the most correlated SS channel signal to reduce the physiological noise. Oxy-hemoglobin (O2Hb) concentration changes of channels belonging to the same hemisphere and Brodmann's Area (BA) were averaged. Additionally, we assessed task-based BA-to-BA functional connectivity (FC). O2Hb concentration changes were influenced by task condition (Friedman's ANOVA with Bonferroni correction). Specifically, cortical activation elicited by the task in the no-HOLD condition was significantly higher at 5 km/h than 3 km/h in the left BA10, BA3 and BA39, and right BA10, BA9, BA8, BA3, and BA40. O2Hb concentration changes in the left BA40 were significantly higher at 5 km/h than 3 km/h, both in the no-HOLD and in the HOLD condition. The analysis of task-based BA-to-BA pairwise FC showed that the correlation value between L-BA10 and L-BA40 was statistically different: it was close to zero in the V3_HOLD condition, but it was very high (r=0.80) in the V5_no-HOLD condition. Speed (3 or 5 km/h) affects cortical activation during treadmill walking, and differences in activation between speeds are reduced when using the handrails. Also, stronger functional connectivity occurs at the higher speed and no handrails use. We suggest that speed and the use of handrails play a role in walking cortical activity patterns, thus they are key ingredients when planning a rehabilitation program. Treadmill-based walking rehabilitation often includes handrails for patient safety, but this alters cortical activation. These considerations should be taken into account when implementing rehabilitation treatments in people with neurological diseases, in favor of protocols based on comfortable speed but without holding.

P03-E-28 - Lower verbal fluency negatively impacts balance and gait variability and rhythm are predictive of fallers in fragile x-associated tremor/ataxia syndrome (FXTAS)

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Background and Aims: FXTAS is a neurodegenerative disorder characterized by cerebellar ataxia, tremor, and executive function (EF) deficits that negatively impact balance and gait and increase fall risk. Neurodegeneration in the cerebellum and cortico-cerebellar pathways in FXTAS interferes with both the automatic and volitional loops for posture and gait control. We aimed to examine the impact of EF on postural control (and gait) in individuals with FXTAS and whether they interact to predict falls.Methods: 33 Participants with FXTAS (68.5 ± 8.3 years; 64% men) and 48 age-matched controls (64.0 ± 10.5 years; 46% men) underwent balance and gait testing using an inertial sensor system (APDMTM). For postural sway, stance (feet apart/together), vision (eyes open/closed), surface stability (firm/foam), and cognitive demand [(single task (ST)/dual task (DT)] were manipulated in 30-s trials. Gait testing consisted of a 25-meter, 2-minute walk test at 1) self-selected speed (ST), 2) fast-paced (FP) speed and 3) dual task (DT) walking while performing a verbal fluency task (animal naming). A neuropsychological test battery measuring several domains of EF was administered. Participants were asked to self-report the number of accidental falls they had in the past year. Fallers were defined as having two or more falls in the past year. Correlations between cognitive variables and gait variables in the domains of pace, variability, rhythm, and gait phase cycle and postural sway variables [total sway area (TSA), jerk, and root mean square (RMS) sway] were first performed. Those significant variables following FDR corrections were then placed in a regression model controlling for age, sex, and years of education to examine differences between groups.Results: Lower controlled oral word association test (COWAT) scores, which measures phonemic verbal fluency, were significantly associated with greater total sway area (TSA), jerk, and root mean square (RMS) sway under numerous ST and DT sway conditions in the FXTAS group (p=0.023–0.0001), but not controls. No EF scores were associated with gait variables. Stride velocity variability during ST, FP, and DT, gait was significantly higher and cadence during ST gait was significantly lower in fallers than non-fallers in the FXTAS group. In the logistic regression model controlling for age, greater stride velocity variability during ST and FP gait and lower cadence during ST gait were significant predictors of fallers in FXTAS.Conclusions: Strong association between phonemic verbal fluency and several domains of postural stability (TSA, sway variability, jerkiness) in FXTAS suggests possible degeneration in shared neural circuitry critical for both balance and verbal fluency causes both motor and executive dysfunction in FXTAS. Higher gait variability and lower cadence might serve as markers to predict fallers in FXTAS.

P03-E-29 - Reducing falls risk post hip fracture in older adults with cognitive impairment: A randomized controlled trial

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BACKGROUND AND AIM: Falls are the cause~95% of hip fractures (HF) in older adults and are an important problem post HF. Exercise is an evidence-based falls prevention strategy. However, whether exercise prevents subsequent falls in cognitively impaired older adults post HF is unknown. Yet, cognitive impairment is a key risk factor for recurrent falls. We examined the effect of a home-based program of progressive strength and balance training exercises in reducing falls risk amongst older adults with mild cognitive impairment (MCI) who sustained a fall-induced HF. METHODS: A 6-month single-blinded randomized controlled trial amongst 60 adults aged ≥65 years with MCI (i.e. Montreal Cognitive Assessment scores < 26/30) who sustained a HF due to a non-syncopal fall in the past 12 months. Participants were randomized to: 1) a home-based

exercise program delivered by a physical therapist in addition to standard of care provided by a geriatrician (EX; n=30); or 2) standard of care alone (CON; n=30). The primary outcome was the Physiological Profile Assessment (PPA). Secondary outcomes included processing speed and verbal memory. We followed the intention-to-treat principle and used linear mixed models with restricted maximum likelikhood estimation to assess between-group difference in PPA. RESULTS The mean age was 80 years and 75% were females. The mean Montreal Cognitive Assessment score was 21.25 (SD=3.0) and the mean baseline PPA was 2.64 (SD=1.26). At trial completion, EX participants had significantly lower PPA score compared with CON (estimated mean difference: -0.73; 95% CI: [-1.45, -0.11]; p= 0.048); EX also significantly better verbal memory (estimated mean difference: 1.11 words; 95% CI: [0.14, 2.09]; p= 0.025). CONCLUSIONS: Home-based progressive strength and balance training exercises show promise in reducing falls risk and promote cognitive function after a fall-induced HF amongst older adults with MCI. FUNDING: Funding was provided by Amgen.

P03-F-30 - Eye-opening insights into postural sway and cognitive load

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BACKGROUND: It is widely recognized that engaging in a cognitive task affects postural control. However, the influence of posture on cognitive performance is less well-documented. This study aimed to determine the effects of posture on cognitive performance and cognitive effort, as measured by pupillary response, in healthy, middle-aged adults. METHODS: Fifteen participants (mean age: 61.7 years (11.3 SD); 5 males/10 females) performed auditory N-back tests (i.e. 1-back and 2-back) while seated and standing. During the task, participants were presented with a sequence of letters one at a time and were required to determine whether each letter matched the one presented n steps earlier in the sequence. Changes in pupil diameter as a natural response of the eye to cognitive effort were recorded using infrared eye-tracking glasses (Tobi Pro Glasses 2). During the standing tasks, postural sway was measured using an inertial measurement unit (APDM OpalV2) placed on the lumbar region. Outcome measures included root-mean-square (RMS) sway, jerk, and changes in pupil diameter and response accuracy across conditions. RESULTS: Pupil diameter increased significantly with task difficulty, particularly in the seated condition. When participants were seated, pupil diameter significantly increased with higher task difficulty, indicating higher cognitive load. A comparison of pupil diameter during match and no-match stimuli (Figure), did not provide evidence that pupil diameter significantly increases during a match compared to a non-match response across posture or cognitive load conditions. Enhanced Response Accuracy was observed for the higher cognitive load condition (2-back trials) when participants performed the test in a standing posture compared to the sitting position ($p < 0.001$). We found no significant differences in RMS sway or Jerk values in the AP direction across cognitive load conditions ($p > 0.05$). However, in the ML direction, there was a significant effect of the cognitive task on both RMS sway and Jerk values. CONCLUSIONS: While postural sway was largely unaltered by cognitive load, response accuracy increased during the standing trials despite decreased cognitive effort (i.e., pupil diameter). This suggests that a standing posture may facilitate the achievement of cognitive activities. Figure Caption. Pupil diameter response during a match versus non-match stimulus in the 1-back condition, comparing sitting and standing postural tasks.

P03-F-31 - Cognitive functioning and falls in older people: A systematic review and meta-analysis

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Background and aim: Impaired cognition has been identified as a risk factor for falls in older people, however it is unclear which specific cognitive functions are most strongly associated with fall risk. This study aims to identify which cognitive functions and specific neuropsychological assessments predict falls in older people living in the community.Methods: Five electronic databases were searched until 30/08/2022 for studies assessing the association between specific cognitive functions and faller status (prospectively and retrospectively determined), in community-dwelling older people. The Newcastle-Ottawa Scale was used to assess risk of bias for each study. Meta-analyses synthesised the evidence regarding the associations between each different neurocognitive subdomains and faller status. Results: Thirty-eight studies (2017 retrospective, 1821 prospective) involving 37,101 participants were included (Figure 1). Most studies were rated high or medium quality. Meta-analyses across 11 neurocognitive subdomains and four specific neuropsychological tests were performed. Poor cognitive flexibility, processing speed, free recall, working memory and sustained attention were significantly associated with faller status. Poor verbal fluency, visual perception, recognition memory, visuo-constructional reasoning and language were not significantly associated with faller status. The Trail Making Test B was found to have the strongest association with faller status.Conclusions: Poor performance in neurocognitive subdomains spanning processing speed, attention, executive function and aspects of memory are associated with falls in older people, albeit with small effect sizes. The Trail Making Test, a free-to-use, simple assessment of processing speed and mental flexibility, is recommended as the cognitive screening test for fall risk in older people.Acknowledgements and Funding: We acknowledge the assistance of Maria Teresa Espinoza Cerda, Carmen Herrera Arbona, Beatriz Herrero Pinilla, Paula Santiago Martinez, Nigel Seng, Natassia Smith and Jasmine Menant.

P03-F-32 - High trait balance vigilance is associated with maladaptive changes in perceptions of stability and postural control in community-dwelling older adults

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BACKGROUND AND AIMIn older adults, dizziness is often experienced as a vague feeling of subjective unsteadiness, where people perceive themselves to be swaying more than they are. One factor that potentially drives such distorted perceptions of instability is (hyper)vigilance towards balance. This study aimed to investigate if older adults who report higher levels of trait balance vigilance (i) are more likely to report sensations of general unsteadiness when their balance is acutely threatened, and (ii) if this is accompanied by maladaptive changes in postural control.METHODSForty-eight healthy older adults without vestibular diagnosis (Mean age = 71.0, range = 60–83) completed the Balance-Vigilance Questionnaire to quantify trait balance vigilance. Participants were fitted a VR headset and completed 60-second, narrow-stance balance trials on a force platform, under conditions designed to create a threatening (20-meter virtual height) or non-threatening (virtual ground level) environment. For each condition, we assessed self-reported stability (0-100%) and fear of falling (0-100%), postural control (sway amplitude and frequency), muscular control (tibialis anterior activity), and cortical activity using functional near-infrared spectroscopy (fNIRS). RESULTSPreliminary results are reported. When presented with a postural threat, high-vigilant older adults (Balance Vigilance Score≥18; N=13) reported significantly greater fear of falling (+25%; p=.027) and more reduced perceived stability (-25%; p=.006) compared to low-vigilant older adults – despite there being no differences in actual sway amplitude (p=.157). Only the low-vigilant group showed evidence of an adaptive ‘stiffening’ strategy in response to threat: i.e. increased sway frequency (p=.028) and tibialis anterior activity (p=.027). fNIRS analysis is ongoing, but will involve the comparison of activity in the left dorsolateral prefrontal and primary sensorimotor cortex between threat and non-threat conditions.CONCLUSIONSPreliminary findings suggest that, in response to a postural threat, older adults with high balance-vigilance are more likely to experience excessive fear of falling and perceptions of instability, and may fail to make adaptive changes to their postural control. Screening for excessive balance vigilance may therefore be recommended.ACKNOWLEDGEMENTS AND FUNDINGThis project was funded by Brunel's College of Health, Medicine and Life Sciences' Research Initiative and Enterprise Fund (BRIEF).

P03-F-33 - Medial lateral separation and age determinants on collision avoidance behaviours

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Background: Navigating environments is an essential part of our daily lives and it is rare that navigation only occurs with inanimate objects, such as poles or benches. Often, navigation occurs between people, making collision avoidance an important task. Collision avoidance behaviours are influenced by situation-specific factors (i.e., environment layout), but whether person-specific factors (i.e., age of interferer) impact collision avoidance behaviours are inconclusive. Recently, studies demonstrated that person-specific characteristics such as an interferer's body size, (age) appearance, and/or gait profile can impact one's collision avoidance behaviours during circumvention tasks. The aim of the current study was to determine whether avoidance behaviours with an approaching virtual pedestrian (VP) are affected by the appearance of the VP. Methods: Twelve young adults (8 female, 4 male; 21.2 ± 0.39 years; 175.4 ± 10.0 cm) were immersed into a virtual reality environment (VE) using an HTC Vive Pro 2 head-mounted display. The VE consisted of an 8 m x 3.4 m pathway with one of two different VPs (a younger or older looking adult) located at the opposite end of the pathway. The VP's starting position was located at one of 17 different medial-lateral (ML) points, ranging from -0.4m to 1.2m, in 0.1m increments, relative to the midline of the path. Participants were instructed to walk towards the end of the pathway while remaining on the path and only deviate if they felt that they were going to collide with the approaching VP. The primary dependent variable was the participant's ML clearance, which is the greatest change in ML position at time of crossing from their starting position.Results: The findings revealed a significant main effect of VP position ($p = <.001$, $\eta^2p= 0.834$), indicating that ML clearance at time of crossing differed depending on the ML position of the VP. The point at which the participants felt they needed to deviate from their original path in order to avoid collision with the approaching VP was when it was located 0.3m or less from the midline of the path (Figure 1). Results also demonstrated that the appearance of the VPs did not affect the magnitude of ML clearance ($p = .41$, $\eta^2p = 0.064$). Conclusion: The appearance of a VP alone may not be enough to impact one's collision avoidance behaviours. It is possible that when people are interacting with an approaching pedestrian, they may be more perceptive of and affected by other person-specific characteristics, such as walking profiles.

P03-F-34 - Identifying modifiable predictors of balance discordance in Parkinson's disease: Implications for fall risk reduction

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Background & Aim: Balance discordance, the alignment or malalignment between actual and perceived balance, is related to retrospective fall history in Parkinson's disease. Therefore, it may be an intervention target to reduce fall risk. The purpose of this study is to identify potentially modifiable factors that are related to balance discordance. This information would inform clinical trials aimed at improving such factors, with the ultimate goal of reducing falls in this population. Methods: A secondary analysis of data from 186 individuals with PD from 2 different studies was completed. Data extracted included demographics (age, sex), disease severity (disease duration, Hoehn & Yahr Scale), daily habitual physical activity (PA) levels as captured via 7 consecutive days of actigraphy (steps/day, sedentary time, time in moderate to vigorous PA) perceived health status (from EuroQol-5D Visual Analog Scale), cognitive ability (Trail Making Test B, Montreal Cognitive Assessment), balance ability (Mini-BESTest (MBT), Timed Up and Go), perceived balance (Activities-specific Balance Confidence scale (ABC)), anxiety and depression (Hospital Anxiety and Depression Scale (HADS)), and quality of life (EuroQol-5D total). Pearson correlational analyses and ridge regression, with subsequent general linear model testing, were conducted to explore the relationship between these variables and balance discordance.Results: Discordance was more strongly related to ABC ($r=0.97$, $p<0.001$) than MBT ($r=0.26$, $p<0.001$) or TUG ($r=0.02$, $p>0.05$)Additionally, EQ5D-VAS ($n=186$, $r = 0.46$, $p<0.01$), depression ($n=88$, $r = -0.47$, $p<0.01$) and anxiety ($n=87$, $r = -0.37$, $p<0.01$), measured via the anxiety and depression subscales of the HADS, were related to discordance. PA metrics were weakly related to balance discordance ($|r|\leq 0.13$). Following ridge regression, the final model accounted for 27.11% of the variance in discordance. This model included only EQ5D-VAS ($\beta = 0.529$, $p < 0.001$) as a predictor of discordance.Discussion/Conclusions: Balance discordance, while comprising the alignment between balance perception and ability, appears to be more strongly related to balance confidence than balance ability. Additionally, perceived health was uniquely and strongly related to balance discordance in PD. In combination, this seems to suggest that shared perceptual constructs may be driving factors behind discordance and its associated fall risk in people with PD. Beyond perception, anxiety and depression were also moderately related to balance discordance and may be potential intervention targets. Surprisingly, PA was only weakly related to discordance. Clinicians should consider these factors when intervening to modify the alignment between balance ability and balance confidence, with the goal of reducing fall risk, maximizing physical engagement, and enhancing quality of life.Acknowledgements/Funding: This study is supported by grants from the Swedish Research Council (2022-00636, 2016-01965), the Swedish Parkinson Foundation as well as the Center for Innovative Medicine (CIMED) (FoUI-975387 and FoUI-973826), the Regional Agreement on Medical Training and Clinical Research (ALF)(RS2021-0855) between Karolinska Institutet and Region Stockholm, and NIH grant No. R25HD105583-03. Further funding was provided by the Augusta and Petrus Hedlunds Stiftelse and Gun und Bertil Stohnes Stiftelse.

P03-F-35 - Measured and perceived body tilt during stance and gait in patients with persistent postural perceptual dizziness (PPPD): Vibro-tactile biofeedback training reduces measured and perceived body tilt

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Background: Patients with persistent postural perceptual dizziness (PPPD) report a disabling discrepancy between their perceived and actual body movements. Therefore, for focused treatment, we searched for efficient markers of PPPD. We explored first, whether linear regressions between amplitudes of these two types of body movements could indicate significant differences between PPPD patients and healthy controls (HCs). Secondly, we sought evidence that these differences existed more for trunk pitch than roll movements. Thirdly, we investigated whether regression parameters could be improved by providing balance training with artificial sensory feedback signals of trunk sway, thereby resulting in a reduced sensory misconception of body tilt. Methods: 10 PPPD patients (age range 29 to 67) and 10 age-matched HCs were studied. Lower trunk pitch and roll sway at L2 were measured with a SwayStarTM system for 14 stance and gait tasks. For 3 stance tasks (eyes open on a firm and on a foam surface, eyes closed on a foam surface) and 2 gait tasks (walk 8 tandem steps, and walk 3m while rotating the head in yaw) subjects were asked, while standing eyes open, to replicate their peak-to-peak roll and pitch trunk sway that occurred in the previous trial. The resulting amplitudes of trunk sway were used to represent "measured" and "perceived" sway, respectively. To improve balance control, PPPD patients received vibro-tactile balance feedback (VT-fb) training 2x a week for 2 weeks using 11 of the 14 balance tasks. Balance was tested 3 times (without feedback): before training and after 1 and 2 weeks of training, yielding new "measured" and "perceived" sway values. The trunk sway thresholds for VT-fb were task specific. Thresholds were reset after 1 week of training. Before measurement sessions, subjects completed the Dizziness Handicap Inventory (DHI). Results: DHI mean scores decreased by 28% over the 2 weeks of VT-fb training. Perceived trunk sway decreased by 35%. At onset of VT-fb training, most (14 out 20) sway variables from PPPD patients had mean "measured" and "perceived" amplitudes greater than those of HCs. After 2 weeks of VT-fb training, PPPD patients had mean amplitudes greater than those of HCs for 7 out of 20 variables. The slope relationship between mean measured and perceived amplitudes was approximately 0.3, and similar for pitch and roll for PPPD and HCs. However, the intercept values were 6x larger for pitch and roll in PPPD subjects compared to HCs. Conclusions: These results indicate that measured and perceived trunk sway of PPPD patients during stance and gait is greater than HCs but can be reduced with VT-fb training. The greatest difference with respect to HCs occurs for pitch standing eyes closed on foam and walking tandem steps suggesting that measures from these tests may serve as markers for PPPD. The relationship between measured and perceived sway is dominated by large pitch and roll offsets in PPPD patients.

P03-F-36 - The attentional demands of backwards locomotion

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Background and aimLocomotion is nearly always performed in a forward direction (forward walking; FW). But sometimes backward walking (BW) is also employed, e.g., as a training modality in sports and rehabilitation contexts. Healthy humans are able to perform BW, but at the expense of extra sensorimotor and cognitive resources. This study tried to assess the attentional requirements of BW using a cognitive-motor dual-task (DT) paradigm. A secondary aim of this study was to try to replicate a previous study (Shapiro et al., 2022) that first made use of this paradigm, so that we could assess how robust and generalizable their findings were.Methods.37 healthy participants walked on a treadmill, either FW or BW, at a self-selected comfortable speed. During locomotion they performed various cognitive tasks: (1) Random number generation; this involved uttering numbers between 1 and 30 in a random order. (2) In another block participants performed an auditory N-back task (both 2 and 3 back). A seated condition (baseline) was also added. All responses were given verbally, so as not to interfere with the biomechanical control of gait. We hypothesized that BW would result in less randomness of the RNG (as quantified by sample entropy) and in more errors during the N-back tasks, all relative to the easier FW condition.We also collected kinematic data of foot placement using Optotrak. This allowed us to calculate parameters such as step width, stride length, percentage double support, and measures related to variability.ResultsAs expected, self-selected gait speed for FW was much faster than with BW (5.2 vs 3 km/h). Sample entropy values did not vary according to walking direction. For the N-back task performance was somewhat better during FW compared to seated, possible reflecting more arousal. For the gait data we found that step width was significantly more variable for the RNG task compared to other tasks. Other parameters showed little effect of task complexity.Conclusions.This is one of the few studies that examined the attentional demands of backward walking. Even though BW was much slower than FW, we found little evidence for cognitive-motor interference. The adopted task (RNG) and entropy measure is likely not suited in this type of paradigm. Also, we could only collect accuracy data in the N-back task, that was characterized by low variability and a ceiling effect. We could not record response times which are arguably more sensitive. Our results are partially in line with the paper of Shapiro et al. (2022) and shed further light into the cortical control of backward walking. Reference:Shapiro, M., Shaki, S., Gottlieb, U., & Springer, S. (2022). Random walk: Random number generation during backward and forward walking- the role of aging. Frontiers in aging neuroscience, 14, 888979.

P03-F-37 - Exploring the relationship of behavioral regulation with freezing of gait

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Background: Freezing of gait (FOG) occurs when individuals with Parkinson’s disease (PD) experience an unexpected and unintended cessation in their walking. While its precise mechanisms remain unclear, FOG has been linked to psychological and cognitive factors, such as anxiety and response inhibition, which can exacerbate FOG. The Behavioral Inhibition System (BIS) and Behavioral Activation System (BAS) are two brain-behavioural systems, described in Reinforcement Sensitivity Theory, which explain individual differences in responses to punishment and reward, underlying traits like anxiety. BIS is classically thought to organize behaviour in response to novelty, punishment or non-reward (avoidance behaviour) and has been linked to anxiety, caution and sensitivity to negative outcomes. In contrast, BAS is associated with extraversion, exploration, novelty-seeking and reward dependence. To date, no studies have explored the relationship between the BIS/BAS and FoG. It is hypothesized that individuals with FOG will report higher anxiety levels and increased BIS sensitivity compared to non-freezers. Aim: The primary aim is to compare BIS/BAS subscale scores between PD individuals with and without FoG. A secondary aim is to correlate FoG severity with BIS/BAS scores. Methods: Forty-eight individuals with PD from the four-year Ontario Neurodegenerative Disease Research Initiative study, who participated in affective and motor severity assessments, were included. Non-freezers (n=36) reported no FoG (score of 0) on question 3 of the FoG-Questionnaire (FOG-Q). Freezers (n = 12) reported FoG at the baseline visit. Clinical features were examined at baseline and 1-year follow-up. Neuropsychiatric assessments included the Generalized Anxiety Disorder (GAD7) scale, and BIS/BAS scale, scored on a 4-point Likert scale, assessing sensitivity to punishment (BIS) and reward-driven behaviors (BAS subscales: Drive, Fun, Reward). FoG severity was evaluated using the total score on the FoG-Q. Results: The Non-freezers (27 males, 9 females) and the Freezers (11 males, 1 female) were matched in age, disease duration, and UPDRS-III. The Freezers had significantly higher Hoehn and Yahr stages ($p = 0.023$) and lower MoCA scores ($p = 0.002$). However, there were no between-group differences found in BIS ($p = 0.862$) nor BAS subscales (Drive, Fun, Reward) (all $p \geq 0.4$). No significant correlation was found between BIS and GAD in Freezers (τ=-0.465, p=0.057) or Non-Freezers (τ=-0.108, p=0.397). Additionally, no significant correlations were reported between FoG and BAS subscales (all $p \geq 0.6$). A negative correlation was found between FoG severity and BIS scores ($r = -0.613$, $p = 0.034$). Conclusions: Greater FoG severity was significantly associated with lower BIS scores, suggesting reduced behavioral inhibition in severe FoG cases, while no differences in BIS/BAS sensitivity were observed between Freezers and Non-freezers

P03-F-38 - Dual-task interference with cortical activation and gait control in Parkinson’s disease: An exploratory pilot study

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Background and aim: Parkinson’s disease (PD) limits the capacity to allocate cortical resources during multi-competencies task performance. The Dual-task (DT) paradigm allows to assess the interference effect of cognitive demands (mainly in the frontal brain) on concurrent gait (motor) behavior. DT affects gait to a problematic extent in people with PD (PwPD), but the underlying cortical mechanism remains poorly explored. This pilot study explores the DT effects on cortical activity, gait metrics and the correlations between them. Methods: PwPD (n = 9, age: 54-77 years, 4F, UPDRS-3: 21.7±12.3, OFF-medication) walked in a 12m corridor in single task (ST, walking) and DT (walking + arithmetic calculations) conditions. Gait metrics and cortical activation were assessed using IMUs sensors and a 32-channel electroencephalogram system, respectively. Gait metrics (i.e., normalized stride length, stride velocity, and duration, swing and stance duration, and cadence) were analyzed. Additionally, Power Spectral Density (PSD) was computed for the alpha (α, 8-13 Hz), beta (β, 14-30 Hz), and gamma (γ, 30-50 Hz) bands considering the channels (average) in the Frontal (Fz, F3, and F4), Central (Cz, C3, and C4), Parietal (Pz, P3 and P4), and Occipital (O1, O2, and O3) brain regions. These analyses were performed for stride-locked segments during both DT and ST conditions (equal number of strides). ST vs. DT were compared via Wilcoxon signed-rank. DT cost ([DT – ST]/ST) for the PSD and Gait metrics were correlated. Cohen's d for T-tests and rho for Spearman were computed, and only effects ≥ moderate (> 0.5 and 0.4, respectively) were reported. Results: Under DT vs. ST, participants indicated walking with lower PSD in the α, β, and γ bands of the Central region (Fig.1a), stride length, swing duration, and stride velocity, and with increased stance and stride duration (d > 0.5). For correlation (Fig. 1b), DT cost in stride length strongly correlated with DT cost in α, β, and γ PSD in Frontal (rho > 0.65). DT cost in velocity moderately correlated with cost in α band in Occipital (rho > 0.53). DT cost in Stance duration, and Cadence correlated inversely with α and γ bands of the Occipital and Parietal regions (rho > - 0.43), respectively. DT cost in stride duration inversely correlated with costs in α and β bands of Frontal and Central regions (rho > - 0.45), and γ band of Central (rho = -0.7). Conclusion: This exploratory study indicated that DT interferes with gait performance, accompanied by a reduction in the Central cortical involvement. Although frontal cortical involvement correlates (moderately to strongly) with longer and faster strides and slower duration, those results may be spurious since virtually no differences occur in frontal PSD between ST and DT. Acknowledgments: IDOR/Pioneer Science Initiative [(www.pioneerscience.org)] and Israel Science Foundation (ISF, # 1657–16).

P03-F-39 - The effects of anxiety and cognitive load on freezing of gait in Parkinson's disease

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Background and aim: Freezing of gait (FOG) in Parkinson's disease (PD) can worsen under stressful conditions, suggesting that anxiety may exacerbate FOG by loading the limbic circuitry. However, it is currently unclear whether and how this interacts with cognitive distraction. Further, effects of anxiety on FOG may be modulated by the type of threat (i.e. FOG or non-FOG directed) or by an oversensitivity to anxiety. Therefore, we determined the interaction between anxiety (FOG and non-FOG threat induced) and cognitive load on FOG-related gait breakdown and whether this differs between freezers, non-freezers and

healthy controls during a FOG-provoking protocol. Methods: We compared the Freezing Ratio (FOGratio) obtained from wearable sensors during a FOG-provoking task in 28 freezers, 19 non-freezers and 19 controls, without (SAFE) and with anxiety and cognitive load. Further we compared the perceived anxiety on a visual analog scale in all conditions. Anxiety was induced using a non-FOG related threat of shock (TOS) paradigm, as well as an exploratory threat of freezing (TOF) condition using sham FOG-provoking braces. TOS settings were personalized to the uncomfortable but not painful threshold. Cognitive load was manipulated with an auditory dual task (DT). Linear mixed models with Tukey corrected post-hoc tests were used.Results: Groups were age-matched (68yrs; p=0.52), but freezers had longer disease duration, higher disease severity and lower cognitive scores compared to non-freezers. The FOGratio was higher in freezers than in non-freezers (p=0.021) and controls (p<0.001) irrespective of condition. Perceived anxiety was overall also higher in freezers compared to controls (p=0.001), but not compared to non-freezers (p=0.19). We observed that imposing a DT, TOS or DT+TOS increased the FOGratio in a similar manner in all groups (p=0.04). In contrast to the TOS, the TOF did not worsen the FOGratio and even induced less perceived anxiety. These effects were similar across groups. Conclusions: Both anxiety and cognitive load increased the FOGratio during a FOG-provoking protocol, but combining them had no cumulative effect. Freezers had higher perceived anxiety but were not oversensitive to it. Furthermore, the type of threat modulated FOG differently, possibly because TOS settings induced higher levels of anxiety than the sham TOF. Alternatively, the threat of shock may have diverted attention away from gait, in a similar manner as DT does, whereas the threat of FOG likely redirected attention towards gait.

P03-F-40 - Height-induced postural threat modulates spinal excitability of the lower-limb muscles: A transcutaneous spinal cord stimulation study

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ACKGROUND AND AIM: Fear of falling is a critical factor that worsens human standing balance. Exposure to elevated surfaces can induce postural threat, which is widely used to investigate the underlying neural mechanisms. During quiet standing, the spinal cord plays a crucial role in balance control. While it has been reported that spinal excitability of the soleus muscle, evaluated by using H-reflex, is less affected by postural threat, it is unclear whether this also applies to other lower-limb muscles. Considering that postural threat increases supraspinal-driven responses in multiple lower-limb muscles, spinal excitability of these muscles might be influenced by descending commands. This study aimed to examine the effects of postural threat on spinal excitability of lower-limb muscles. METHODS: Eleven healthy males (19–38 yr) participated. Participants stood on firm surfaces while experiencing virtual reality (VR) through a head-mounted display for 90 s. Postural threat levels were manipulated by combining real (ground or 0.7 m desk)

and VR (ground or 7 m bridge) environments, resulting in three conditions: (1) low-threat(real ground × VR ground), (2) medium-threat(real 0.7 m desk × VR ground), and (3) high-threat(real 0.7 m desk × VR 7 m bridge). During the task, 15 transcutaneous spinal cord stimuli (tSCS) were applied to the lumbar region at 6-s intervals to elicit spinal reflexes in lower-limb muscles. Electromyograms (EMG) were recorded from six muscles of the right leg: vastus medialis, biceps femoris, tibialis anterior, soleus, medial gastrocnemius, and lateral gastrocnemius muscles. Background EMG was calculated by rectifying and averaging the EMG amplitude over 100 ms immediately before tSCS. Spinal excitability was quantified as the peak-to-peak EMG amplitude induced by tSCS. For each condition, the 15 background EMG and spinal reflex amplitudes for each muscle were averaged.RESULTS: Background EMG did not significantly differ among conditions for all muscles (all $p > 0.05$, Wilcoxon signed-rank test with false discovery rate correction). Regarding the spinal excitability, the tibialis anterior muscle showed significantly larger spinal excitability in the high-threat condition compared to the low-threat condition (mean±SD: 116.9±27.5 [%low-threat], $p = 0.041$). However, for all other muscles, spinal excitability was not significantly different among conditions (all $p > 0.05$).CONCLUSIONS: Our results suggest that postural threat increases spinal excitability of the tibialis anterior muscle, implying the strategy enabling immediate ankle stabilization. These findings provide fundamental insights for improving standing balance in individuals with fear of falling.

P03-G-41 - Mechanical support rather than sensory feedback is required to resolve differences in postural sway between traumatic unilateral transtibial prosthesis users and unimpaired age- and sex-matched adults

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Background: The loss of peripheral sensorimotor function and reorganization of central sensorimotor processing after lower limb amputation may contribute to lower limb prosthesis (LLP) users' elevated postural sway.1,2 LLP users may attempt to minimize the impact of their sensory and motor deficits on postural sway by seeking out intermittent contact with external surfaces for additional sensory feedback and/or mechanical support.3 The extent to which supplementary sensory feedback or mechanical support may resolve LLP users' elevated postural sway remains unknown. The objective of this study was to determine if sensory feedback from light touch or mechanical support from heavy touch is sufficient to resolve differences in quiet stance postural sway between traumatic unilateral transtibial prosthesis users (TTPU) and unimpaired age- and sex-matched adults. Methods: 11 unilateral TTPUs and 11 unimpaired age- and sex-matched adults (i.e., matched controls) participated in the study. Participants performed three 70-second trials of three quiet stance tasks: no touch (NT), light touch (LT), and heavy touch (HT).4Participants performed NT trials with their arms crossed over their chest. In LT trials participants lightly touched (< 1N) the surface of a force sensor with the tip of their index

finger.5 Participants applied a force as large as desired (> 5N) during HT trials. Ground reaction forces, collected at 1200Hz and low-pass Butterworth filtered at 10Hz, were used to calculate the net anterior-posterior (AP) and medial-lateral (ML) center-of-pressure (COP) trajectories. Postural sway was quantified by the mean velocity of the net AP and ML COP trajectories, with larger mean velocity indicating greater postural sway.6 Results: A Hotelling's T2 test identified a significant difference in COP mean velocity between TTPU and matched controls (F(2,19)=4.9, p=0.019). Post hoc tests revealed that net ML but not AP COP mean velocity was significantly greater in TTPU than matched controls (ML: TTPU=1.7 mm/s, CONT=1.2 mm/s, F(1, 20)=7.9, p=0.011; AP: TTPU=7.5 mm/s, CONT=5.9 mm/s, F(1, 20)=3.8, p=0.06). 1-sided independent sample t-tests adjusted for multiple comparisons revealed that only HT resolved the significant differences in net ML COP mean velocity between groups (LT: TTPU=1.6 mm/s, CONT=1.2 mm/s, t(20)=1.88, p=0.038; HT: TTPU=1.4 mm/s, CONT=1.2 mm/s, t(20)=1.01, p=0.16). Conclusion: The success of HT mediated mechanical support and the failure of LT mediated sensory feedback to resolve TTPUs' elevated postural sway suggests a mechanical rather than sensory basis for this balance-related deficit. The development and testing of clinically feasible interventions that provide, restore, or augment mechanical support may address TTPUs' increased postural sway. Research to determine the ability of sensory feedback versus mechanical support to improve other balance domains in TTPU is warranted. References: [1] Kavounoudias et al., 2005; [2] Liao et al., 1995; [3] Murray et al., 1969; [4] Duarte et al., 2010; [5] Oshita et al., 2015; [6] Prieto et al., 1996.

P03-G-42 - Exploring the effect of focus of attention on COP parameters: Virtual reality versus real world environment

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Background and Aim Postural control is a complex sensorimotor function that integrates vestibular, somatosensory, and visual inputs within the nervous system to maintain balance. The dynamics of the center of pressure (CoP) are analyzed to elucidate the complexity of the postural control system. Alterations in postural control have been observed in response to instructions that direct attentional focus. Studies suggest that due to variations in sensory inputs and task requirements, virtual reality (VR) imposes distinct challenges to postural control compared to the real world (RW). The present exploratory cross-sectional study aimed to investigate postural control by manipulating attentional focus in VR and to compare with RW. Methods Forty-two healthy university students (females: n=31) between the ages of 18 and 26 were included to either VR group (mean age: 22.05±1.68 years; females: n=13) or RW group (mean age: 22.05±1.68 years; females: n=18) for postural control asssessment. Both groups performed single leg stance tests on the posturographic platform while the CoP parameters were being recorded. All participants completed the test under randomly assigned attentional focus instructions (internal, external, or neutral), with a 10-minute rest interval between each. The volunteers were excluded if they: (1) had a VR experience, (2) had positive result for Fukuda Step Test, and (3) experienced motion sickness while wearing the VR glasses. Results In VR group, the lowest means for all the CoP parameters were observed for external focus whereas the highest means for internal focus. However, no statistically significance was found for the difference between three instructions in terms of CoP parameters ($p>0.05$). Under the all attentional focus instructions, total displacement (X) and velocityx ($p<0.0001$), mediolateral displacement (ML) and velocityML ($p<0.0001$), anteroposterior displacement (AP) and velocityAP ($p<0.001$), and the surface ($p<0,002$) for CoP displacement were found significantly greater in VR group according to RW group ($p<0.001$). Conclusions Our findings demonstrate that manipulating attentional focus of healthy adults with instructions (internal, external, or neutral) did not produce statistically significant differences in CoP parameters in VR. However, the VR environment was associated with significantly greater CoP displacement and velocity across all directions (mediolateral, anteroposterior, and total), as well as increased surface area, compared to the RW group under all attentional focus conditions.

P03-G-43 - Children and adults have different neuromuscular coordination strategies of lower limb muscles during gait

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Background and aimHuman gait is an integral part of daily life and requires a well-organised activation of multiple muscles to coordinate movements of the lower limbs. Quantifying this coordination is essential in our understanding of fundamental movement control. While previous work has quantified muscle synergies of children during gait1, the ‘non-negative matrix’ technique applied assumes that all muscle activations positively contribute to a measured movement. This is problematic since excitatory input during one part of a movement must be balanced by inhibitory input at other points to ensure smooth movements are achieved. To overcome these methodological issues, a principal component analysis (PCA) can provide both positive (excitatory) and negative (inhibitory) loading scores2, providing greater insight into the neuromuscular control strategies used during gait. Thus, the aim of this study was to compare the neuromuscular coordination patterns of lower limb muscles during gait between children and adults, using principal component analysis. MethodsSurface electromyography (sEMG) of eight lower-limb muscles of the right leg were recorded during gait from ten children (10±2yrs; 1.37±0.19m; 36±4kg) and ten young adults (22±1yrs; 1.78±0.09m; 76±10kg). Participants walked in shoes at their self-selected normal walking speed until a minimum of 30 gait cycles were recorded. Neuromuscular coordination patterns were then identified using principal component analysis. Preliminary analyses are presented from a subset of children (n=3) and adults (n=3).ResultsAverage walking speed was similar between children and adults (1.30±0.08

vs. 1.33±0.08m·s-1; p>0.05). In both groups, seven principal components (PCs) explained ≥95% of the variability in the sEMG dataset. PC1 explained 27-28% of the respective coordination patterns, however in children this was predominantly excitatory control, whereas in adults this was predominantly inhibitory control of most lower limb muscles (Fig. 1). Similar general coordination patterns of most muscles were then observed in PC2 and PC4 between groups, except in the vastus lateralis and tibialis anterior (PC4; Fig. 1).ConclusionsPreliminary analyses indicate that the predominant neuromuscular coordination strategy (PC1) adopted during gait is different between children and adults, while less prominent strategies (PC2, PC4) show more similarity. This may indicate that while general gait parameters are considered to reach maturity by ~7-8yrs3, the underlying neuromuscular coordination strategies may not reach full maturity until later in the growth and development process. If true, this may have implications for assessing mechanisms of movement impairment in children. However, future work is required to determine the age at which these strategies reach full maturity.

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P03-G-44 - Impact of support surface characteristics on postural sway during standing

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Background and Aim: Various types of support surfaces are used to evaluate balance control[1]. Foam pads are effective for challenging somatosensory input during standing and different foam pad properties may influence balance performances[2]. However, foam pads are less suitable for dynamic tasks like gait. In such cases, insoles could serve as an alternative. Until now, most research focused on the balance-enhancing effects of insoles, rather than on their capacity to challenge the somatosensory system[3]. Therefore, this study aimed to measure the effects of foam pads and insoles with varying densities on postural sway in bipedal and unipedal stances. Methods: Five different support surfaces were evaluated: a) a blue foam pad (48x40x6 cm/Airex®, Switzerland), b) a gray foam pad (40x33x5 cm/Jianzhongxidianzishangwu Co., Ltd., China), c) an insole made from the blue foam (2cm), d) an insole made from the gray foam (2cm), and e) a firm surface. The characteristics of the support surfaces were evaluated using the Indentation Force Deflection (IFD) Test and density calculations. The densities of blue and gray foam were 66.0 kg/m^3 and 41.2 kg/m^3, respectively. IFD testing showed Young's modulus was 76.78 N/m^2 for blue foam and 244.45 N/m^2 for gray foam, indicating the blue foam was softer. Then, healthy young adults (n= 20, 26.7± 3.3 years, 70% female) without any comorbidities were recruited and were asked to stand on the support surfaces in a random order. Center of pressure (CoP) data were collected using K-force plates® (Kinvent®, Montpellier, France) during 30-second trials of bipedal and unipedal stances (dominant leg). The CoP area was calculated using the 95% confidence interval ellipse area. Results: During bipedal stance, significant differences in CoP area were found between the different support surfaces (p<0.001). More specifically the CoP area was significantly larger while standing on blue foam (Z=2.817, p=0.005), gray foam (Z=2.199, p=0.028), and gray insole (Z=2.455, p=0.014) compared to on firm surface. Furthermore, there was no significant difference between the blue foam and gray insole (Z=-1.067, p=0.286). However, the CoP area significantly differed in blue insoles in comparison to blue foam pads (Z=-3.157, p=0.002) (Figure 1). No significant difference was found in the unipedal stance trials (p=0.116), and posthoc analysis did not reveal any differences between the unipedal conditions (p>0.05 for all).Conclusions: While no significant differences were observed in the unipedal stance, comparisons of different support surfaces during the bipedal stance showed that both foam pads and gray insoles produced a significant perturbation effect on postural sway. These findings suggest that blue foam pads, commonly used to evaluate balance control during standing, could potentially be replaced by gray insoles to assess balance control during more dynamic tasks such as gait, given their similar effect in unipedal stance as well.Keywords: Postural balance, Posturography, Foam, and Proprioception. References[1] Chaikeeree N, Saengsirisuwan V, Chinsongkram B, Boonsinsukh R. Interaction of age and foam types used in Clinical Test for Sensory Interaction and Balance (CTSIB). Gait Posture 2015;41:313–5. https://doi.org/10.1016/j.gaitpost.2014.09.011.[2] Gosselin G, Fagan M. Foam pads properties and their effects on posturography in participants of different weight. Chiropr Man Therap 2015;23:2. https://doi.org/10.1186/s12998-014-0045-4.[3] Nor Azhar A, Bergin SM, Munteanu SE, Menz HB. Footwear, Orthoses, and Insoles and Their Effects on Balance in Older Adults: A Scoping Review. Gerontology 2024;70:801–11. https://doi.org/10.1159/000539591.

P03-G-45 - Transition between discrete and rhythmic dynamics in human walking

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BACKGROUND AND AIM: Human movement is structured through a set of dynamic primitives, neuromechanical attractors that simplify control by the central nervous system. At the end-effector level, these primitives give rise to two main types of movements: discrete (point attractors or submovements) and rhythmic (limit cycles or oscillations). Evidence from upper-limb tasks (as wrist flexion-extension) suggests that these movements types rely on distinct neural substrates and exhibit asymmetrical transfer of motor learning. This framework helps explain why rhythmic arm movements are often less impaired than discrete ones following stroke. Previous studies have shown that under temporal constraints, fast discrete movements tend to merge into rhythmic oscillations, while slow rhythmic movements disrupt into discrete submovements. While this phenomenon has been extensively studied in the upper limb, the transition between discrete and rhythmic dynamics in lower limb movements, particularly during

locomotion, remains poorly understood.Our study investigates whether such a transition occurs in locomotion, whether the threshold for this transition is consistent across individuals, and whether the process is affected by hysteresis. We also explore whether the coordinated muscle activations (muscle synergies), understood as functional groupings of muscles, reflect the underlying dynamic primitives that govern this transition.METHODS: 20 healthy adults walked on a treadmill across systematically varied speeds (0.5–5 km/h) under three conditions: incremental, decremental, and randomized progression. Kinematic data were recorded using a 10-camera Vicon motion capture system (100 Hz), and EMG signals were collected bilaterally from 12 lower-limb muscles. Movement classification into discrete or rhythmic dynamics was based on established smoothness metrics, including spectral arc length (SAL) and mean-squared jerk ratio (MSJR).RESULTS: Both MSJR and SAL showed significant changes around 2 km/h compared to comfortable walking speeds (4–5 km/h), suggesting the existence of a speed threshold marking the transition from discrete to rhythmic movement dynamics. The direction of speed progression slightly modulated the onset of the transition, indicating a mild hysteresis effect. These findings are consistent with hysteresis observed in walk–run transitions and suggest a nonlinear mechanism. Preliminary analysis of EMG-derived muscle synergies revealed distinct activation patterns corresponding to discrete and rhythmic states.CONCLUSIONS: This study extends the dynamic primitives framework to human locomotion, providing novel insights into how the central nervous system transitions between control strategies at different walking speed. A deeper understanding of these dynamics may have implications for motor learning, exercise strategies, and neurorehabilitation. Future research should investigate these mechanisms in clinical populations to evaluate their diagnostic and therapeutic potential.

P03-G-46 - Contribution of sensorimotor function to gait performance in people with COPD compared with age-matched controls

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BACKGROUND & AIMPeople with COPD have a higher incidence of falls than healthy peers, with many falls occurring during walking. The contributing risk factors to gait impairment in individuals with COPD is unclear, but sensorimotor function is one possibility. Our aims were to 1) understand the differences in sensorimotor function and gait quality outcomes in people with COPD compared with age-matched controls, and 2) determine which sensorimotor function factors contribute to gait performance and how these may differ for people with COPD versus controls. METHODSA total of 31

participants (n=15 with COPD [PwCOPD]; n=16 without COPD [CON]) completed a battery of sensorimotor function tests, including vibration sensitivity, voluntary activation, stretch-reflex response, ankle and knee joint isometric MVC, and hand grip strength. Participants also completed walking trials over a GaitRite pressure mat to record their gait performance during normal single-task walking.We considered metrics covering the “5 S’s” of gait – speed, symmetry, smoothness, stability, and security. Differences between the two groups in sensorimotor function and gait indicators were established via independent t-tests. Associations between sensorimotor function and gait indicators were established via correlations for each group. Gait performance was predicted via multiple linear regressions, separately for PwCOPD versus Controls, with sensorimotor function factors as independent variables and using “Enter” and “Stepwise” inclusion criteria. RESULTSIn general, PwCOPD exhibited impaired neuromuscular function (plantar flexor MVC, Quadriceps MVC, Hand Grip Strength) and gait performance (Speed, Smoothness, Security) compared with Controls. Sensorimotor function factors did not exhibit much difference between groups except for longer H-Reflex latency in PwCOPD (35.9 ms vs 33.4 ms, p=0.046) (Table 1). There were typically stronger associations between sensorimotor function (Quads MVC, Voluntary Activation, M-wave amplitude) and gait speed for PwCOPD group versus the Controls. Multiple linear regressions were carried out with Gait Speed (gait speed), Smoothness (SD of Stride Time), Security (% Single Support), Stability (Stride Width), and Symmetry (Step Length Asymmetry %) as dependent variables, regressed against selected sensorimotor factors based on correlation results. Sensorimotor factors accounted for moderate to large variance (R2 = 0.73 to 0.90) in gait performance indicators for PwCOPD, with less variance accounted for in the same regressions for the Control groups (R2 = 0.28 to 0.80). A range of the sensorimotor factors were included as predictor variables in the stepwise regressions. CONCLUSIONSPeople with COPD do exhibit impaired neuromuscular capacity and gait performance when compared with a group of age-matched healthy counterparts but there is less difference in the more sensory elements of sensorimotor function between groups. With the PwCOPD group, the associations between sensorimotor function and gait performance factors are typically stronger than seen for Controls, suggesting that in this clinical population the level of sensorimotor function plays an important role in regulating gait. Therefore, improving sensorimotor function in this group via training and rehabilitation, with a focus on the motor response elements rather than sensory inputs, has potential to benefit gait performance indicators.

P03-G-47 - Choice of formula impacts estimate and interpretation of co-contraction levels: A study with synthetic EMG

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Background: Co-contraction (CC) is a major determinant of locomotor efficiency, stability, and joint loading. Multiple co-contraction indices (CCI) have been used to calculate CC levels1-3. However, their behavior under different experimental conditions and suitability for different research questions remain largely unknown, limiting recommendations for which CCI is best suited for a given study4. This gap is attributable to relying solely on experimental data to assess CCI behavior. In contrast, synthetic EMG data allows for comprehensive exploration of CCI behavior using known values and expected outcomes. Our objective here was to evaluate how three commonly used CCI in posture and gait research behave under controlled conditions created with synthetic EMG data. The findings will help researchers select the CCI that best suits their data and research questions.Methods: 50 sets of synthetic EMG signals for two muscles were generated using linear or piecewise linear functions. The signals varied in shape, amplitude, and overlap to mimic potential experimental data scenarios (e.g. Fig. 1A-D). For each synthetic scenario, CC values were compared across three CCI: Falconer & Winter (CCIFW)1, Rudolph (CCIR)2, and Unnithan & Frost (CCIUF)3.Results: Three main behaviors among CCIs were identified. First, CC values from the same overlap area vary across CCIs (e.g., Fig 1A), making direct comparisons impossible. Researchers should consider reporting CC values scaled to the theoretical maximum of their chosen index to enhance comparability and focus on trends when comparing results between studies. Second, CCIFW always produces maximum CC values for EMG signals with similar shapes, regardless of their amplitude. CCIR and CCIUF, however, require both similar shapes and high amplitude to produce maximum CC values (Fig. 1B-C). CCIFW may fail to detect differences in CC that are based on variations in amplitude, suggesting that the choice of CCI can influence the detection of group differences. Researchers should consider reporting multiple CCIs that account for signal shape, amplitude, and duration. Finally, CCIFW was more sensitive to low-level EMG than other CCIs, producing relatively higher values (Fig. 1D), which may not reflect a “meaningful” level of CC. Researchers should consider applying amplitude thresholds to minimize the impact of low-level background EMG on CC values, and carefully define what constitutes “meaningful” CC in a given population.Conclusions: These results show that the choice of CCI can produce more liberal or conservative CC estimates, influencing interpretation of study results. Researchers should consider what their data looks like to choose the appropriate CCI for their research questions.[1] K Falconer & DA Winter. 1985. Electromyogr Clin Neurophysiol. [2] KS Rudolph et al. 2000. Knee Surg Sports Traumatol Arthrosc. [3] VB Unnithan et al. 1996. Electromyogr Clin Neurophysiol. [4] MCN Rosa et al. 2014. J Electromyogr Kinesiol.

P03-G-48 - Motor unit firing behavior during ankle joint control in standing

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BACKGROUND AND AIM: Postural control during standing is achieved by integrating sensory information to control neuromuscular activity. Importantly, ankle joint control

during standing involves both voluntary and involuntary muscle activity. Therefore, the purpose of this study was to identify the specific characteristics of postural control by comparing intramuscular coherence (IMC) during quiet standing with isometric ankle contractions primarily involving voluntary control. IMC reflects synchronization between motor unit (MU) firings. The frequency at which IMC occurs varies depending on the neural sources generating the IMC. Comparing IMC across different conditions allows us to examine how neural inputs to spinal motor neurons vary depending on the motor task. METHODS: This study included 18 healthy male participants. High density electromyographic (HDsEMG) signals were recorded from the unilateral medial gastrocnemius (MG) and soleus (SOL) muscles. The experimental tasks consisted of a 2-minute quiet standing task and a 30-second isometric plantarflexion task. During the isometric task, participants performed an EMG-matching task based on the maximum EMG amplitude identified during quiet standing task. MU firing behavior was identified from the acquired HDsEMG data using an EMG decomposition method based on independent component analysis. The number of MUs, MU firing rate, and IMC were then analyzed. Regarding the IMC, the frequency bands analyzed were defined as follows: delta (1–5 Hz), alpha (5–15 Hz), and beta (15–30 Hz). All coherence reflects common synaptic input, with each frequency band thought to represent different sources: delta for force-related input, alpha for vestibular and afferent signals, and beta for corticospinal input.. The coherence area within each frequency band was calculated and compared between the conditions. RESULTS: There were no significant differences in the average number of motor units and their firing rates between sitting and standing in either the SOL or the MG ($p > 0.05$). Regarding IMC, alpha-band coherence in the MG was significantly higher during standing ($p = 0.03$), suggesting increased common synaptic input. In contrast, delta- and beta-band coherence in the SOL was significantly lower during standing compared to isometric contraction ($p = 0.01$ and 0.03), which may reflect reductions in force-related and corticospinal input. CONCLUSIONS: Our results show that IMC differs between standing and voluntary contraction in both muscles. In particular, alpha band coherence was higher in the MG. This result suggests that a control strategy involving common neural input to the MG may be employed during the standing. Furthermore, the characteristics of IMC during standing and voluntary contraction varied between muscles, indicating that the neural inputs responsible for postural control differ depending on the muscle.

P03-G-49 - Does vestibular system affect the anticipatory postural adjustments during gait initiation?

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BACKGROUND AND AIM: The vestibular system is essential for maintaining standing postural control, and the central nervous system (CNS) adjusts anticipatory postural adjustments (APAs) based on individual, environmental, and task factors before gait initiation (GI). Although sensory inputs related to postural stability before gait initiation modulate APAs during GI, it remains unclear how the vestibular system influences APAs.METHODS: Eighteen healthy young adults participated in the experiment. Participants were instructed to start walking with their dominant limb at maximum speed under three conditions. A DC-STIMULATOR PLUS was used to deliver noisy galvanic vestibular stimulation (noisy GVS). In the 'noise' stimulation mode, a random level of current is generated for every sample (sampling rate 1,280 sps). Noisy GVS (0.1–640 Hz) was delivered at +/- 0.4 and +/- 0.2 mA peak to peak amplitude over a bipolar mastoid arrangement from static standing to gait termination. Additionally, a no-GVS condition was also conducted. Kinematic data were collected using a VICON Nexus 3D motion capture system with ten cameras operating at 100 Hz. The peak velocity of the center of mass (peak COM velocity) and the mean acceleration values of the center of head segment mass (head COM) along each axis during static standing (ML, AP, and Vertical head COMstatic) were calculated. Six force plate signals were used to measure the center of pressure (COP) signal in the horizontal plane. The peak COP shifts during APAs (APApeak), and the initiation time of COP shifts (APAonset) were calculated along anteroposterior (AP) and mediolateral (ML) directions based on force plate signals.RESULTS: A significant difference in the absolute values of AP APAonset and ML APAonset was found among the conditions. A post-hoc analysis revealed that AP APAonset and ML APAonset occurred significantly earlier in the noisy GVS at 0.2 mA than in the no-GVS condition. Conversely, no significant between-condition difference was found in the spatial component of APAs in terms of the absolute value of AP APApeak and ML APApeak, and in initial head sway, and GI performance in terms of each head COMstatic and peak COM velocity.CONCLUSIONS: Noisy GVS affects the temporal component of APAs but not the spatial component during GI. These results suggest that the CNS might modulate the temporal components of APAs via vestibular input, both before and during the anticipatory phase. Vestibular inputs provide information about the surroundings and one's body, such as body schema, and vertical transfer through the parieto-prefrontal pathways is critical to building motor programs of step initiation (Takakusaki, 2023). The participants were forced to initiate their gait at maximum speed. Hence, the CNS selects an earlier latency of the COP shift to generate the maximum velocity.ACKNOWLEDGEMENTS AND FUNDING: This work was supported in part by a Japanese Grant-in-Aid for Scientific Research (20K19426, 24K02423).

P03-G-50 - How does credit assignment of error during practice of a balance task influence generalizability of learning?

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Background and aim: A mismatch between the predicted and the actual state of the body during a movement is interpreted by the internal model as an error signal. This error signal is used to update an internal model resulting in modified motor output appropriate to the conditions. An error signal could come from an external or internal source. The credit assignment hypothesis posits that the central nervous system estimates the source of error, with errors assigned to internal source more likely to generalize to novel situations than external errors. This study's purpose was to directly determine if credit assignment of error influences the generalization of motor learning while participants learn a novel balancing task. We hypothesized that participants who practice a motor task in the presence of small external perturbations but are unaware of them would show improved generalization compared to those aware of them. Methods: Participants practiced and learned a novel balancing task. In the practice task, participants stood on a stabilometer and were asked to keep it level as long as possible for 42 trials. Participants were assigned to one of four practice conditions: perturbed-external, perturbed-internal, unperturbed-external, and unperturbed-internal. Participants in the perturbed groups experienced small external perturbations to the stabilometer during practice. Participants in external groups were informed that they would experience platform perturbations and should attribute errors in performing the task to the external perturbations. Participants in the internal groups were told that no perturbations would occur and should attribute errors with the task to themselves. The transfer task, standing on a ‘tilt board’ with no perturbations, was completed immediately after practice and 24 hours later. Results: Our primary results (20 participants) suggest an improved stabilometer balance performance after practice for all groups. During the immediate transfer task, external and internal unperturbed groups spent more time in balance (mean±standard deviation: 30.3±9.1 and 34.2±5.8 seconds out of 40 seconds, respectively), compared to internal and external perturbed groups (24.1±13.0 and 24.3±8.8, respectively). For the retention and transfer task, the internal-perturbed group spent more time in balance on the tilt board task after 24 hours (34.8±4.3) compared to other groups (28.9±7.3, 30.2±7.0, and 30.3±6.3 for external-perturbed, external-unperturbed, and internal-unperturbed group, respectively). Conclusion: Our primary results suggest that participants who experience external perturbations during practice but assign the perturbation errors to themselves have a better generalization to a novel balance task compared to those who assign errors to the external source. The findings of this study may help to improve motor skill learning with perturbation-based training by tailoring individualized plans via a careful selection of perturbation types.

P03-G-51 - Impact of unexpected upper limb perturbations on postural control in young adults

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Background and aim: Object manipulation is a functional task that enables interaction with the environment and the execution of daily activities. When reaching for an object, our control system predicts the weight of the object to perform this task without affecting balance. However, unexpected changes in object weight during this task may affect the center of mass (COM) behavior, compromising postural stability and task performance. This study investigates the effects of unexpected upper limb perturbations on object lifting and COM behavior in healthy young adults.Methods: Fifteen right-handed individuals, aged 18-30, performed a reaching lifting task (900-g cylinder) while maintaining a quasi-static posture. The task was recorded using a Vicon motion capture system at 200 Hz. A total of 50 trials were conducted, divided into five blocks of 10 repetitions. Perturbations (n=8) involved an unexpected weight reduction from 900 g to 100 g. The first block (10 trials without weight change) served as baseline. In subsequent blocks, two perturbations occurred randomly, with at least two baseline-weight trials in between. Object movement onset was defined as the first value exceeding 5% of its peak acceleration. Analyses focused on the interval between object movement onset and object peak elevation. Variables assessed included object lifting amplitude, duration, peak vertical acceleration, and time to peak vertical acceleration. COM peak vertical and anterior-posterior (AP) acceleration and time to these peaks, normalized by movement duration, were also analyzed. Perturbed trials were compared to baseline means using repeated-measures ANOVA ($p<0.05$).Results: Object lifting amplitude did not differ across conditions ($p>0.05$). Lifting duration was shorter in perturbation conditions compared to baseline ($p<0.01$), except for the first perturbation, where the difference was not significant ($p=0.801$). Peak object acceleration increased significantly in all perturbations compared to baseline ($p<0.001$). Time to object peak acceleration showed no difference across conditions ($p=0.346$). Vertical COM acceleration was significantly higher in all perturbations compared to baseline ($p<0.05$), while time to peak vertical COM acceleration did not differ ($p=0.070$). In the AP direction, COM peak acceleration did not differ between conditions ($p=0.182$), nor did the time to peak show any difference ($p=0.707$).Conclusion: Perturbations affected object lifting dynamics, resulting in shorter elevation duration and higher peak acceleration, particularly after the first perturbation. Regarding the COM, vertical acceleration was higher during perturbations but no differences were observed in AP acceleration. Time to peak vertical and AP COM acceleration suggests balance was largely unaffected by upper limb perturbation in young adults.Acknowledgements and Funding: This study was supported by the São Paulo Research Foundation (FAPESP), grant 2023/18414-8.

P03-G-52 - Clinical utility of instrumented gait assessment in patients with limb girdle muscular dystrophy R2

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Background and Aim: Dysferlinopathy is a rare form of limb girdle muscle dystrophy (LGMD R2) caused by pathogenic variants in the DYSF gene located on chromosome 2p13. A deficiency in dysferlin disrupts membrane repair in skeletal muscle, leading to progressive fibre damage (myonecrosis) and impaired gait. Magnetic resonance imaging (MRI) of muscle is an important tool supporting the diagnosis of dysferlinopathy [1,2]. Disease-specific clinical scales are used to evaluate motor performance. Instrumented gait analysis provides objective, quantifiable outcomes which may be useful for monitoring disease progression and evaluating therapeutic response. This study aimed to establish the clinical validity of gait in dysferlinopathy.Methods: Patients with genetically confirmed dysferlinopathy were assessed as part of the Jain Foundation funded Clinical Outcomes Study [3] and completed the following assessments during a single visit:Gait: Using an instrumented walkway, gait was evaluated at a self-selected preferred pace. Up to six 10-m intermittent walks were collected. 8 temporal-spatial features of gait were averaged across all steps. NSAD: The North Star Assessment for LGMD (NSAD) is a 29-item scale of motor performance, with lower scores indicating reduced motor performance [4]. Muscle MRI: Dixon MRI data were collected from the thigh and leg muscles. Weighted mean fat fraction (wFF) values were calculated according to muscle size and contractile cross-sectional area (cCSA) was determined from the size of regions of interest and wFF scores. cCSA is defined as the area of muscle that is occupied by contractile tissue. Spearman's correlations were used to evaluate relationships between patient demographics (age, height, mass), NSAD, gait and muscle MRI.Results: 19 participants were assessed (age 23-75y, 10 females, years since symptom onset: 2-33y). Height and mass correlated with muscle MRI (cCSA only; n=4/12) but not gait or NSAD (Table 1). Age was correlated with gait (n=1/8) and MRI (n=1/4).Moderate-to-strong correlations were found between the NSAD and gait (n=6/8) indicating that better motor performance was associated with faster gait, longer steps and quicker step, stance, swing and single limb support times. Moderate-to-strong correlations were found between the MRI and gait (n=17/32) indicating that higher wFF and lower cCSA were associated with slower gait, shorter steps, and longer stance, swing and single limb support times.Strong correlations (rho>0.70) were found between NSAD and MRI of the thigh only (n=2/4).Conclusions: Given the prominent role of the proximal and distal lower limb muscles involved in dysferlin-deficiency [5], gait may serve as a useful surrogate marker of muscle pathology. Further analysis will explore the contribution of individual muscles to locomotor control.[1] Verdú-Díaz 2020 PMID 32029545 [2] Bolano-Diaz 2024 PMID 38007344 [3] Harris 2016 PMID 27602406 [4] James 2022 PMID 35932452 [5] Diaz-Manera 2018 PMID 29735511

P03-G-53 - Simultaneous pseudorandom multidimensional platform and visual perturbations increased postural responses

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Postural sway evoked by pseudorandom perturbations (Peterka, 2002) has a high potential to predict fall risk (Maki, 1994). To quantify postural responses evoked by multi-dimensional pseudorandom perturbations, this study quantified postural responses evoked by (a) three platform motion perturbations that included two tilts in the planes of the vertical semicircular canals (RALP and LARP) alongside an earth-vertical (EV) translation, (b) three visual rotation perturbations in RALP, LARP, and yaw dimensions, and (c) both platform and visual perturbations. We hypothesized that the platform perturbations would increase postural responses to the visual perturbations. Each of six sum-of-sines (SoS) trajectories was generated by summing signals at five out of 30 possible unique frequencies (0.04-1.55 Hz). This enabled us to simultaneously deliver spectrally separated perturbations for each of six motion dimensions using a motion platform (Virtualis, Motion VR) and VR goggles (HTC VIVE). Postural responses of 20 healthy adults (32.3±13.1 years, 10 females) were collected (i) at the head (3 translations and 3 rotations), (ii) near the hips (3 translations), and (iii) at the feet (3 forces and 3 torques measured using a 6DoF AMTI AccuSway-Optimized forceplate). All participants completed five trials that included two trials with (a) platform perturbations alone, one trial with (b) visual perturbations alone, and two trials with (c) both platform and visual perturbations. Trial order was randomized to mitigate order effects. The spectral data showed clearly distinguishable and independent postural responses at the stimulated frequencies. More specifically, yaw head rotations evoked by the visual yaw perturbations were distinguishable from those evoked by the visual RALP/LARP perturbations (Panel. A). Three-way repeated measures MANOVA indicated greater postural responses of the head, hip, and feet under combined visual and platform perturbations than visual perturbations alone ($p < 0.016$). For example, the simultaneous platform and visual perturbations evoked 2 times larger roll head rotations than the visual perturbations alone (Panel. B). Postural responses of the head, hip, and feet significantly increased at RALP/LARP platform perturbation frequencies when visual perturbations were also present ($p < 0.006$). In particular, the simultaneous platform and visual perturbations evoked 18% larger head translations in Medial-Lateral (ML) and 12% larger head translations in Anterior-Posterior (AP) than the platform perturbations alone. These findings highlight that we were able to quantify postural responses at the head, hip, and feet for these six-dimensional perturbations. This preliminary study showed the feasibility of our approach, which we propose to expand to study postural responses evoked by 12-dimensional perturbations (6D platform motion + 6D visual motion) that better simulate random naturalistic perturbations that trigger falls.

P03-G-54 - The role of functional capacity in fall risk assessment among older adults with knee Osteoarthritis

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BACKGROUND AND AIM:Knee osteoarthritis (KOA) is a chronic musculoskeletal disease that affects older adults globally. Falls among older adults represent a critical health issue, constituting a well-known public health concern. KOA is one of the major contributors to disability and is recognized as a significant risk factor for falls. KOA is characterized by a significant decline in functional capacity. Aim: This study aimed to examine the relationship between functional capacity and fall risk in older adults with KOA and determine whether specific functional capacity tests can predict falls. METHODSA cross-sectional study was conducted among older adults (≥60 years) diagnosed with KOA attending outpatient physical therapy clinics. Fall risk was assessed using the Stay Independent Self-Risk Assessment, while functional capacity was measured using the Timed Up and Go (TUG) test, the 30-Second Chair Stand Test (30s-CST), and the 4-Meter Walk Test. Binary logistic regression analyses were used to identify significant predictors of fall risk. RESULTSMultivariate logistic regression showed that gait speed was a significant predictor of fall risk (OR = 0.03, 95% CI, 0.00 to 0.35, p = 0.006). Higher pain levels (OR = 1.26, 95% CI, 1.03 to 1.58, p = 0.031), greater medication use (OR = 1.41, 95% CI, 1.09 to 1.88, p = 0.013), and living with caregiver (OR = 0.11, 95% CI, 0.01 to 0.73, p = 0.030) were also associated with increased fall risk. While TUG and 30s-CST were associated with fall risk, they were not significant predictors in the multivariate model. CONCLUSIONSThe findings showed that gait speed was an independent predictor of fall risk. Pain levels, medication use, and living situation were also key risk factors. ACKNOWLEDGEMENTS AND FUNDINGThis research received no funding.

P03-G-55 - Foot placement control based on center-of-mass velocity feedback may be underestimated

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Background and aimFoot placement control ensures stability during steady-state walking [1-3]. On each step, we adjust foot placement based on the center-of-mass (CoM) kinematic state (i.e. position & velocity with respect to the stance leg) during the swing phase [4] to maintain stability [5]. Sensory feedback of the CoM kinematic state [6, 7], as well as muscle activity in the early swing phase [8, 9], proved essential to direct the foot to the appropriate location. Understanding contributions of respectively CoM position and CoM velocity feedback can improve training interventions [10, 11]. Fall-prone stroke patients demonstrate disrupted velocity feedback control [12], whilst training interventions mainly target, and achieve effects, on position control [10]. CoM position is considered as the main contributor to foot placement control [13], yet this higher contribution may have been due to defining foot placement as "step width" rather than as "the distance between the foot and the CoM at heelstrike". Only the latter definition relates directly to stability performance. Stability is not per se dependent on how far the foot was placed from the other stance foot, but rather on how close the foot was placed to the CoM. We aimed to explore the contributions of CoM position and velocity in predicting either "step width" or "the distance between the foot and CoM at heelstrike". Whilst contributions in early swing reflect feedback control, contributions at terminal swing can be considered as stability control performance measures.Methods18 healthy adults walked on a treadmill at comfortable (CS) and slow speed (1.4 km/h, SS). Kinematics of heel and sacrum (proxy for CoM [4]) markers were recorded. We computed partial correlations (ρ, i.e. the relationship between a predictor and the dependent variable whilst controlling for the other predictor) of two linear foot placement models with CoM kinematic state (CoMpos and CoMvel) as predictors and different dependent variables. The first model predicted step width (SW), the mediolateral distance between the feet, and the second model predicted foot placement (FP), the mediolateral distance between the CoM and the placed foot at heelstrike. We tested: 1) ρpos from the SW model against ρpos from the FP model at midswing (CS&SS) 2) ρpos against ρvel for the model predicting FP at terminal swing (SS).ResultsAt both speeds, ρpos was higher for the model predicting SW than for the model predicting FP ($p<0.01$). As a result, for the model predicting FP the difference between ρpos and ρvel was smaller (Figure 1). At SS ρvel even exceeded ρpos towards terminal swing ($p<0.01$).ConclusionDespite frequent use of the SW model to quantify foot placement control, FP may better reflect stability performance. The inflated contribution of CoM position feedback in the SW model may have overshadowed CoM velocity. As a stability control performance measure ρvel may prove an important training outcome. Acknowledgements and fundingWe acknowledge funding support from the Joint Programme for Neurodegenerative Disease (JPND grant acronym StepuP).References1. Hof, A.L. (2007) Journal of biomechanics.2. Bruijn, S.M. and J.H. van Dieën. (2018) The Royal Society Interface3. van Leeuwen, M., S. Bruijn, and J. van Dieën. (2022) Brazilian Journal of Motor Behavior4. Wang, Y. and M. Srinivasan. (2014) Biology letters5. Mahaki, M., S.M. Bruijn, and J. H. van Dieën. (2019) PeerJ6. Arvin, M., et al. (2018). Frontiers in physiology7. Reimann, H., et al. (2017) PloS one8. Rankin, B.L., S.K. Buffo, and J.C. Dean. (2014) Journal of neurophysiology9. van Leeuwen, A.M., et al. (2020). Plos one10. van Leeuwen, A.M., S.M. Bruijn, and J.C. Dean. (2024) Human Movement Science 11. Heitkamp, L.N., K.H. Stimpson, and J.C. Dean. (2019) IEEE Transactions on Neural Systems and Rehabilitation Engineering12. Dean, J.C. and S.A. Kautz. (2015) Journal of rehabilitation research and development13. Stimpson, K.H., et al. (2018) Journal of biomechanics

P03-G-56 - Relationship between posture and gait stability in children with Cerebral Palsy

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BACKGROUND AND AIMCerebral palsy (CP) is the most common cause of motor impairment in childhood, leading to deficits in posture and gait stability. Stability relies on the integration of the sensory, central nervous system, and musculoskeletal systems, which are impaired in CP. The relationship between the posture and gait stability remains unclear. For example, compensatory mechanisms may allow children with poor posture control to achieve good gait stability.Many children with CP, particularly those classified as GMFCS Levels I and II, use ankle-foot orthoses (AFOs) to optimize gait and improve functionality. The effect of AFOs on posture and gait stability is not well known.Our aims are: 1- to explore the relationship between posture and gait stability in CP walking barefoot, and 2- to investigate the effect of AFOs on stability.METHODSWe are recruiting children as they present to the lab for the first aim. We intend to recruit a minimum of 14 children (5-18 years) with spastic CP (GMFCS levels I&II) standing and walking with and without AFOs for the second aim. Posture stability was measured using two Kistler force plates and quantified by the 95% CI ellipse area of the CoP. Gait stability was assessed using 3D motion capture and the range of the Whole-Body Angular Momentum (WBAM) in the sagittal, frontal, and transverse planes.RESULTSSo far, data from 10 children with CP were collected, 5 of which with and without AFOs. Walking barefoot, the correlation between posture and gait stability were the strongest in the frontal and transverse plan with ρ around 0.5. Boxplots of stability with and without AFOs were not visually different from the range of WBAM in the sagittal plane and the 95% CI Ellipse area.CONCLUSIONSThese are preliminary results; we cannot conclude at this time. It seems posture stability is a medium predictor of gait stability, and AFOs may not have a major impact on stability measures. Full results will be available at the time of the conference.ACKNOWLEDGEMENTS AND FUNDINGNo funding. We acknowledged the personnel of the Centre for Clinical Movement Analysis at UKBB for their assistance with data capture.

P03-G-57 - Postural control and its relation with pregnancy-related lumbopelvic pain in multigravid pregnant women

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Background and Aim: Pregnancy induces biomechanical adaptations, challenging postural control. Pregnancy-related lumbopelvic pain (PLPP) affects 50%-90% of pregnant women, impairing their quality of life. The mechanisms underlying PLPP remain largely unknown, and its relationship with postural control is unclear. This study aims to determine potential differences in postural control between pregnant and non-pregnant women, as well as between different stages of pregnancy, and to investigate the relation with PLPP in the third trimester of pregnancy.Methods: A total of 68 women were included: 17 multigravid women in the first trimester of pregnancy (age 32.1±2.3yr, BMI 23.7±3.5), 25 multigravid women in the third trimester of pregnancy (age 32±2.6yr, BMI 28.4±4.2), and 26 non-pregnant women (age 29.7±3.7yr, BMI 22.2±1.8). Postural control was assessed in upright standing on a force plate under various postural conditions (with/without vision, feet together/20 cm apart, and/or stable/unstable support surface).

The following variables were measured: mean center of pressure (COP) sway anterior-posterior (AP), mean COP velocity AP, and COP 95% confidence ellipse area (CEA). In the third trimester, PLPP intensity was assessed with the Numerical Pain Rating Scale (NPRS) to categorize into a no-PLPP subgroup (NPRS=0, N=9) and a PLPP subgroup (NPRS>0, N=16). Linear mixed models or Kruskal-Wallis tests, at nominal significance level 0.05, were used to compare COP variables across postural conditions between pregnant women (first or third trimester) and non-pregnant women, and between trimesters (uncorrected for BMI). The same tests were applied to compare COP variables between the no-PLPP and PLPP subgroups. Results: Pregnant women in the third trimester had significantly greater mean COP sway AP and COP 95% CEA compared to non-pregnant women when standing with feet together ($p<0.05$). In contrast, mean COP velocity AP did not differ significantly between these two groups ($p>0.05$). No significant differences were found for any COP variable between pregnant women in the first trimester and non-pregnant women nor between pregnant women in the first and third trimesters ($p>0.05$). Similarly, the COP variables did not differ significantly between subgroups with and without PLPP ($p>0.05$). Conclusions: Pregnancy in the third trimester affects postural control when standing with feet together, as shown by increased mean COP sway AP and COP 95% CEA. This is likely due to growing biomechanical adaptations associated with advanced pregnancy. Postural control seems unrelated to PLPP in the third trimester of pregnancy, although these findings should be interpreted cautiously due to the limited sample size. Our findings need confirmation in larger cohorts.

P03-G-58 - Gait speed-dependent and asymmetrical foot placement control of paretic and non-paretic steps in persons with chronic stroke

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Background The foot placement strategy is the primary control mechanism for mediolateral (ML) balance during gait. This strategy seems impaired in persons with chronic stroke (PwCS), particularly in paretic steps, contributing to instability and fall risk. While foot placement control seems gait speed-dependent and less tightly regulated at low speeds in healthy adults, this relationship remains unexplored in PwCS. As this population often reports increased balance difficulties at speeds below and above comfortable walking speed (CWS), this study characterized foot placement control across a range of speeds in PwCS and controls.Methods Sixteen PwCS and twenty-one controls walked on a treadmill at speeds from 0.2 m/s to 1.6 m/s for controls and from 0.2 m/s to each PwCS's maximum gait speed, in 0.2 m/s increments. Foot placement control was assessed with foot placement deviation, defined as the RMSE between predicted and actual foot placements. Predicted foot placements were based on a linear regression as reported by (1), using ML center of mass position and velocity at heel strike as predictors. The relationship gait speed - foot placement deviation was

analyzed at speeds below and above CWS in PwCS and over all speeds in controls, using mixed models with gait speed as a fixed effect and leg (paretic vs. non-paretic) as an additional fixed effect for PwCS. Random intercepts and slopes accounted for individual variability. Linear, exponential, and quadratic models were tested for best fit based on the lowest AIC. Demographics were compared using independent t-tests ($\alpha = 0.05$). Results Best model fits were linear below CWS, and quadratic above CWS and for controls. In PwCS, below CWS, foot placement deviation decreased (improved) on average by 0.18 cm per 0.1 m/s ($\beta = -1.8$, SE = 0.6, $p = 0.01$), with no significant difference between the paretic and non-paretic legs ($p = 0.62$). At CWS, no deviation difference was found between legs ($p = 0.46$). Above CWS, foot placement deviation did not change with speed for the non-paretic leg ($\beta = 0.2$, SE = 0.3, $p = 0.63$), but increased (worsened) for the paretic relative to the non-paretic leg ($\beta = 1.2$, SE = 0.4, $p = 0.02$). Controls showed higher (worse) foot placement deviation at lower speeds, which decreased (improved) and stabilized as speeds increased. No demographic differences were found between groups.Conclusion Worse foot placement control at low speeds for paretic, non-paretic steps, and controls supports earlier work and the notion that low gait speeds require less precise control of foot placement. While controls improve towards consistent ML foot placement control with increasing gait speed, paretic control worsens whereas non-paretic control remains consistent in PwCS. The finding that higher gait speeds amplify paretic motor control deficits highlights the potential of incorporating gait speeds above CWS into training or therapy design. 1. Wang, Y., & Srinivasan, M. (2014). Biology letters.

P03-G-59 - Turning speed and instability in people with unilateral vestibular loss during the functional gait assessment gait with pivot turn

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Background and aim: Unilateral vestibular loss (UVL) impairs the ability to use vestibular information for balance and gait. While many people with UVL exhibit impaired gait using standard clinical evaluations, such as the Functional Gait Assessment (FGA), objective methods of assessing mobility using inertial measurement units (IMUs) can detect more subtle impairments. Prior work has highlighted the role of IMUs in detecting slower and smaller head movements in UVL during specific items of the FGA. Here, we sought to examine objective measures of mobility during the Walk with Pivot Turn item of the FGA. Because the Walk with Pivot Turn is clinically scored based on the speed and stability of the patient after the turn, the purpose of this study was to estimate a new 'time to stability' metric, derived from IMUs, in people with UVL compared to healthy controls (HCs).Methods: Participants of this IRB-approved study provided informed consent and included people who had undergone unilateral vestibular schwannoma resection surgery (UVL) (n = 14; 5 M/9F; mean (SD) = 47.2 (13.1) years) and HCs (n = 21; 4M/17F; mean (SD)

= 29.4 (8.3) years). All participants completed the FGA while wearing five IMUs (APDM Opal, Portland, OR, USA; Sampling rate = 128 Hz). This analysis used the data from the IMU placed on the lumbar region of the spine, during the FGA5 Walk with Pivot Turn, task. This task involved walking at one's preferred speed and completing a 180° pivot turn when instructed to “stop and turn” by the research administrator. Time to stability was calculated as the time required to reach stability after initiating the pivot turn, where stability was defined using thresholds on acceleration (<1.07g) and angular velocity (<14°/s). Additionally, turn duration and peak turning speed were calculated for each trial. We built linear regression models adjusted for age to evaluate between-group differences in time to stability, turning speed, and turning duration.Results: People with UVL had slower peak angular rates (p = 0.003) and took longer to regain stability after initiating the turn (p = 0.009), despite no differences in turning duration (p = 0.324), compared to HCs (Figure 1). Age effect was found significant in time to stability (p < 0.001), turning speed (p < 0.01) and turning duration (p < 0.001). Comparatively, 10 out of 14 patients with UVL were scored a perfect 3, while the remaining four individuals with UVL scored 2; all HCs achieved the maximum score of 3. Conclusions: Instrumented measures of time to stability, turning speed, and turning time identified differences between people with UVL and HCs during the FGA Walk with Pivot Turn despite many patients with UVL exhibiting normal clinical scores. Considering the ceiling effects of clinical scoring on tasks like the FGA5, using turning metrics derived from IMUs may provide a more sensitive and effective option for identifying persistent dynamic postural control deficits in individuals with vestibular dysfunction.

P03-G-60 - Proactive and reactive modulation of mechanical work during underfoot perturbations with varying physical certainty

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BACKGROUND AND AIM: Walking in complex environments requires proactive and reactive control strategies to manage balance disturbances effectively. Proactive adjustments often enhance reactive responses, but these require accurate predictions of the future body state. For instance, knowing the specific effects of an upcoming perturbation enables faster recovery. However, the mechanisms underlying faster recovery remain unclear, as proactive kinematic adjustments are not always evident. This study explored changes in control mechanisms from an energetic perspective by analyzing proactive and reactive changes to mechanical work during certain and uncertain underfoot perturbations.METHODS: Nine participants [26.8(5.6) years old (mean(sd)); 5 female, 4 male] completed five-minute walking trials on an instrumented treadmill (Bertec FIT, Columbus, OH) with two underfoot perturbation directions (inversion and eversion) under two certainty conditions: (1) Certain, where a single perturbation direction was applied throughout the trial, and (2) Uncertain, where

perturbation directions varied randomly. Participants provided written informed consent for this University of Utah IRB-approved study. Perturbations were delivered using a mechanized shoe that inverted or everted the ankle during the stance phase. A warning tone signaled an upcoming perturbation one step in advance. Kinetic and kinematic data from a prior study were used to calculate positive, negative, and total mechanical work for the proactive step (before perturbation), reactive step (during perturbation), and recovery steps (one and two steps after perturbation). Linear mixed-effects models evaluated the effects of certainty and perturbation direction on percentage changes in total leg mechanical work relative to normal walking.RESULTS: Proactive Phase: Certainty influenced proactive strategies differently for inversion and eversion perturbations ($p = 0.040$). Specifically, larger increases in proactive, positive work were observed for Certain inversion perturbations compared to Certain eversion perturbations. Conversely, smaller increases in proactive, positive work occurred for Uncertain inversion perturbations compared to Uncertain eversion perturbations.Reactive Phase: Participants exhibited reduced negative work during the reactive step compared to normal walking, with greater decreases observed during eversion than inversion perturbations ($p < 0.001$) (Figure 1).CONCLUSIONS: Perturbation direction leads to distinct mechanical responses and proactive strategies to regulate mechanical work. Reduced energy dissipation during the reactive step of eversion perturbations underscores the unique mechanical demands of perturbation direction, driving differences in proactive strategy. Proactive modulation effectiveness depends on prior knowledge of the perturbation.

P03-G-61 - Comparison of mechanisms for frontal plane control of dynamic balance during walking and stepping-in-place

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Background and aim: Dynamic balance control in the frontal plane or medial-lateral (ML) direction is known to require active, neurally-mediated control to maintain ML stability during walking gait. For the investigation of mechanisms contributing to gait stability, a stepping-in-place (SiP) experimental paradigm offers potential advantages over walking (e.g., simplified instrumentation) that may facilitate future clinical applications. However, it is unknown if the mechanisms contributing to dynamic stability during SiP differ from those during walking. Our aim was to compare the properties of four mechanisms contributing to ML dynamic stability in SiP and walking.Methods: We quantified the contributions to stability related to the modulation of measures of (1) step width, (2) ankle torque, (3) stance duration, and (4) swing duration by calculating 'asymmetry measures' that compared changes over adjacent steps in these measures as balance was perturbed by a pseudorandom galvanic vestibular stimulus (GVS) during SiP on a dual force plate and while walking on a GaitRITE mat under two visual conditions (clear and blurred vision). Regression analysis was used to characterize the influence of

ML center-of-mass (CoM) angular position, angular velocity, and position-velocity interaction on the time course of the asymmetry measures. Regression coefficients from SiP and walking tests were compared to evaluate similarities and differences in the mechanisms used to maintain dynamic stability. Data were obtained from twenty young adult healthy Veterans (mean age 32.8 years, SD 4.0 years).Results: GVS evoked ML sway on both SiP and walking tests. There were minimal differences in results on clear versus blurred vision tests. During both SiP and walking the regression coefficients from ankle torque, stance duration, and swing duration asymmetry measures showed modulation as a function of either CoM angular position, angular velocity, or both in a manner that indicates contributions to ML dynamic stability. That is, step-to-step changes in gait measures were consistent with the generation of corrective torque actions that compensated for sway evoked by the GVS. However, during SiP there was essentially no modulation of step width while step width asymmetry during walking showed clear changes as a function of both CoM angular position and velocity. Additionally, the contributions of sway velocity to the modulation of ankle toque, stance duration, and swing duration were larger during walking than during SiP. Conclusions: During both SiP and walking gaits ML sway evoked by GVS resulted in step-to-step changes in gait measures that contributed to maintaining dynamic balance. Common to both SiP and walking were compensatory changes in ankle torque, stance duration, and swing duration although the contributions of sway velocity were larger in walking compared to SiP. A notable difference between SiP and walking was the absence of modulation of step width in SiP.

P03-G-62 - Effect of variable movement amplification gains on center of mass dynamics and stepping kinematics in people with chronic stroke

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Background and aim: People with chronic stroke (PwCS) often have poor walking balance that limits participation in walking activities. Interventions that amplify self-generated movements may accelerate learning of walking balance by enhancing perception of movement errors. Thus, we used a cable-driven robot to create a Movement Amplification Environment (MAE) during treadmill walking. The robot applies continuous forces to the pelvis that are proportional in magnitude and direction to real-time lateral velocity. The MAE magnifies mediolateral motion making it more challenging to maintain straight walking. With the long-term goal of using a MAE to improve walking balance, we examined if, and how, PwCS adapt their gait patterns—center of mass (COM) dynamics and stepping kinematics—in response to MAE gain changes. We hypothesized that increasing MAE gain will increase the challenge to maintain walking balance and that PwCS will adapt their stepping kinematics to control their COM dynamics to different MAE gains.Methods: 10 ambulatory, community dwelling PwCS who were able to walk 10

meters with or without a single cane, and/or ankle-foot orthosis were included. Participants completed 2-minute walking trials with four MAE gains: 1) Null: no applied forces, 2) Low: 25 Nsm-1, 3) Medium: 35 Nsm-1, and 4) High: 45 Nsm-1 at preferred and fast walking speeds. Trial order was randomized. Our outcome measures were: 1) Lateral COM excursion (peak side-to-side distance per stride), 2) Peak lateral COM speed, 3) Lyapunov exponent of lateral COM velocity (λs), 4) Step length, 5) Step width, and 6) Ratio of stance time (paretic/non-paretic side) averaged during each trial. Results: Lateral COM excursion and peak lateral COM speed were reduced in the low gain when compared to Null. With increasing MAE gains both lateral COM excursion and peak lateral COM speed increased. When compared to Null, λs had a greater rate of divergence in the MAE, confirming that all MAE gains challenged participants walking balance. There was no difference in mean step length or width between trials. At the preferred speed, with increasing MAE gains stance times on the non-paretic limb decreased, indicating increased paretic weight bearing and greater symmetry between limbs. Stance times were dominated by the non-paretic limb during fast speeds regardless of MAE gain.Conclusions: PwCS demonstrated the ability to adapt to varying MAE gains by modulating COM dynamics primarily through underlying changes in stance time rather than foot placement (changes in step length or width). Our findings indicate that all MAE gains challenged walking balance, and that at lower gains and preferred walking speeds, PwCS adapt step timing to control lateral COM dynamics (reduced excursion and velocity). As MAE gains increased, controlling lateral COM dynamics became more difficult. These findings motivate future research in PwCS to explore if gait training in MAE is beneficial for improving walking balance.Acknowledgements and funding: This research was supported by an American Heart Association postdoctoral fellowship #24POST1195671 and National Institutes of Health #1R21HD112813.

P03-G-63 - Comparison of craniovertebral angle between using a portable analog head posture instrument (PAHPI) and a radiograph in healthy young adults

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Background and aims: Forward Head Posture (FHP) is a prevalent postural deviation among young adults due to prolonged use of digital devices and sedentary lifestyles. The craniovertebral (CV) angle is a reliable metric for assessing FHP, but traditional measurement methods have limitations related to accuracy, accessibility, and exposure to ionizing radiation. This study introduces the Portable Analog Head Posture Instrument (PAHPI), a novel, non-invasive device designed to measure the CV angle with high precision and portability. This study was to compare the accuracy and reliability of CV angle measurements obtained using the PAHPI against radiographic imaging, the gold standard, in healthy adolescent participants. Methods: The study involved healthy volunteers aged 18-25 with a BMI of 25 kg/m^2. Cervical spine characteristics were evaluated through physical assessments and goniometer measures. Craniovertebral

angle was measured using PAHPI, with three assessors conducting the measurements. Statistical analyses were conducted using R Studio, comparing mean values obtained through PAHPI measurements and X-ray imaging. Data analysis included paired t-tests, Wilcoxon signed-rank tests, linear regression models, and Bland-Altman analysis to assess agreement and potential biases. Results: This study showed consistent mean CV angles of 51 (2.3) °, but a higher mean CV angle of 63.1 (3.6) ° was found. A moderate positive correlation was found between PAHPI measurement rater1 and X-ray imaging, but no significant correlations were observed between rater2 and rater. Conclusions: The study reveals significant differences between PAHPI and X-ray measurements of the CV angle, with moderate predictive capacity for one rater. This highlights the potential and limitations of PAHPI in postural assessment, emphasizing the need for standardized protocols and advanced imaging technologies. The variability between raters underscores the need for further training to improve measurement accuracy and consistency. Further studies and validation are needed.Keywords: forward head posture, craniovertebral angle, postural assessment, radiographic imaging, reliability, validity

P03-G-64 - Disturbed proprioceptive postural control may be related to impaired multifidus muscle quality in people with low back pain

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BACKGROUND AND AIMLow back pain (LBP) is the leading cause of disability worldwide. Impaired proprioception during postural control might be a contributing factor to LBP, but it remains unknown if this relates to structural changes in spine-controlling muscles such as the lumbar multifidus.Therefore, this study aimed (1) to investigate potential differences in lumbar proprioceptive use during standing as well as multifidus size and echo-intensity between people with and without LBP, and (2) to determine the association between proprioceptive use during standing l and multifidus size and echo-intensity.METHODSIn 36 participants with recurrent LBP (19 men, 17 women; Age= 44 ± 11 years; BMI= 25.3 ± 3.7) and 32 healthy controls (11 men, 21 women; Age= 38 ± 11 years ; BMI= 22.2 ± 2.4), proprioceptive use was evaluated by applying muscle vibration to ankle and back muscles during standing on stable and unstable ground. Center of pressure displacements in response to vibration were measured with a force plate (Kistler). Multifidus volume was measured from lumbar level L2 to L5, cross-sectional area and echo-intensity were measured at lumbar level L5 with three-dimensional freehand ultrasound (SonixTouch Q+ with Optitrack V120:Trio, NaturalPoint, USA). Between-group differences were assessed using non-parametric tests. Spearman correlations were calculated and Bonferroni corrections were applied for multiple comparisons (p= 0.013).RESULTS Compared to healthy controls, people with LBP showed a more ankle-steered postural control (p= 0.019), decreased lumbar proprioceptive reliance on unstable ground (p= 0.04) and increased multifidus echo-intensity (p< 0.002), without reduction in multifidus size (p> 0.60). After Bonferroni correction, only center of pressure displacement during back muscle vibration on stable ground showed a small negative correlation with multifidus echo-intensity (r= -0.38, p= 0.015).CONCLUSIONSThis study confirmed that compared to healthy controls, people with LBP showed impaired ability to up-weight lumbar proprioceptive use during more challenging postural conditions. This decreased proprioceptive acuity could perhaps be related to impaired multifidus quality, but not to multifidus size. However, there was only a moderate correlation on stable ground, and a few trends for significance after Bonferroni correction, but no associations in more complex postural conditions. Future studies could use larger samples with more advanced measurement techniques to determine muscle quality, such as muscle biopsies, or texture analysis for echo-intensity. This further clarify the relation between muscle quality and proprioceptive postural control in people with LBP.ACKNOWLEDGEMENTS AND FUNDING: FWO (grant 11B6522N, grant G072122N)

P03-G-65 - Kinematic and muscle networks reveal the modular control of sit-to-stand movements

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Background and aimThe neural control of movement is inherently complex due to the numerous degrees of freedom (DOF) in the musculoskeletal system and its biomechanical redundancy. Through the coupling of DOFs multiple muscles can become functionally linked and modularity has been proposed as the key organizational principle in motor control. Despite its importance, the modular organization of the neuromuscular system remains poorly understood. This study employs complex network analysis to examine the community structures of kinematic and muscle networks, providing new insights into the modular control mechanisms underlying sit-to-stand (STS) movements. MethodsWe investigated modular control by constructing functional muscle networks and a "kinectome" based on joint angle correlations. Data were collected from 20 healthy participants performing STS movements at fast and slow speeds. Full-body 3D kinematics and surface EMG signals from 16 muscles were analyzed. Kinematic networks were built by correlating 12 joint angle time series, while muscle networks were mapped using intermuscular coherence derived from EMG envelopes across muscle pairs. ResultsThe kinectome analysis revealed greater interlimb coordination between the knees and hips, along with stronger knee-spine coupling during faster movements. Muscle network analysis identified three multilayer networks corresponding to different frequency bands of intermuscular coherence: 0–7 Hz, 7–26 Hz, and 26–60 Hz. These networks displayed distinct activation patterns, with networks 1 and 3 showing peak

activation at maximum hip flexion. The third network exhibited significant effects of movement speed ($p < 0.001$) and task phase ($p < 0.001$), with higher activation during faster movements and standing up compared to sitting down. ConclusionComparing muscle networks and kinectomes across varying speeds and phases of STS movements highlights how kinematic and kinetic task constraints influence neuromuscular modular organization. Notably, intermuscular connectivity at higher frequencies peaked during maximum hip flexion, corresponding to the transfer phase when weight shifts between the chair and feet. Observed differences in movement speed and direction during this phase suggest a critical role in dynamic balance control. Acknowledgement and funding. Tjeerd Boonstra was supported by the European Union's Horizon 2020 Research and Innovation Program under the Marie Sklodowska-Curie grant agreement No 895914.

P03-G-66 - Impact of vestibular schwannoma characteristics on gait control: Can KOOS scores inform functional affordance?

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Background and Aim: vestibular schwannomas (VS) are benign tumors that typically grow at a slow rate within the internal auditory canal causing abnormal gait and postural control. The Koos score (KS) is a 4-stage classification system widely used to characterize VS development and guide therapeutic interventions. This study aimed to investigate the extent to which alternative indicators of VS progression (e.g., volume, cerebellar displacement) correlate with kinematic measures of functional gait performance as compared to the KS. Methods: Eighteen female (57 ± 12 years) and 16 male (54 ± 13 years) individuals diagnosed with VS at various stages of development (KS 1 n = 8, KS 2 n = 8, KS 3 n = 8, KS 4 = 10) were included. Participants completed standard walking tasks (e.g., 10-meter walk test (10MWT), timed up and go (TUG) and functional gait assessment (FGA) wearing six, light-weight inertial measurement sensors (IMUs) to record their kinematic behavior (e.g., gait cycle duration and range of motion (ROM)). The IMUs were placed on the head, trunk, pelvis, right hand, left and right ankles, respectively. Magnetic resonance imaging was used to confirm KS, determine VS volume and inform the extent of cerebellar displacement, if any. Results: Quantitative analyses between VS indicators and kinematic measures during standard clinical gait assessments revealed weak positive correlations between KS and gait cycle duration. Scattered weak-to-moderate, positive correlations were observed between KS and ROM, while correlations with ROM variability were strongly negative. Furthermore, moderate positive correlations were observed between gait cycle duration versus tumor volume and cerebellar displacement. Although borderline, those moderate correlations were four and five times stronger, respectively, than those observed relative to KS. As for the relationship between volume and cerebellar displacement with ROM while walking, fewer weak positive and negative correlations were observed than compared with KS. Conclusions: Although the KS classification system is a reliable tool to characterize VS growth, KS are not informative of functional gait adaptations in response to tumor development. Instead, tumor volume and cerebellar displacement were much more informative of changes in gait cycle duration. We suggest, therefore, that clinicians caring for VS patients should consider these metrics. Our data suggest that people living with VS may be attempting to preserve control of their spatial parameters of locomotion (e.g., ROM) at the expense of temporal parameters (e.g., cycle duration) - a hypothesis to be probed in future studies including comparison with healthy populations.

P03-G-67 - The impact of visual perturbations on balance control during walking

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Background: Visual perturbations may lead to illusions of self-motion, affecting balance control during walking. We explored how people deal with different visual perturbations during walking by assessing foot placement and center of mass (CoM) states. Methods: We recruited seventeen healthy young people and collected pelvis (as a proxy of the CoM) and foot kinematic data during walking. Participants were asked to walk on a treadmill at a speed of 3.6 km/h in different conditions: normal walking (NW), tracking a moving target with head rotation (MT-HR), and fixating on a stationary target while the background moved (MB). Visual perturbations were created by a projection on a screen 1.6m in front of the treadmill. Visual perturbations were always triggered at right heel strikes. Each perturbation included a moving phase (45 degrees right movement over 4s) and a stationary phase (8s). Linear models were fit to the kinematics data to predict foot placement from CoM state at mid-swing. Foot placement errors for the first ten steps after onset of the visual perturbation were calculated. Results: Over the whole trial, the presence of visual perturbations caused an increase in step width variability, foot placement residual error, and CoM position variability. During MT-HR perturbations, a significant right deviation of foot and COM trajectories was observed in the stationary phase. Rightward foot placement errors were significant at the fourth, seventh, nineth and tenth step. During MB perturbations, a left deviation of foot and COM trajectories was observed at the beginning of the moving phase. At the second, third, fourth, and sixth step, there was significant leftward foot placement error, while at the tenth step, there was a significant rightward foot placement error. Conclusions: Visual perturbations hamper stabilization of walking. MT-HR led to deviations in the direction of the target, while MB caused a deviation opposite to the background movement. The response to the visual perturbations was delayed in MT-HR, while it was fast in MB. Opposite to our expectations, foot placement errors did not coincide with subsequent CoM deviations in the opposite direction. Apparently, foot placement errors were followed by stance phase adaptations moving the CoM in the same direction as the foot. This study enhances our

understanding of the effects of visual perturbations on balance control during walking. Future studies will compare young and older adults.

P03-I-68 - Investigating the effects of foot orthotics on dynamic stability in females with pes planus foot posture

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Background and aim: Dynamic stability is defined as the center of mass (COM)'s ability to remain within the base of support during gait. Foot orthotics, a device which can modify the mechanical interaction between foot and the external environment, along with changes to the sensory inputs to the central nervous system are commonly prescribed for individuals with pes planus foot postures. As female's sport-related risk factors for injury remain high [1], and there is a higher prevalence of planus foot posture in females compared to males [2], the purpose of this study was to investigate the role of foot orthotics on controlling dynamic stability when females with pes planus foot posture experience a modified foot placement orientation during walking. Methods: Eighteen healthy young females (21.78 ± 3.23years) were instrumented with 12 IRED markers (100Hz, Optotrak Certus; Northern Digital Inc., CAN) to calculate the COM and performed trials with and without prefabricated foot orthoses placed in Brooks Ghost athletic shoes during 31 walking trials. Experimental trials of level walking, and steps onto inverted or everted wedges, challenged participants' dynamic stability while kinetic data (100Hz) was sampled from 3 force plates flush with the walkway (OR6-5-2000, AMTI, USA). Gait parameters (step length, width and walking velocity) and dynamic stability (center of mass – base of support (COM-BOS) max, min and range, medio-lateral center of pressure (ML-COP) and antero-posterior center of pressure (AP-COP) max and min) outcomes were statistically evaluated with a repeated-measures ANOVA by within-subject factors of foot orthotic (none, orthotic) and step orientation (level, inversion, eversion). The relationship between foot posture index (FPI) score and dynamic stability was evaluated with spearman correlations for non-parametric data. Results: Walking in foot orthotics (22.6±14.5mm) significantly reduced the COM-BOS range ($F_{1,259}=4.73$, $p=0.03$) compared to shod walking trials (24.5±15.9mm). Dynamic stability was modified similarly regardless of changing the orientation of the loaded foot. In level walking, as FPI score increased, the COM-BOS range ($r(166) = -0.46$, $p<0.001$) was reduced and AP COM-COP max ($r(135) = 0.31$, $p<0.001$) and ML COM-COP max ($r(136) =0.32$, $p<0.001$) and min ($r(134) = 0.27$, $p=0.002$) increased during level walking trials in orthotics. Conclusions: As the foot becomes more flexible (increased FPI score), foot orthotics effectively controlled dynamic stability by minimizing movement between the COM and BOS. Foot orthotics may be a useful preventative measure to reduce injury risk in females with pes planus foot postures. [1] Collings et al., (2021). Sports Medicine, 51(4), 759-776. [2] Aenumulapalli et al., (2017). J. Clin. Diagn. Res. 11(6); AC17-AC20.

P03-I-69 - Visual and tactile biofeedback without training

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Visual and Tactile Biofeedback Without TrainingMarcel Tesolin1, Nourallah Salem1, Taylor Cleworth1 1York UniversityBACKGROUND & AIM: Balance control is a complex motor skill accomplished through the integration of multisensory information from the visual, vestibular, and somatosensory systems [2]. Providing individuals with biofeedback, such as in the form of vibrotactile feedback or enhanced optic flow, has been shown to improve postural control [2,3,4]. However, there is limited work on the combined effects of vibrotactile feedback and modified optic flow on postural control. Therefore, the purpose of this study was to identify the relationship between vibrotactile feedback and modified optic flow gain during quiet stance.METHODS: Forty-five young, healthy adults stood for 30 seconds on a foam pad with their stance width standardized to their foot length. Participants wore 1 sensing inertial measurement unit strapped at the level of the L5 vertebrae, 4 feedback units strapped to their upper right and left arms, abdomen, and upper back, and a virtual reality head mounted display displaying a realistic environment. The gain of the visual scene motion was manipulated by a factor of 0x, 1x or 4x, which caused the head position-derived scene motion to be nulled (0x), unaffected (1x), or amplified (4x), respectively. Participants completed three baseline trials followed by six experimental trials in which vibrotactile feedback (on vs. off) and optic flow gain (0x,1x and 4x) were manipulated. Vibrotactile feedback was provided when participants swayed beyond a threshold of ±40% of the 90% range calculated from baseline conditions [1]. The amplitude of angular displacement and velocity, frequency of angular displacement, and amplitude of linear acceleration, were analyzed and used to quantify balance behaviour.RESULTS: The amplitude of angular displacement and linear acceleration decreased between gain values of 0x and 4x. The frequency of angular displacement and the amplitude of angular velocity increased with tactile biofeedback.CONCLUSIONS: Tactile biofeedback resulted in an increased speed and frequency of postural sway, while amplified visual biofeedback decreased sway amplitude. The lack of interaction effects between tactile biofeedback and visual gain suggests that combined tactile and visual biofeedback do not improve postural stability. Practice trials and training may aid in familiarizing participants with the vibrotactile sensation, which may improve postural stability during tactile feedback. Further work is needed to examine the interaction between vibrotactile feedback and augmented optic flow in populations who may have balance deficits.REFERENCES:[1] Allum et al. (2017). JVR.[2] Lavalle & Cleworth (2023). Neurosci. Lett. [3] Mancini et al. (2012). JNER.[4] Sienko et al. (2012). JNER.

P03-I-70 - Towards Myoelectric model-based control of bionic legs in the outdoors

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BACKGROUND AND AIM: Biomimetic motorized ankle-foot prostheses are becoming increasingly viable solutions to restore the mobility in patients after a transtibial amputation. In a recent paper by Damonte et. al., a novel myoelectric human-machine interface for continuous volitional control of a bionic leg was proposed. It featured an EMG-driven neuromechanical model-based controller, which simulated the phantom limb in real time and converted the residual muscle EMGs into low level commands to drive a motorized ankle-foot prosthesis. The study was performed in a laboratory setting. Our goal is to take a myoelectric bionic leg outside of the lab and evaluate it in real world scenarios. In this work we propose a fully portable solution that could facilitate this transition and we evaluate its technical feasibility.METHODS: To avoid the hardware limitations identified by Damonte et. al., we chose the ankle module of the Open-Source leg version 2 (OSLv2) for our motorized prosthesis (battery powered, peak torque: 160 Nm, range of motion: 30° plantarflexion, 30° dorsiflexion). The control logic of OSLv2 runs on a Raspberry Pi 5 (RPi 5) at 300 Hz. Neuromusculoskeletal modelling of the phantom ankle for our mid-level control was done with the open-source CEINMS-RT platform, slightly modified to run on the RPi 5. To evaluate the system's performance, we timed the execution of the two most computationally intensive parts of CEINMS-RT (calculation of kinematics of the musculotendon units and the EMG-driven model) on over 6000 prerecorded samples of data. Both of these operations as well as the OSLv2 control loop ran on separate threads.RESULTS: On a RPi 5 embedded system, the average computational time of the MTU kinematics component was 0.22 ms (compared to 0.39 ms on a desktop computer reported in literature) with 95% of the samples being produced within 0.55 ms. The average computational time of the EMG-driven model on RPi 5 was 0.29 ms (0.31 ms on a desktop computer from literature) with 95% of the samples being produced within 0.80 ms.CONCLUSIONS: The computational latencies on the Raspberry Pi 5 embedded controller were comparable to those on a desktop computer from literature. The OSLv2 control logic can run unimpeded at 300 Hz. The total latency in our system is significantly lower compared to the 30 to 100 ms physiological electromechanical delay typically observed in human skeletal muscles. Therefore, we expect no performance loss when transitioning from the lab to a fully portable solution for the outdoors.ACKNOWLEDGEMENTS AND FUNDING: This work was funded by the Össur and Ottobock Research Trust Fund at the University of Iceland - Closed loop control of a powered ankle prosthesis using neuromusculoskeletal modelling and artificial sensory feedback (PERSONIFY).

P03-J-71 - Individual calf muscle structural and functional responses to 12 weeks of eccentric training

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Individual Calf Muscle Structural and Functional Responses to 12 Weeks of Eccentric TrainingC. Rivares1, M. Sartori11 Department of Biomechanical Engineering, University of Twente, Enschede, NetherlandsEmail: c.rivaresbenitez@utwente.nlBackground and AimNeuromuscular disorders can significantly affect quality of life as skeletal muscle function often progressively declines. Slowing or preventing this deterioration requires targeted interventions. To support this, we need a better understanding of how skeletal muscles adapt in vivo. In this study, we examined changes in calf muscle morphology and function in healthy young adults following 12 weeks of eccentric training. Muscle volume, muscle tendon complex length and fascicle length, as well as force production were assessed to capture the remodelling process over time. These insights can help to develop predictive of muscle adaptation and contribute to the development of robotic technologies to support gait rehabilitation and clinical care.MethodsWe assessed calf muscle adaptation in six healthy university students (3 male, 3 female, mean age 25 ± 4 years). Muscle volume and length were measured using 3D ultrasound, following validated methods [1]. To assess muscle force, we used dynamometry. Participants followed a 12-week eccentric training program, training every other day. Each session included four sets of 8 to 12 controlled eccentric contractions, using one-leg calf raises and one-leg donkey calf raises. To ensure progressive overload, we gradually increased the load over time. Both legs were trained.Results and DiscussionPreliminary results indicate that eccentric training significantly increased peak force of the gastrocnemius medialis after 12 weeks ($p < 0.05$; Fig. 1A). Changes in muscle volume and physiological cross-sectional area were subject-specific (e.g., Fig. 1B). A similar trend was observed for muscle and tendon lengths, with changes varying across subjects and over time (Fig. 1C).ConclusionsOur findings highlight the considerable individual differences in how muscles adapt to eccentric training. This underlines the importance of personalized approaches in neuromuscular rehabilitation, athletic training, and regenerative medicine.AcknowledgmentsThis work was supported by the European Research Council with StG grant INTERACT (no. 803035) and CoG grant ROBOREACTOR (no. 101123866). We thank dr. G. Weide for his assistance in implementing 3D ultrasonography in this study.Figure 1: Subject-specific changes in gastrocnemius medialis and Achilles tendon following 12 weeks of eccentric training. (A) Increased peak force ($P<0.05$). (B) Muscle volume. (C) Muscle length (left y-axis) and tendon length (right y-axis). Results are presented for each subject individuallyReferences[1] Weide G. et al. (2017). J. Vis. Exp., 129, 55943.

P03-J-72 - Effects of tailored intense physical exercise in the hospital and patients' daily life in Parkinson's disease and atypical Parkinsonian disorders. A multicenter, double-blind, randomized controlled trial

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Background and Aim:Gait and mobility impairment are pivotal signs of parkinsonism, and they are particularly severe in atypical parkinsonian disorders (APD) including multiple system atrophy (MSA) and progressive supranuclear palsy (PSP). A pilot study demonstrated a significant improvement of gait in patients with MSA of parkinsonian type (MSA-P) after physiotherapy and matching home-based exercise, as reflected by sensor-based gait parameters. In this study, we aim to investigate whether gait-focused physiotherapy (GPT) and matching home-based exercise lead to a larger improvement in gait performance compared with a standard physiotherapy and home-based exercise program (standard physiotherapy, SPT). Methods: This study is a registered multicenter, double-blind, randomized-controlled trial (Mobility_APP, NCT04608604). Patients were recruited at the Movement Disorders Units of Innsbruck (Austria), Erlangen (Germany), Lausanne (Switzerland), Luxembourg (Luxembourg), and Bolzano (Italy). The study starts with one week of mobility monitoring using wearable sensors. Afterwards, patients were randomized into either the GPT or SPT group. Each group conducted daily inpatient physiotherapy over two weeks, followed by five weeks of unsupervised home-based training. Finally, a one-week physical activity monitoring was repeated during the last week of intervention. Primary outcome is the change in gait speed (baseline to week 7) derived from sensor-based, standardized gait tests in the hospital. Secondary outcomes included mobility parameters derived from sensor-based recordings in daily life. Results: In total, 106 patients were recruited (33 MSA, 26 PSP, and 47 PD). Baseline characteristics reveal that APD patients showed a shorter disease duration compared to patients with PD. Participants with MSA and PSP featured more severe motor impairment, as reflected by higher MDS UPDRS III scores. They presented reduced gait velocity during gait analysis in the hospital, with higher variability and asymmetry in most sensor parameters. In daily life, apart from a lower step count per day, APD participants also showed less activity (locomotion vs. non-locomotion), lower intensity (cadence), and simpler mobility patterns. Disease-specific characteristics, differentiating MSA and PSP, were observed in both sensor and clinical parameters. Additionally, strong correlations were found between clinical scores and both sensor-based gait parameters in the hospital and patients' daily lives across all the groups. Further effects of exercise interventions will be presented at the conference. Conclusion: This study includes a large cohort of PD and APD patients and presents a comprehensive characterization of gait and mobility in patients with APD, assessed by gait tests in the hospital and mobility monitoring in daily life. Identifying potential differences in the effects between both exercise intervention arms is the subject of this analysis.

P03-J-73 - Koku4pd - co-development of the keep on keep up program for people with Parkinson's

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Background and aim: Keep On Keep Up (KOKU) is a tablet-based strength and balance programme that incorporates the safety features and progressive intensity levels of the evidence-based Otago Exercise Program[1]. The original KOKU app was designed to prevent physical decline and frailty in older adults at risk of falls, but has potential for implementation in other at-risk clinical groups[2]. This three-phase study aimed to: 1) determine the usability of the original KOKU app for people with Parkinson's (PwP); 2) develop the app for PwP based on findings from phase 1; and 3) determine the impact of KOKU4PD on gait and balance.Methods: In phase 1, 20 PwP (14 male, 6 female; mean age: 68.5±9.8 yrs; mean disease duration 5.9±4.8 yrs; mean H&Y stage 1.8±0.62) used the KOKU application to exercise unsupervised at home, 3 times a week, for 4 weeks. Usability of the application was explored through semi-structured interviews and questionnaires. In Phase 2, themes generated from Phase 1 data were used to guide discussions within a series of focus groups involving participants, clinicians and the KOKU app developers. Key areas where KOKU could be improved for use by PwP were identified and the app was modified. 14 PwP trialled the new KOKU4PD app (4 male, 10 female; mean age 65.4±7.25 yrs; mean disease duration 4.9±4.23 yrs; mean H&Y stage 1.71±0.73). Usability of the app was assessed with the System Usability Scale (SUS). Initial efficacy of the app was explored through a range of laboratory-based clinical assessments (e.g. Mini BESTest, Timed Up and Go – TUG) and iSway outcomes (instrumented sway using APDM® Mobility Lab).Results: Findings from Phase 1 revealed limitations of the original KOKU app relating to exercise progression, inadequate guidance on intensity and repetitions and a lack of motivational features to maintain engagement for PwP. The app was modified to include questions around Parkinson's-specific symptoms, the inclusion of "big movement" warm-ups and enhanced content relating to exercise targets, performance feedback and visual incentives. The mean SUS rating for the modified KOKU4PD (SUS; 0–100 range, higher scores indicating better performance) was 84.33±8.29points (indicating "excellent" usability). Preliminary efficacy data showed a mean 2-point increase in Mini-BESTest scores (r=0.53, p=0.007) and a mean 1 second reduction in time taken to complete the TUG test (r=0.37, p=0.048) following 4 weeks of app use. There were also improvements in iSway outcomes during standing on a firm surface at follow up (postural sway centroidal frequency r=0.49 p=0.050).Conclusions: Preliminary findings suggest that the KOKU4PD programme can be considered a useful and user-friendly app to support home-based exercise for PwP, with early signals of efficacy in relation to gait and balance outcomes. Future work will be required to determine the efficacy of KOKU4PD and factors affecting long term engagement in a larger cohort of PwP.1. Campbell, A., & Robertson, MC., Otago exercise programme to prevent falls among older adults., U.o. Otage, Editor. 2003.2. Choi, N.G., et al., A Feasibility Study of Multi-Component Fall Prevention for Homebound Older Adults Facilitated by Lay Coaches and Using a Tablet-Based, Gamified Exercise Application. J Appl Gerontol, 2021. 40(11): p. 1483-1491.

P03-J-74 - Optimal reactive balance training characteristics post-stroke: Secondary analysis of a randomized controlled trial

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Title: Optimal reactive balance training characteristics post-stroke: secondary analysis of a randomized controlled trialJúlia O. Faria1; Cynthia J. Danells2, Elizabeth L2. Inness; Avril Mansfield2 1. Ribeirão Preto Medical School, University of São Paulo, Ribeirão Preto, Brazil2. KITE-Toronto Rehabilitation Institute, University Health Network, Toronto, ON, Canada Background: Regaining balance is crucial for independent walking, but reactive balance strategies are frequently impaired after stroke. Although these strategies are essential for fall prevention, they remain undertrained in rehabilitation, where anticipatory balance training is often prioritized. Reactive balance training (RBT) addresses this gap and has demonstrated potential for improving reactive balance control and reducing falls post-stroke. However, findings of previous studies are mixed, which may be due to variability in training characteristics. This study aimed to determine the influence of RBT characteristics on improvements in reactive balance control and falls in daily life among people with chronic stroke.Methods: This secondary analysis included participants with chronic stroke in a randomized controlled trial who were assigned to RBT. Included participants completed the mini-Balance Evaluation Systems (mini-BEST) pre- and post-training and self-reported falls in daily life after training. Participants completed up to twelve one-hour RBT sessions over six weeks (twice per week), delivered one-on-one in a research laboratory equipped with an overhead safety harness system. Each session included a warm-up, balance tasks involving internal and/or external balance perturbations, and a cool-down. Perturbations were induced by the participant's own movement (e.g., losing balance while kicking a ball) or by the physiotherapist (e.g., pushes).Training sessions were structured to include four progressively challenging task types: stable (e.g., standing), quasi-mobile (e.g., weight shifting), mobile (e.g., stepping), and unpredictable. Each session aimed for at least 60 balance perturbations during task performance. Tasks were tailored to participants' abilities and adjusted in difficulty as needed. We analyzed associations between training characteristics (number of perturbations, difficulty level, types of tasks completed, perceived difficulty, and success rate) and fall rates and mini-BEST reactive sub-scores post-training.Results: The total number of perturbations was associated with a better post-intervention reactive balance control; each 100 additional perturbations was associated with a 0.49-point increase in the mini-BEST score section 2 (Reactive Postural control) score (95% confidence interval: [0.09–0.90]; p=0.019). No significant predictive value was found for adaptation difficulty levels and different tasks (stable, semi-mobile, mobile and unpredictable), or for fall rates.Conclusion: Exposure to a higher number of perturbations—often achieved by participants who completed more sessions—was associated with greater improvements in reactive balance. Adaptation difficulty levels

were not significant predictors of improved reactive balance control or reduced fall risk, indicating that other factors, such as training volume may play a more substantial role. These findings highlight the importance of the overall structure and progression of the training program rather than isolated adjustments to task difficulty.

P03-J-75 - The effect of lower limb movement velocities on trunk muscle activity and dynamic stability during the Sahrmann core stability test

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[Background and Aim] Methods for evaluating core stability are widely utilized in numerous studies, with static assessments such as the plank test and side bridge test commonly adopted (Friedrich et al., 2017). Conversely, methods for assessing dynamic stability also exist, and the Sahrmann Core Stability Test (SCST) can evaluate core stability during movement (Chan et al., 2020; Kuniki et al., 2022). However, it remains unclear how variations in lower limb movement speed during the SCST affect core muscle activation patterns, contraction timing, and activity intensity. This study aims to evaluate the impact of different lower limb movement speeds during the SCST on core muscle contraction timing, muscle activity levels, and bilateral muscle activity balance, and to examine their contribution to dynamic stability. [Methods] Sixteen healthy adult males (mean age: 24.9 ± 5.0 years) participated in this study with informed consent. This study adhered to the Declaration of Helsinki and was approved by the Kanazawa Orthopedic Sports Medicine Clinic Ethics Committee (kanazawa-OSMC-2024-010). The testing protocol employed Level 3 of the SCST in the supine position. Participants began from a start position with both legs raised and, using a pressure sensor set to 40 mmHg (±10 mmHg) to maintain lumbar stability, lowered one leg to a height of 12 cm above the floor. The test involved three movement speeds: slow (5-second), medium (3-second), and fast (1-second). The conditions were randomized, with 3-minute rest intervals between trials to minimize fatigue and learning effects. Electromyography (EMG) was recorded from six sites: bilateral rectus abdominis (RA), external oblique (EO), and internal oblique/transversus abdominis (IO/TrA). EMG data collected during contractions were processed using root mean square smoothing, and %MVC was calculated by measuring maximum muscle strength. Additionally, an accelerometer attached to the thigh was used to determine the start of movement. Average %MVC was calculated for five intervals: 500 ms before movement onset (pre-500ms), 250 ms before movement onset (pre-250ms), the first third after movement onset (post-1), the middle third after movement onset (post-2), and the final third after movement onset (post-3). These averages were compared across the three trials. Statistical analysis was performed for each muscle using the Friedman test across the three trials, and post-hoc tests were conducted where significant differences were found. [Results] In the post-2 interval,

muscle activity of the right EO, left EO, and left RA was significantly higher in the fast condition compared to the slow and medium conditions (Friedman test, $p < 0.05$). Post-hoc pairwise comparisons (Wilcoxon test) revealed a significant difference between the fast and slow conditions for the left EO ($p = 0.018$). No significant differences were observed between trials in other pairwise comparisons (Wilcoxon test, $p > 0.05$). [Conclusion] Variations in lower limb movement speed during the SCST may influence core muscle contraction timing, activity levels, and bilateral muscle activity balance. Specifically, at higher speeds, the activity of bilateral EO and contralateral RA is enhanced from early after movement onset, suggesting a contribution to dynamic core stability. These findings may provide valuable insights for establishing speed criteria in the SCST.

P03-J-76 - Dose-response relationship of treadmill perturbation-based balance training for improving reactive balance in older adults at risk of falling

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Background and aim: The inability to appropriately react to balance perturbations is a common cause of falls. Perturbation-based balance training (PBT) is especially beneficial for improving reactive balance and shows high potential for fall prevention. However, its dose-response relationship, feasibility, and acceptability remain to be determined among older adults at risk of falling. The FEATURE study aimed to compare the efficacy of two treadmill PBT protocols with different session numbers to improve reactive balance, and to evaluate their feasibility and acceptability in this population.Methods: In this randomized controlled pilot trial, 36 older adults at risk of falling were allocated to receive either six (6PBT) or two treadmill PBT sessions (2PBT). Reactive balance in standing (Stepping Threshold Test [STT]) and walking (Dynamic Stepping Threshold Test [DSTT]) was assessed as primary outcome at baseline (T1), post-intervention (T2), and 6-week follow-up (T3). Secondary outcomes included measures on physical, psychological, and cognitive functioning. Feasibility was assessed via PBT adherence, planned perturbations completed, and adverse events; acceptability via questionnaire. Between-group changes over time were compared using repeated-measures analyses of variance with Bonferroni-corrected post-hoc tests. Data analyses followed the intention-to-treat principle.Results: A significant time effect was observed for the DSTT ($p=0.008$), with both groups significantly improving from T1 to T2 ($ps<0.01$). A significant interaction effect ($p=0.027$) revealed that only the 6PBT group maintained these improvements (T1 vs. T3: $p<0.001$) and scored significantly higher than the 2PBT group at T3 ($p=0.015$). No significant interaction effects were found for the STT or any secondary outcome, but improvements over time were observed for dynamic balance, gait capacity, functional mobility, physical activity, concerns about falling, and executive functioning (time effects: $ps<0.05$). PBT adherence, planned perturbations completed, and acceptability

were high in both groups, with no significant between-group differences. No intervention-related serious adverse events were reported.Conclusions: Findings suggest that a low number of treadmill PBT sessions can lead to task-specific improvements in reactive balance during walking, with a higher practice dose enhancing sustainability. Treadmill PBT appears feasible and well-accepted among older adults at risk of falling, regardless of sessions received. Acknowledgment and funding: We kindly thank Colin Ludwig, Meret Nickel, Carolin Breitwieser, and Lara Daugs for their assistance with screening, recruitment, training, and assessment in the FEATURE study, and all the volunteers for their willingness to participate in the study. No external funding was received.

P03-K-77 - Targeted stepping in persons with stroke: The role of external support and pre-step strategy on foot placement accuracy and precision

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Background and aims: Foot placement accuracy, the position of the foot relative to a target location, is crucial for gait stability, especially in challenging conditions. In persons with stroke (PwS), this ability is often compromised, with greater errors typically observed in the paretic leg. Previous studies have focused on single-step tasks from a static position, providing limited insight into pre-target stepping strategies or adaptive control in multi-step walking toward distant targets. We aimed to examine how PwS adapt stepping strategies and foot placement accuracy to targets placed at varying distances, with and without external hand support. Methods: Nine PwS (age: 67.7 ± 9.7 years; time since stroke onset: 12.1 ± 5.3 months; Lower-extremity Fugl-Meyer:20.1± 6.5; Berg Balance Scale:46.7± 8.1) performed a targeted stepping task on a stationary treadmill equipped with pressure sensors (Zebris FDM-T, Zebris Medical GmbH, Germany). Circular targets (6 cm diameter) were projected at three locations calibrated to each participant's stride length: normal (100% of stride length), medial (15% medial deviation from the stride center), and far (115% of stride length). Participants were instructed to step onto each target as quickly and accurately as possible. A custom MATLAB script was used to extract and analyze foot pressure data. Foot placement accuracy was defined as the mean absolute error (MAE), distance between the point of maximal pressure and the center of the target. Foot placement precision was defined as the mean variable error (MVE), representing the standard deviation of foot placement locations across repeated trials for the same leg. Linear mixed models were used to test the effects of 'target location', 'hand support condition' (supported vs. unsupported) and 'stepping leg' (paretic vs. non-paretic). Results: No significant differences in accuracy or precision were observed across the three target locations; thus, data were pooled across targets. For the step toward the target, significant main effects of 'leg' and 'support condition' were found: the paretic leg was less accurate than the non-paretic leg (p = 0.012), and handrail

support significantly improved accuracy (p = 0.008). A significant leg × support interaction (p = 0.003) revealed that leg-related differences in accuracy were only present in the unsupported condition (Figure 1); with support, no significant differences were found between legs. No significant effects were found for precision. For the pre-target step, a significant main effect of 'leg' was observed. When the non-paretic leg performed the pre-target step, it landed closer to the target in the anterior-posterior direction, but showed decreased mediolateral precision compared to the paretic leg. Conclusions: PwS exhibit reduced foot placement accuracy but not precision in the paretic leg, particularly when external support is not provided. Additionally, the stepping strategy prior to target contact differs between legs, potentially reflecting compensatory adaptations. These findings highlight the importance of distinguishing between foot placement accuracy and precision, as this differentiation can reveal the specific nature of motor control impairments post-stroke and guide the development of targeted rehabilitation strategies tailored to the underlying deficit.

P03-K-78 - Design considerations for fall-resisting skills training trials in older adults: A pilot study

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BACKGROUND AND AIM: Training fall-resisting skills (e.g., proactive gait adaptability, gait robustness (GR), reactive gait recovery (RGR)) may prevent falls in older adults. This pilot study guided the design of an RCT of fall-resisting skills training by investigating key design factors. The aims were: 1) check if selected non-task-specific balance tasks can be perceived as training and potentially used as placebo control tasks, 2) investigate the anxiety - task unpredictability relationship, and 3) explore quantification methods of a stability loss threshold for GR assessment to assess the size of perturbations that can be tolerated before overt reactive gait recovery is needed.METHODS: 7 healthy older adults (75±6y) performed non-task-specific "placebo" balance tasks (weight-shifting, dual-task walking) and fall-resisting skills tasks on the CAREN (Motek Medical, NL). For aim 1, participants answered open questions regarding perceived training benefits, balance improvement, and recommendation of the training to others. For aim 2, participants walked with perturbations that progressed from single to multiple directions, to multiple directions with an additional auditory dual task. Anxiety levels were assessed with a 7-point Likert scale and open questions. For aim 3, participants walked with perturbations of gradually increasing magnitude. A threshold for stability loss previously used in the literature (defined as when MoS at recovery step touchdown exceeds the average pre-perturbation MoS by 3SD) was compared to participants' perceptions of stability, using a 7-point Likert scale, and balance loss (yes/no).RESULTS: 6 of 7 and 3 of 7 participants thought they could improve on the weight-shifting tasks and dual tasks, respectively. 6 of 7 felt the placebo training would improve their balance and would recommend the training to others. Participants started with an anxiety score of 2.8±1.7 (single direction

perturbations). As perturbation unpredictability increased, anxiety scores decreased from 1.7±1.2 (multiple directions) to 1±0 (multiple directions and dual task). For the GR task, the 3SD MoS threshold did not consistently align with participants' perceptions of stability and balance loss, with participants sometimes indicating feeling instability and balance loss already with smaller perturbations, despite only showing smaller deviations in MoS.CONCLUSIONS: Weight-shifting placebo control tasks will be perceived as balance training by most older adults, while dual-task walking is less perceived as able to improve balance. Using multiple types of perturbations in combination with dual tasks does not appear to induce much anxiety as long as they are introduced in this order (i.e., repetition reduces anxiety). A single 3SD threshold based on the MoS may not be sufficient as a measure of GR since this is sometimes inconsistent with participants' perceptions of stability and balance loss; a multicriteria threshold may be more robust.

P03-K-79 - Structural neural correlates of balance recovery responses among fallers and non-fallers older adults

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Background and aim. Balance-recovery responses to unexpected balance loss are a consequence of a complex, synergic, multi-systemic integration of sensorimotor processes, which are susceptive to deterioration due to natural aging. It has been suggested that there are underlying structural neural differences which may also explain age-related deterioration in motor performances among older adults. Here, we aimed to investigate variations in kinematic parameters and strategies of balance recovery-stepping responses during treadmill walking, as well as differences in gray matter volume within predefined regions of Interests (ROIs) among older adults who are fallers and non-fallers. Additionally, we aimed to explore the associations between gray matter volume in specific ROIs and balance recovery ability (i.e., fall threshold) when balance is lost unexpectedly while treadmill walking. Fall threshold was defined as the perturbation intensity that results in unsuccessful balance recovery, i.e., when a participant was unambiguously supported by the harness system.Methods. A sample of 37 older adults (age range 70–90) performed a structural MRI brain scan required for ROI analysis of gray-matter volume and an assessment of reactive stepping responses to unexpected balance perturbations during walking. Participants were exposed to six gradually increased perturbation magnitudes. Single-step threshold, (i.e., the minimum perturbation intensity that consistently elicits a compensatory step that extended the base of support in at least two consecutive perturbation intensities), spatiotemporal kinematic parameters and gray-matter volume in 10 cortical and subcortical ROIs were assessed and compared between fallers and non-fallers. Participants were considered

'fallers' based on their fall threshold during the perturbed walking trials, i.e., if a participant fell into the harness system during the perturbation trials. Participants who completed the full experiment without falling were considered as 'non-fallers.' Associations between fall threshold and gray-matter volume were also explored using partial correlation analysis. Results. Fallers (n=22) exhibited a longer recovery step initiation time (p=0.057), lower step-threshold (p=0.056) and a trend for longer swing time (p=0.073) compared to non-fallers (n=6). No significant differences were found in any gray-matter volume between fallers and non-fallers. Results from the partial correlation analysis showed that reduced gray-matter volume in the cerebellum was associated with a diminished fall threshold during perturbed walking (r = 0.56; p=0.01). Conclusions. This is an exploratory study indicating the central role of the cerebellum in effective reactive balance performance among older adults. Our findings should be replicated in larger cohorts and potential changes in gray-matter volume resulting from perturbation-based balance training should be explored.

P03-K-80 - Center of pressure control in a forward fall arrest

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Background and aim:An inverted pendulum model has been used to model upright stance and provided significant insight into the biomechanics of upright stance and balance. Here we extend the model to gain insight into using the arms to arrest a forward fall. When balance recovery is not possible, the center of mass (CoM) is outside of the base of support and the body is accelerated toward the ground. When the hands contact the ground the base of support may be extended to contain the vertical projection of the CoM and arrest the downward acceleration. The aim of this work is to develop a model to characterize the level of instability experienced during a forward fall arrest. Methods: Figure 1 shows a diagram of a forward fall arrest modeled as an inverted pendulum. Summing moments around point O, assuming small angles, and simplifying gives (1)where vGRF is the vertical ground reaction force, u is the CoP location, m is the mass, g is the acceleration due to gravity, x is the CoM location, L is the pendulum length, and y is the vertical position of the CoM. The time to contact can be estimated at a specific instant in time by solving the quadratic equation associated with equation (1). The margin of stability (MoS) can be estimated by taking the product of the time to contact and instantaneous velocity [1]. Twelve older adults (4 females, 72 (7) yrs) and 11 younger adults (3 females, 23 (11) yrs) were instructed to perform a single push-up 'as fast as possible'. Instructions to perform the push-up 'as fast as possible' were meant to induce the most unstable state that participants were willing to tolerate. Example data is shown in the bottom frame for figure 1 for the lowering phase of a push-up, a forward fall arrest-like movement. The time to contact and MoS were estimated when the vGRF under the hands was at a minimum. Results: Younger adults performed the lowering portion of the push-up (780 (258) s) more rapidly than older adults (1123 (650) s). The time to contact was shorter (t), and the MoS was more negative for younger adults (t = 0.34 (0.12) s, MoS =-0.039 (0.025) m) indicating a greater level of instability compared to older adults (t = 0.52 (0.21) s, MoS =-0.027 (0.018) m). Conclusions: We hypothesize that participants performed the task as quickly or allowing as large a CoP-CoM displacement as they can arrest without impacting the floor. This may be explained by age-related declines in the energy absorbing capacity of the arms. The framework provides a novel avenue for investigating fall arrest strategies and a possible construct for feedback control of a fall simulator developed by the authors. Acknowledgments: The authors acknowledge a support from the Kahlert foundation and the Stevenson Summer Scholars Research Program. References: [1] Hof et al. (2005), J Biomech 38(1).

P03-K-81 - Identifying key clinical and mobility measures for fall risk classification in Parkinson’s disease

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Background and aim: Falls are a serious concern in Parkinson’s disease (PD), often leading to loss of independence, reduced quality of life, and increased healthcare costs [1]. Effective management of falls requires early identification of high-risk individuals. Although many clinical and mobility-related outcomes have been linked with falls, it remains unclear which selection of outcomes best discriminate fallers from non-fallers [2].Methods: Participants with PD were recruited to the ICICLE-GAIT study. Data presented are from the 54-month follow-up assessment. Participants were stratified into fallers and non-fallers based on monthly prospective fall reports [3]. A total of 299 outcomes across 4 domains (clinical, lab-based gait and turning, real-world mobility) were collected. The clinical domain included demographics and disease specific measures (n=9). Gait was assessed using an instrumented walkway (GAITRite) walking at a preferred and fast speeds (n=60). Turning (180°) was evaluated using a lower-back inertial sensor (Opal) (n=99[4]). Real-world mobility was monitored using a triaxial accelerometer (Axivity AX3) worn on the lower back for 7 days (n=131[5]). Outcomes were reduced by selecting those with significant group differences($p<0.05$) and moderate to high effect size($d>0.10$). Receiver operating characteristic (ROC)analysis was conducted within each domain and across domains to evaluate the classification models distinguishing fallers from non-fallers. Area under the curve (AUC) determined which models were optimal. Results: Of the 48 participants, 32(67%) were classified as fallers and 16(33%) as non-fallers. Significant group differences were found in all domains; clinical (n=2/9), lab-based gait (n=4/60), lab-based turning (n=19/99) and real-world mobility (n=5/131). ROC analysis (Fig1a) showed the turning model had the highest discriminative ability (AUC=0.89), followed by the real-world mobility (AUC=0.82). Lab-based gait (AUC=0.73) and clinical (AUC=0.71) models exhibited lower but comparable performance. Any domain combination included turning yielded resulted in high

accuracy: AUC=1.00 (Fig1b). In contrast, combinations excluding turning showed suboptimal performance (Fig1c, AUC≤0.84).Conclusion: Turning measures showed superior discriminative power in identifying PD fallers, outperforming clinical, lab-based gait, and real-world mobility assessments. Real-world mobility also had strong predictive value, highlighting the importance of ecologically valid continuous monitoring. Combining turning with other mobility outcomes improved classification, achieving perfect discrimination in some models. Future models should incorporate real-world turning to improve predictive accuracy and better reflect the daily mobility challenges faced by people with PD.[1] Alfonso 2017 PMID: 29067726[2] Canning 2014 PMID: 25095816[3] Hunter 2018 PMID: 28573883[4] Rehman 2020 PMID: 32961799[5] Del Din 2016 PMID: 27175731

P03-K-82 - The effect of functional electrical stimulation combined with reactive balance training on reactive stepping in individuals with incomplete spinal cord injury: A randomized clinical trial

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Background: People with motor incomplete spinal cord injuries (iSCI) are at increased risk of falling. Prevention of falls requires intact reactive balance responses, such as taking a reactive step. Reactive balance training (RBT) involves repeated practice of reactive steps through manually applied perturbations during standing and walking tasks. RBT improves balance control in individuals with iSCI; however, it is difficult to participate in RBT without the ability to initiate a reactive step independently. A potential solution is the use of functional electrical stimulation (FES) to initiate a reactive step after a perturbation. FES to the common fibular nerve (CFN) elicits a flexor withdrawal response causing hip and knee flexion and ankle dorsiflexion. CFN stimulation during RBT (RBT+FES) could facilitate repetitive practice of reactive stepping and lead to a therapeutic effect.Aim: We compared the efficacy of RBT+FES to RBT alone in individuals with chronic, motor iSCI. We hypothesized that following RBT+FES, participants would show greater improvements on measures of balance, balance confidence, lower limb strength and proprioception than participants of RBT.Methods: Twenty-two individuals (11 Women, 11 Men, 63.1 ± 14.8 years old) with chronic, motor iSCI (3.7 ± 2.7 years post-injury) participated. Participants were randomly allocated to RBT+FES or RBT alone and completed 18 one-hour training sessions over six weeks. Outcome measures included the Berg Balance Scale (BBS), mini-BESTest (reactive subscale), Activities-specific Balance Confidence (ABC) Scale, Falls Efficacy Scale International (FES-I), Lower Extremity Motor Score (LEMS) and a clinical measure of proprioception. Ten trials of the Lean-and-Release (L&R) test, which simulates a forward fall in standing, were completed to measure reactive stepping and the behavioural responses (i.e., single-step, two-step,

≥3-step, or fall) were recorded. Assessments were completed by a blinded assessor pre- and post-training. A two-way mixed ANOVA was used to compare group performance over time.Results: Significant main effects of time were observed for the L&R test behavioural response, including increased proportions of single-step responses ($F_{1,18}$ = 11.9, p = 0.003, η^2 = 0.147) and decreased proportions of falls ($F_{1,18}$ = 22.2, p < 0.001, η^2 = 0.208). Similarly, significant improvements over time were observed for the BBS ($F_{1,18}$ = 48.1, p < 0.001, η^2 = 0.103), miniBESTest ($F_{1,18}$ = 44.6, p < 0.001, η^2 = 0.474), ABC Scale ($F_{1,18}$ = 18.5, p < 0.001, η^2 = 0.096), FES-I ($F_{1,18}$ = 20.3, p < 0.001, η^2 = 0.174), and LEMS ($F_{1,18}$ = 9.4, p = 0.007, η^2 = 0.018). No significant main effects of group or group × time interactions were observed suggesting that improvements over time were similar between the RBT+FES and RBT groups.Conclusions: Both RBT+FES and RBT alone led to significant improvements in balance, balance confidence, and lower limb strength. However, no additional benefit of FES was observed.

P03-K-83 - Detecting gait disturbances in older adults using Machine Learning on week-long acceleration data

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Background: Gait disturbances increase fall risk in older adults. Detecting such disturbances isparticularly critical for individuals, who have recently experienced a severe fall, as this event furtherelevates their risk. While previous research has employed a machine learning algorithm to detectgait disturbances in a controlled laboratory setting using a perturbation treadmill and body-wornsensors [1], it remains essential to evaluate their performance in real-world environments. This stepis critical for assessing whether models trained under controlled conditions can be translated toeveryday life. This study aims to detect gait disturbances in daily life by leveraging data from abody-worn sensor and using a pre-trained machine learning model.Methods: Data was analyzed from the ongoing SeFallED study [2], which follows up on individualsaged 60 years or older who presented to the emergency department following a fall withoutsubsequent hospitalization. Daily activity was recorded with a thigh-worn accelerometer(activPAL4, PAL Technologies Ltd., UK) for seven days within four weeks of the initial fall. Thedeep convolutional long short-term memory (DeepConvLSTM) network from Hellmers et al. [1],which was trained on laboratory-based data, was applied to detect gait disturbances in walkingbouts in everyday life.Results: Among the 335 participants enrolled in the SeFallED study, 234 individuals providedcomplete accelerometer data for a minimum of five days. The participants had a mean age of 75.7± 8.9 years and recorded an average daily step count of 6059 ± 3702 steps per day. Ongoing workfocuses on adapting the machine learning algorithm to apply the trained model to the new data.Additionally, the associations between the disturbances detected and participant characteristicswill be explored.Conclusions: The results will provide insights into the application of machine learning algorithmsfor detecting gait disturbances in everyday life, with the potential to

support the early identificationof risk of falls in a high-risk population. Furthermore, results will reveal if models trained in laboratorysettings can be effectively applied to daily life scenarios. Prospective fall data from the SeFallEDstudy will further substantiate this potential, with the long-term goal of enabling timely interventionsfor those at need to reduce the risk of future falls.References:1. Hellmers S, et al: Comparison of machine learning approaches for near-fall-detectionwith motion sensors. Front Digit Health. 2023 Jul 26;5:1223845.2. Stuckenschneider T, et al.: Sentinel fall presenting to the emergency department(SeFallED) - protocol. BMC Geriatr. 2022 Jul 18;22(1):594.

P03-K-84 - Subjective instability perception and stepping responses in Bilateral Vestibular Hypofunction

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Background and aimThe relationship between how unsteady we are (objective instability) and how unsteady we feel (subjective instability) follows a fairly tight logarithmic function. However, perceived instability can be impacted by a range of processes e.g. it can increase by anxiety. Here, we explore the relationship between objective and subjective instability in patients with bilateral vestibular hypofunction (BVH) during a dynamic postural task. MethodsParticipants stood on a platform oscillating at different velocities. Objective sway (trunk sway path), subjective instability and anxiety ratings were obtained. Foot lifts were also measured to investigate if protective stepping responses are critically dependent on vestibular function. ResultsPatients with BVH showed a larger sway path than controls (t: -2.153, $p<0.05$). Patients had a marginally steeper objective-subjective instability curve slope compared to controls ($p=0.053$). Sled velocity thresholds to generate a foot response were not different between BVH patients and controls ($p=0.904$). Moreover, this foot response generation threshold was not correlated with their objective-subjective instability slope ($p=0.427$). ConclusionBVH patients' objective-subjective slope data indicates a marginally heightened perception of instability for the same degree of objective sway. Importantly, patients with BVH did not exhibit changes in step generation. Our results indicate that the construction of perceived instability, and the generation of protective steps in response to such instability, relies on a central representation of the centre of mass rather than on peripheral vestibular input.Acknowledgements and funding Mr. David Buckwell provided technical support. This investigation was supported by the Dunhill Medical Trust and the Imperial College London Biomedical Research Centre. P.C. was funded by a CONICYT scholarship. T.J.E. is supported by a Wellcome Trust Sir Henry Wellcome Postdoctoral Fellowship.

P03-K-85 - Influence of Levodopa-Induced Dyskinesia on falls and injuries caused by falls in people with Parkinson's disease: A PPMI prospective cohort study

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Background and aim: Levodopa-induced dyskinesia (LID) is one of the main motor complications in Parkinson's disease (PD), causing a massive impact on the quality of life and mobility in those living with LID. However, the impact of LID on falls in people with PD is still unclear. Thus, this study aimed: (i) to assess the prevalence and incidence of falls, (ii) to identify the contributors to falls, and (iii) to examine the injuries and consequences caused by falls in people with PD with and without LID.Methods: This prospective cohort study uses data from the Parkinson's Progression Markers Initiative. Participants were allocated into two groups according to the presence (LID group, n=65) or absence (Non-LID group, n=203) of LID assessed by part IV of the Movement Disorders Unified Parkinson's Disease Rating Scale (MDS-UPDRS). Demographic and clinical information were extracted. The reason for falls was extracted considering falls related and not related to freezing of gait (FOG), and injuries and consequences caused by falls were assessed. The prevalence and incidence analyses were performed.Results: Unadjusted univariate regression revealed differences between groups in the baseline and 1-year follow-up for falls unrelated to FOG. In the adjusted analysis by disease duration, these differences did not remain. Regression models revealed that the contributors to falls were MDS-UPDRS-IA only at baseline. The differences between groups in the injuries and consequences were found only for falls in 1 year of follow-up, indicating that people with LID are more susceptible to suffering from these consequences (e.g., injuries, hospitalization).Conclusions: This is the first study examining the contributors to falls in people living with LID. People with LID suffered more falls, injuries, and consequences of falls over time, highlighting the importance of examining LID and taking it into account as part of the care plan for those living with PD. Finally, LID, FOG, disease duration, and non-motor symptoms are contributors to falls in people with PD, as observed in other studies.

P03-K-86 - Surface perturbation treadmill training program enhances and improves reactive unloaded-leg stepping strategies during standing in older adults: A single-blinded randomized controlled trial

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Background and aim: Perturbation-based balance training is an effective regime that reduces fall rates dramatically by triggering and improving balance recovery skills. We aimed to examine whether multidirectional surface perturbation treadmill training,

designed to address age-related reactive deficits, effects reactive first-step strategies and the kinematics of these strategies following lateral perturbations in a standing. Methods: Fifty-three older adults aged 80.1±5.2 years, living in retirement housing, independent in daily living activities, were randomized into two groups: 1) surface perturbation-based hands-free treadmill training (SPTT, n=27) and control group, hands-free treadmill walking training without perturbations (TT, n=26). Both received a 12-week, 24-session training program. Reactive balance was assessed in standing. Right/left unannounced platform translations were applied and controlled at 13 perturbation magnitudes for a total of 26 perturbation trials. For primary outcome measures, we assessed changes in the proportion of first-step strategies used across all stepping trials, and the kinematics of each strategy. ClinicalTrials.gov, NCT01439451. Results: Performing intention-to-treat analyses, a total of 2,562 perturbation trials were analyzed as pre- and post-tests, of which 1,049 resulted in reactive stepping responses. Figure 1 (attached) presents changes of first-step strategies by perturbation magnitudes using mosaic plots. Regarding the total frequencies of first-step strategies, compared with TT (completed the intervention, n=19), the SPTT (completed , n=21) led to a significant reduction in executing loaded leg sidesteps (LLSS; p=0.018), and a significant increase in using all unloaded leg strategies together [e.g., unloaded leg sidesteps (ULSS), complete and incomplete crossover steps (CoS and I.cos, respectively) and leg abduction (Abd); p=0.021]. Both groups showed a significant decrease in performance I.cos, (p=0.006), and a significant increase in using ULSS (p=0.001). In kinematic analysis, SPTT significantly shortened the first I.cos [e.g., faster first-step duration (p=0.046) and shorter first-step length (p<0.001)] and the total balance recovery responses initiated with I.cos [e.g., faster total recovery step duration (p=0.048) and shorter total recovery-step length (p<0.001)], compared to TT that increased these I.cos kinematic parameters. Both groups performed faster first LLSS and achieved faster and shorter total balance recovery, with reduced CoM displacement compared to their baseline. Conclusions: A 12-week SPTT reduces the risk of falls by enhancing reactive unloaded leg strategies (considered to represent young balance and coordination) and reducing the usage and improving the kinematics of I.cos strategy (a strategy associated with falls) in retirement-housing older adults. This study also addressed the generalizability of perturbation training benefits from walking to standing.

P03-K-87 - The priming effects of mechanical vibrations on trip-like stance perturbations in healthy adults

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Background and Objective: Mechanical vibration affects balance and gait, with its impact varying based on intensity and timing (1). Perceptual vibrations negatively impact steady-state gait by altering gait kinematics, such as increasing hip and ankle flexion. However, these responses may enhance clearance during trip-like perturbations. This study,

therefore, investigates the priming effects of mechanical vibration on clearance, stability, and compensatory mechanisms of trunk and lower limbs during forward balance loss.Methods: Twenty healthy young adults (13 females, 24 ± 5 years) received perturbations while standing a treadmill (ActiveStep treadmill system) to induce forward balance loss (backward acceleration, 21 m/s^2, 0.02 m displacement). Prior to balance loss, participants received three randomly distributed vibration conditions on their recovery stepping leg: no vibration, and vibration of the triceps surae (ankle), or quadriceps (quads) at 60 Hz for 3 minutes. Recovery responses were recorded using the Qualisys motion capture system to assess measures related to clearance, stability, and compensatory kinematics. Outcome measures included step length and height, the center of mass relative to base of support (COMx) at lift-off and touchdown, sagittal trunk and lower limbs angles (2). Linear mixed models with Holm-adjusted posthoc comparisons evaluated the vibration effects.Results: The analysis (Figure 1) showed that ankle and quads vibration compared to no vibration significantly increased step height (Quads: 0.028m, SE=0.007, p<0.001; Ankle: 0.026m, SE=0.006, p<0.001) and positioned the CoMx (Quads: 0.118, SE=0.047, p=0.028; Ankle: 0.096, SE=0.045, p=0.034) and trunk forward (Quads: 2.762°, SE=0.890, p=0.002; Ankle: 2.723°, SE=0.848, p=0.002) at lift-off. At touchdown, the position of CoMx (estimate=0.126, SE=0.043, p=0.006) and trunk (estimate=4.505°, SE=1.263, p<0.001) remained forward after ankle vibrations, while lower limb angles only altered after quadriceps vibration (Thigh: 3.075°, SE=1.299, p=0.035; Shank: -2.30°, SE=0.818, p=0.009; Foot: -3.352°, SE=1.255, p=0.015). Step length did not differ between conditions. Conclusion: Vibratory priming of the triceps surae and quadriceps muscles resulted in a more anterior loss of balance shown by a forwardly shifted, more flexed upper body position during lift-off – consistent with previous research (4). These postural changes are associated with reduced stability and a higher risk of falls, particularly during trip-like perturbations (3). This suggests that while somatosensory perception remains relatively unaffected, proprioceptive pathways showed some disturbance in young adults resulting in compensations via hip/trunk strategies after ankle vibration and lower limb adjustments after quadriceps vibration. Future research should examine these compensatory effects across age groups, as aging may impair proprioception, affecting step initiation and balance recovery even more.Acknowledgement and funding: Funds and facilities were provided by the European Union with YUF4postdoc fellowship (EU Horizon Europ MSCA cofund, grant 101081327), by the Fulbright Scholarship Program and the University of Illinois at Chicago.References: 1) Xie, H., et al (2023) Gait & Posture; 2) Asghari, M., et al. (2024). Heliyon; 3) Grabiner MD et al (2021) Front Sports Act Living; 4) Wang & Bhatt (2022). Biomechanics

P03-K-88 - Elevated vestibular perceptual thresholds and their impact on balance in older adults

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BACKGROUND AND AIMVestibular perceptual thresholds (VPTs) reflect the sensitivity of central and higher-order vestibular networks to self-motion. Age-related decline in VPTs has been linked to imbalance and falls in community-dwelling older adults. To ascertain the burden of impaired VPTs and potential rectifiable factors for falling in this group, we assessed the prevalence, risk factors and impact of elevated VPTs upon both balance and gait.METHODSWe included 163 community-dwelling older adults (62–90 years; 75.2 ± 6.2; 82.2% female). Vestibular perceptual thresholds (VPTs) were measured using a validated (yaw-plane) rotating chair paradigm in which participants had to indicate perception of different acceleration intensities. Vestibulo-ocular reflex was also measured to confirm intact peripheral vestibular function. Balance and gait were assessed using APDM Mobility Lab, with participants wearing inertial sensors while performing Timed-Up-and-Go (TUG), 360° turn, and standing on foam (eyes open and closed). Cluster analysis identified groups (higher or normal VPTs) based on threshold values. Linear regression models were then used to identify potential risk factors for elevated thresholds and to examine associations between thresholds and balance and gait parameters.RESULTSHigh vestibular perceptual thresholds were identified in 18.4% of community-dwelling older adults, despite intact peripheral vestibular function (normal vestibular-ocular reflex values). Among the potential associated factors, global cognition (MoCA) independently predicted VPTs ($p = 0.007$), whereas age, executive function, vestibular-ocular reflex function, handgrip strength, and ankle proprioception did not. We further explored the impact of perceptual thresholds affect balance and gait parameters. Higher VPTs independently predicted greater anteroposterior (AP) sway in the “eyes open, foam” condition, which remained significant when controlling for key covariates, including global cognition (MoCA) and ankle proprioception ($p = 0.003$). However, no significant associations were observed between VPTs and sway in the “eyes closed, foam” condition. VPTs were also significantly associated with TUG duration, turn velocity, and lumbar range-of-motion in the coronal plane. Among these, TUG duration remained significantly associated after covariate adjustment ($p = 0.031$).CONCLUSIONSElevated VPTs are relatively common in older adults and are linked to global cognitive function. Elevated thresholds were independently associated with worse postural and gait performance (increased TUG duration). These findings highlight the role of vestibular perception in age-related imbalance. Ongoing work is currently exploring if baseline VPTs predict future falls in community-dwelling older adults.ACKNOWLEDGEMENTS AND FUNDINGThe authors gratefully acknowledge all the participants in this study. This work was supported by Lee Family Scholarship awarded to Yuxiao Li and a Wellcome Trust Sir Henry Wellcome Postdoctoral Fellowship awarded to Toby J.

P03-L-90 - The effects of dual-tasking on gait parameters in individuals with concussion

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Background: Concussions are common traumatic brain injuries that can result in persistent motor and cognitive impairments, including deficits in gait. Traditional gait assessments, conducted in isolation, may not fully capture the impact of concussion on motor performance, especially in complex real-world scenarios. Dual-task paradigms, which incorporate cognitive demands while walking, offer a more sensitive method for identifying these impairments. This study examines how dual-tasking, specifically backward counting by 7s from 100, affects various gait parameters in individuals with concussion and healthy controls.Methods: A total of 29 participants aged 19.6±1.32 years, including individuals with a current concussion (n=4), a history of concussion (n=10), and healthy controls (n=15), were assessed for multiple gait parameters under single-task (walking) and dual-task (walking while performing backward counting) conditions. Mixed-model analyses were conducted to examine the effects of concussion and dual-tasking on gait parameters including cadence, step width, time, and length, and percentages of swing, stance, and double support.Results: The analysis revealed significant main effects of concussion on gait parameters. A significant main effect of concussion was observed on step time, $F(2, 26) = 3.73$, $p = .038$, indicating significant differences in step time between the groups. Post hoc Tukey HSD tests revealed that the concuss group had significantly lower step time (M=0.59 seconds) compaired to healthy participants (M=0.56 seconds) ($p = .018$). Similarly, a significant main effect of concussion was found on stride time, $F(2, 26) = 3.74$, $p = .037$, suggesting significant group differences in stride time. Post hoc Tukey HSD tests revealed that the concuss group had significantly lower stride time (M=1.20 seconds) compaired to healthy participants (M=1.12 seconds) ($p = .016$). Additionally, a significant main effect of dual-tasking was found on step width, $F(1, 26) = 9.75$, $p = .004$, with step width of (M = 5.70 inches) observed in the dual-task condition and (M= 5.21 inches) during the single-task condition. No other significant main effects or interactions were found for the remaining gait parameters.Conclusion: The results underscore the impact of concussion on gait parameters such as step time and stride time, with individuals with concussion demonstrating significant impairments. Moreover, dual-tasking significantly affected step width, emphasizing the importance of cognitive-motor integration in gait performance. These findings highlight the utility of dual-task assessments in concussion management and rehabilitation, revealing subtle gait deficits that might not be detected during single-task evaluations.Keywords: dual-tasking, gait parameters, concussion, step time, stride time, step width, backward counting

P03-L-91 - Exploring the effects of torque pulse magnitude, duration, and timing at the ankle on muscle activity during walking

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BACKGROUND AND AIMExploring how gait characteristic respond to small perturbations can deepen our understanding of neuromechanics and inform gait therapies. Previous research in gait entrainment showed that individuals changed their gait frequency to synchronize to periodic plantar-flexion torque pulses delivered to the ankle, and the synchronization occurred during push off [1-2]. However, there is not enough knowledge about why people tend to entrain during push-off and how torque pulse shape affects entrainment. Here, we explored how the pulses changed electromyography (EMG) signals in Tibialis Anterior (TA), Gastrocnemius Medialis (GM) and Lateralis (GL), Soleus (SO), and Rectus Femoris (RF). METHODS6 people walked with their preferred speed on a treadmill, while wearing ankle exoskeletons and EMG sensors (CometaSystems, Inc.). We normalized the time series of the EMG envelope for strides between 0 to 100% of stance and 0 to 100% swing. The exoskeleton torque pulses had trapezoidal shape with 3 magnitude levels (peak torque of 5, 10, or 15 Nm during stance, and 2.5, 5, 7.5 Nm during swing) and lasted for 3 different durations (100, 150, or 200 ms). The exo applied pulses to the left leg at 5 different times during the gait cycle (10, 40, 80 % of stance, and 20, 45 % of swing). All 45 pulse conditions (9 pulse shapes, 5 gait timings) were repeated 4 times in a random order and with a randomised gap of 4 or 5 strides. For each perturbed stride, we calculated the root mean square error (RSME) between the normalized EMG envelope of the stride and the average normalized envelope from the previous 3 strides for each muscle. We used linear mixed-effects model for each gait phase and muscle to predict the logarithm of RMSE with magnitude levels and duration as fixed effects and participants as random effect. RESULTSWe found that increasing pulse duration decreased RMSE of the TA (p= 0.018) and RF (p=0.005) EMG envelope when pulses were delivered at 80% of stance. Also, increased pulse magnitude showed a statically significant increase in the RMSE for TA when delivered at 10 and 80% of stance and during swing, for GM when delivered at 10 and 40% of stance, for GL when delivered at 10% of stance, for SO when delivered at 80% of stance and 45% of swing, and for RF when delivered at 10 and 40% of stance and during swing. Across muscles, we found that pulses delivered at 80% of stance tended to have the smallest RMSE of all gait timings. CONCLUSIONSOur results suggest that lower-limb muscle activity is more responsive to pulse magnitude than pulse duration. We also found that muscle activity were least modified when the pulses were applied during push off (~80% stance). Adapting to the pulses in order to minimize perturbation may explain why previous work found pulses synchronized with push-off during gait entrainment [1-2]. REFERENCES [1] Ahn J & Hogan N.,PLoS One. 2012, [2] C.M. Thalman et al., in IEEE Robotics and Automation Letters, 2021

P03-M-92 - Are individual-specific differences in gait dynamics maintained in overground versus treadmill walking?

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Background and Aim: While walking behavior emerges from complex, nonlinear interactions between neural and biomechanical systems, it remains difficult to assess features of gait that reflect individual-specific motor strategies versus task-specific demands. Using a data-driven, generative approach, the Gait Signatures model encodes individual-specific gait dynamics from time series kinematic data. Gait Signatures exhibit systematic changes due to task constraints imposed by variations in walking speed while maintaining individual differences. However, it remains unclear how the Gait Signatures model generalizes to walking in real-world environments, as existing analyses have been limited to treadmill walking. Toward translating Gait Signatures to clinical and naturalistic settings, we seek to characterize the effect of treadmill versus overground walking on individual gait dynamics as defined by the Gait Signatures model. We hypothesize that individual-specific differences in gait dynamics are maintained across walking contexts, despite the influence of task-specific constraints on gait. We compared the Euclidean distances between treadmill and overground Gait Signatures across subjects and walking speeds. We predicted that individual differences in Gait Signatures would persist across task constraints imposed by both walking environment and speed. Methods: 2 neurotypical young adults completed 3 trials each of slow and self-selected (SS) speed overground walking, and one speed-matched 60s treadmill trial per overground speed, recorded using marker-based motion capture. Bilateral hip, knee, and ankle kinematics were reconstructed using an existing Gait Signatures model trained on treadmill walking data, which employs a single-layer recurrent neural network and principal component analysis to generate a low-dimensional latent space representation of gait dynamics. Results: The Gait Signatures model trained on treadmill walking captured a similar amount of variance in overground and treadmill gait kinematics (80.5% versus 78.3%). Across all conditions, Euclidean distances between Gait Signatures within individuals (61± 28) were smaller than distances between individuals (95 ± 25). Across walking contexts, within-subject changes in Gait Signatures Euclidean distance across speed-matched trials (36 ± 12) were smaller than Gait Signature distances between individuals (82 ± 19). However, across speeds, distances within individual Gait Signatures during both overground (83 ± 15) and treadmill walking (74 ± 29) were comparable to distances between individuals (82 ± 19). Conclusions: Our preliminary results suggest that gait dynamics remain individual-specific across contexts, enabling greater generalization of the Gait Signatures model. More detailed analysis may identify features of Gait Signature changes specific to individuals, context, and speed. Funding: NSF GRFP 2024377807 to EWS; F32HD108927 to MCR; F31HD107968 to TSW.

P03-M-93 - A phenomenological approach to understand the mechanical properties of the tibialis anterior during gait

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1. Background:The Hill-type Muscle Model (HMM) is widely used in musculoskeletal simulations to represent skeletal muscle mechanics. Despite its success, concerns have been raised about its reliability, particularly in predicting muscle actions during eccentric contractions within physiological operation ranges. These limitations have prompted questions about the reliability of musculoskeletal simulations for understanding individual muscle actions, especially when investigating muscle dysfunctions associated with neuromotor diseases. Specifically, there are notable challenges in predicting the mechanics of the Tibialis Anterior (TA), an ankle dorsiflexor crucial during the swing phase of gait. Despite these concerns, studies examining discrepancies between simulated and measured TA activity during gait are limited. Therefore, our study aimed to assess the performance of an HMM-based musculoskeletal simulation in predicting TA mechanics during normal gait.2. Methods: Thirty healthy participants (15 female; mean age: 25.4 ± 2.9 years) performed five 5-metre self-paced gait trials. Movements were tracked with a Vicon system, and ground reaction forces were measured using two force plates. Data were simulated in OpenSim with a musculoskeletal model, and TA muscle dynamics were predicted using Computed Muscle Control (CMC). Ultrasound images of the TA were analysed via a semi-automated tracking method. The signals were synchronized with a trigger, and discrepancies between the simulated and ultrasound results were analyzed using custom software. The magnitude difference was computed with Root Mean Square Error (RMSE), and pattern similarity was assessed using Pearson correlation after normalizing the signals.3. Results:Fascicle length and pennation angle results were used to compare simulated data with ultrasound data. Both results showed that the simulated data exhibited large variations throughout the gait cycle, whereas the ultrasound data remained relatively flat with minimal changes (fascicle length RMSE: 8.05±1.11mm, pennation angle RMSE: 1.24±0.09°). While the scale between the simulated and ultrasound data differs significantly, the correlation between the trends is also weak, with Pearson correlations of 0.05±0.09 for fascicle length and -0.21±0.12 for pennation angle.4. Conclusions:The HMM demonstrated significant discrepancies when predicting the mechanics of the TA during normal gait, particularly in fascicle length and pennation angle. Although the scale between simulated and ultrasound data differed substantially, the weak correlations between the trends highlight the limitations of the HMM in accurately capturing TA muscle dynamics during gait. These findings suggest that while HMM-based simulations offer valuable insights, they may not fully represent the nuanced behaviour of muscles, particularly in the context of neuromotor diseases where accurate muscle function prediction is critical. Future improvements in muscle models may be necessary to enhance the reliability of musculoskeletal simulations for clinical applications.5. Funding:This research was supported by Biotechnology and Biological Sciences Research Council (BBSRC).

P03-M-94 - A model-based investigation of standing behaviour during centre of mass immobilization

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Background and aim: Traditional theories propose that balance operates as a closed-loop feedback system, where joint torques are generated in response to body centre of mass (COM) deviations from an equilibrium position. However, studies have reported increases or no change in torque when the COM is immobilized during quiet stance, which is seemingly contrary to predictions of closed-loop control. The effects of 'opening the loop' of balance via COM immobilization have yet to be directly examined within existing feedback models. Therefore, this study aimed to determine whether behaviour observed during COM immobilization can be simulated with a closed-loop balance control model. Methods: Participants (n=14) were secured to a closed-loop pulley system positioned over a force plate. The system permitted natural sway (Unlocked) until a brake was applied, which discreetly immobilized the COM (Locked). Participants completed a series of standing trials in 4 sensory conditions that manipulated the amount of visual (eyes open/closed) and haptic (light touch cue) feedback. Each sensory condition was maintained throughout a trial, which contained 90-s Unlocked and Locked sway states. The amplitudes of COM and centre of pressure (COP) displacement were compared using a within-subject ANOVA across sensory conditions and sway states for experimental and simulated data. Experimental sway responses were simulated using a linear feedback control model with sensory (1/f) noise. The model used single-link inverted pendulum body dynamics and included a neural controller with a time delay and positive torque feedback. For each sensory condition, sensory noise was scaled to generate realistic Unlocked sway; the same noise was then used in the Locked state simulations. A sensitivity analysis was performed to examine the effect of changing model parameters on Unlocked and Locked sway simulations. Results: A significant interaction between sensory conditions and sway states was observed in experimental but not simulation data. In the Unlocked state, sway amplitude was reduced with increases in sensory feedback (experiment) and reductions in sensory noise gain (simulation). With experimental COM immobilization, COP amplitude did not change in conditions with the least sensory feedback but increased in conditions with the most sensory feedback. In simulations, COP amplitude decreased with COM immobilization across all sensory conditions. Adjusting model parameters, including neural stiffness, sensory noise gain, and torque feedback gain, produced simulated Locked sway that more closely matched experimental Locked sway. Conclusions: The effect of immobilizing the COM was inconsistent between experiments and simulations. Model-based interpretations suggest that closed-loop control may lead to behaviour observed in experiments only with significant adjustments to model parameters used in simulations. Further work is needed to clarify the mechanisms underlying this behaviour.

P03-M-95 - Insights from human walking kinematics decomposition

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Background: The degrees of freedom (DOF) and inverse kinematics (IK) problems are fundamental challenges in the motor control of both biological and robotic systems. A common strategy for addressing the DOF problem is to seek a lower-dimensional representation of the system. One approach to dimensionality reduction assumes that multiple DOFs are governed by a shared, lower-dimensional set of source functions or primitives. Recently, Barliya and colleagues proposed that if both body and task space representations are based on the same set of primitives, these primitives could serve as mediators in solving the IK problem. However, both spaces can be represented in multiple ways, and it remains unclear which of these is utilized by the central nervous system (CNS). In this study, we apply a novel algorithm, the Fourier-based Anechoic Demixing Algorithm (FADA), to examine these questions in the context of human walking, within the conceptual framework proposed by Barliya. Methods: We analyzed walking kinematics from 17 healthy adults. The body space data included anatomical joint angles of the lower limb (hip, knee, and ankle), as well as elevation angles of limb segments (thigh, shank, and foot). The task space data captured the position of the mid-foot, expressed in both Euclidean coordinates (X and Y, relative to the hip joint) and Polar coordinates (hip-to-mid-foot distance and segment elevation angle). Using the FADA algorithm, we decomposed the kinematic data from each representation into a set of kinematic primitives. Results: Two kinematic primitives explained over 99% of the variance across all representations. The primitives derived from the elevation angles were remarkably similar to those extracted from the task space representations (both Euclidean and Polar), and significantly more so than those derived from anatomical joint angles. The FADA algorithm accounts for time delays in the activation of primitives. While such delays introduce flexibility into the control system, they also increase its complexity. We found that these delays varied systematically both within and between DOFs and coordinate frames, from one gait cycle to the next. This systematic variability may reflect how the CNS balances flexibility with control complexity. Discussion: Our findings support the hypothesis that the CNS employs a lower-dimensional source function space to simultaneously address the DOF and IK problems during human walking. Furthermore, given the gravitational dependence of elevation angles, our results also support the idea that gravity plays a central role in body space representation and in the motor control computations based on it.

P03-N-100 - Clinical relevance of instrumented gait assessments in hospital and everyday life in patients with sporadic and atypical Parkinson's syndromes

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Background and aim: Parkinson's disease (PD) is a slowly progressive neurodegenerative disease featuring severe gait impairment with recurrent falls only in the later stages of disease. In contrast, atypical parkinsonian disorders (APD) including multiple system atrophy (MSA) and progressive supranuclear palsy (PSP) are associated with a high risk of falling early on. To improve accuracy of rater-independent and quantitative measures for mobility assessments, sensor-based recordings of gait using IMUs provide important objective data both in the hospital and everyday life of patients with parkinsonian disorders. However, these gait recordings might be challenging and time-consuming especially for APD patients. Currently, gait assessments with different walking distances and durations are instrumented, but the clinical relevance of the data for PD and APD is not yet fully understood. Therefore, the aim of this study is to evaluate which instrumented gait assessments are the most clinically relevant when associated with clinical, functional and patient-reported scores.Methods: The multi-centered Mobility_APP study recruited 43 PD patients, 29 patients with Parkinsonian type MSA (MSA-P) and 21 patients with PSP of Richardson's-type in Germany, Austria and Italy. Functional and clinical scores were collected by therapists and physicians, as well as patient-reported questionnaires about quality of life and physical activity. Gait parameters were measured during standardized 2x10m and 2-minute walk tests (2MWT) as well as during 1 d in everyday life (≥ 8h) using foot worn motion sensors (GaitLab). Daily life recordings were categorized by short/ medium walking bouts (WB, > 60sec) and long WB (≥60sec). Data analysis included Spearman correlations between the Berg Balance Scale (BBS), the postural instability and gait difficulty (PIGD) and gait parameters, p-value was corrected.Results: Mean Gait velocity (GV) and stride length showed stronger correlations for all disease entities with functional, clinical and self-reported scores in the 2MWT compared to the 2x10m. Additionally, the variability (CV) for GV in the 2MWT showed meaningful correlations with the BBS and the PIGD score (r= │.326 - .646│) but less prominent in the 2x10m (r=│.032 - .502│. A similar result was observed for the gait recording in daily life. GV of long WB showed stronger correlations especially with the PIGD score (r=│.455 - .590│) compared to short/ medium WB (r= │.239 - .409│).Conclusion: Gait assessments with long WB (2MWT) in the clinic setting provide more clinically relevant data than those with short WB (2x10m). Gait parameters from patients' everyday life resemble the hospital findings; however, the correlations are weaker. This study indicates that gait parameters from everyday life provide complementary information on gait performance particularly when considering long WB. Future studies need to investigate within-day and day-to-day variability in personalized approaches.

P03-N-101 - Movement deficits in sit-to-stand and stand-to-sit transitions during the five times sit-to-stand test in Parkinson's disease

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BACKGROUND AND AIM: Sit-to-stand (SiSt) and Stand-to-Sit (StSi) are one of the most common postural transitions during daily life. However, the kinematics of these postural transitions in people with Parkinson's Disease (pwPD) are impaired. A detailed understanding of the biomechanics of SiSt and StSi movements could help in tailoring the therapeutic interventions. The aim of the study was to conduct a biomechanical analysis of the SiSt and StSi movements in pwPD to identify the specific impairments or alterations in the movement patterns, which could be specifically targeted in therapeutic interventions in order to improve functional performance.METHODS: 16 pwPD and 16 controls performed a Five Times Sit-to-Stand (FTSTS) test. The data was collected using optical motion capture system. Kinematics of the hip and knee, namely peak angular velocity (PAV) and its timing (i.e., when in the movement as PAV reached) were identified for the fastest, median and slowest cycles and compared between the groups. Furthermore, coordinated hip-knee kinematics, namely joint angles throughout the movement, were evaluated by the means of cyclograms. RESULTS: PD group had lower PAV values, compared to controls, during hip flexion, hip extension and knee extension during SiSt and hip and knee flexion and hip extension during StSi. The PD group reached PAV earlier during the hip extension and the knee extension during the slowest movement. Cyclogram deviations from the symmetry line showed no differences between the groups. The PAV and PAV timing relationships between different joints showed less consistency in the PD group.CONCLUSIONS: This study identifies altered movement patterns in people with Parkinson's Disease, including difficulties with eccentric muscle control and impaired adaptation to movement speeds. These findings can inform targeted physiotherapy to improve postural transitions.ACKNOWLEDGEMENTS AND FUNDING: Not applicable.

P03-N-102 - Retropulsion and backward falls in neurorehabilitation

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Background and aim: Retropulsion seems common in neurological patients and with increasing age. Affected patients show a posterior shift of their center of mass with a tendency to fall backwards. Like lateropulsion (pusher behavior), patients with retropulsion orient their body towards an impaired inner reference of verticality. Retropulsion can be caused by different brain disorders such as strategic vascular lesions, Parkinsonian syndromes, normal pressure hydrocephalus, as well as geriatric conditions. Although retropulsion is common studies on retropulsion are sparse. That is in part because a validated clinical assessment tool was missing in the past. We asked the question if the new Scale for Retropulsion (SRP) can detect the condition in a cohort of subsequent patients admitted to neurorehabilitation.Methods: The SRP was

developed via an international and multidisciplinary expert panel (Delphi). The scale includes four subtests: A) static postural control, B) reactive postural control, C) resistance, and D) dynamic postural control which are tested in a sitting and standing (initial) position. The score ranges from 0 (no signs of retropulsion) to 24 (very severe retropulsion). The SRP is a bedside test which can be easily implemented into the clinical routine (application time is 5–10 minutes). The clinimetric properties of the SRP were determined in 70 patients with different neurological disorders. The scale showed excellent internal consistency and good to excellent test-retest and interrater reliability. The scale was now applied to 186 consecutive neurological patients.Results: Data obtained revealed that retropulsion is common in neurorehabilitation: 65.6% (122 of 186) patients showed at least some signs of retropulsion (SRP score ≥1). The median SRP score in these patients was 12 (Q1,Q3 5,19) and covered the whole range of the scale (min–max 1–24). Retropulsion occurred most frequently in patients with Parkinsonian syndromes. In a subgroup of patients, the SRP was assessed on admission and at discharge from rehabilitation to investigate retropulsion during rehabilitation. 77% of patients showed signs of retropulsion at the beginning of rehabilitation (median SRP score 3 (1,10) and 60% (median 2 (0,3)) at discharge. The severity of retropulsion at admission moderately correlated with the time of rehabilitation (rSp=0.665): The more severe the retropulsion, the longer the rehabilitation time. Further, patients with retropulsion showed a higher fear of falling (Falls Efficacy Scale-International). There was a positive correlation between the severity of retropulsion and the level of concern about falling (rSp=0.719).Conclusions: Retropulsion is a frequent problem of postural control in neurorehabilitation that occurs in various neurological diseases. The SRP is a valid and reliable clinical bed side test for the diagnosis of retropulsion. Our data give preliminary evidence that retropulsion is associated with a longer rehabilitation duration as well as an increased fear and risk of falling. Acknowledgements and funding: The study was funded by the German Federal Ministry of Education and Research (BMBF).

P03-N-103 - Cue-driven cortical modulation during the gait cycle in Parkinson's disease and healthy adults

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BACKGROUND AND AIM: External cues improve gait quality and freezing of gait in patients with Parkinson's disease (PD) but their effectiveness varies across individuals. Clarifying the cortical mechanisms underlying cueing benefits could inform tailored therapeutic strategies for PD. To test the hypothesis that cueing facilitates recruitment of cortical motor systems that compensate for impaired subcortical gait control, we use electroencphalography (EEG) to examine how auditory and visual cues modulate cortical activity during the gait cycle in PD patients with and without freezing of gait. We focus on beta activity in the 13–30 Hz range, as prior studies in healthy adults have shown contralateral swing-phase beta suppression during voluntary changes in gait speed, step synchronization, and surface adaptation. METHODS: 22 PD patients without freezing (PD-NF), 18 PD patient with freezing (PD-F) and 19 age-match controls (HC) walked overground along a pre-defined path while wearing a mobile 64-channel EEG cap and inertial measurement units (IMUs) on their limbs. Participants completed three conditions: normal gait (no cue), synchronizing steps to an auditory metronome (auditory cue), and stepping over lines projected by shoe-mounted lasers (visual cue). Gait speed and stride length were extracted from IMU data. EEG was segmented into individual gait cycles and analyzed for event-related spectral perturbations from 2–55 Hz. Independent component analysis and dipole fitting identified left and right sensorimotor activity (LSM, RSM). Linear mixed models assessed the effects of cue and group on gait speed, stride length, and beta activity during the contralateral swing phase ($\alpha = 0.05$).RESULTS: Group and cue had significant main effects across all models, with an interaction found only in gait speed. Both external cues increased speed and stride length relative to no cue across all groups. In stride length, HC on average had the longest strides, followed by PD-NF, then PD-F. In speed, PD-NF showed greater cue-related improvements from no cue than PD-F, driving the interaction effect. In EEG, both cues increased beta suppression in the RSM across all groups, while in the LSM, only visual cues had this effect. PD-F showed heightened contralateral swing-phase beta suppression than HC in both RSM and LSM. PD-NF did not differ in beta suppression from either group. CONCLUSIONS: Although PD-NF showed greater gait parameters with cueing than PD-F, their beta suppression was similar to controls, while PD-F exhibited significantly greater beta suppression than controls. We speculate that PD-NF may retain more intact subcortical or automatic mechanisms, enabling relatively effective cue use with minimal cortical engagement. In contrast, the heightened beta suppression in PD-F may reflect increased top-down control to compensate for impaired automaticity, consistent with the idea that more severely affected individuals rely more on conscious effort to maintain gait and balance.ACKNOWLEDGEMENTS AND FUNDING: Research reported in this abstract is supported, in part, by The US DoD [W81XWH2110974, KC] and The NIH T32 Training in Neurotechnology Translation [T32NS115753, LM]

P03-N-105 - The influence of motor asymmetry on gait adaptation in Parkinson's disease before and after long-term split-belt treadmill training

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Background and aim: People with Parkinson's disease (PwPD) exhibit asymmetrical motor impairments, and often have difficulties when navigating asymmetrical conditions such as turning. It is not yet clear whether motor symptom asymmetry impacts the ability to adapt to asymmetrical constraints, such as to a split-belt treadmill (SBT), and what the specific spatial-temporal contributors are. Further, we were also interested in whether gait adaptation following long-term SBT training depended on the pattern of motor asymmetry. This study therefore investigated whether gait adaptation on a SBT is influenced by reducing the belt speed on the best (best side reduction - BSR) or worst side (worst side reduction - WSR) before and after long-term SBT training.Methods: Data was collected within a randomized controlled trial to investigate the effects of SBT versus regular treadmill training on turning and gait adaptation in PwPD. Fifty-one PwPD performed a gait adaptation protocol on the SBT (50% speed reduction) with BSR and WSR, in a randomized order. The best and worst sides were defined by motor symptom severity (least and most affected side) or by overground step length (longer or shorter step length side). Gait adaptation was characterized by bilateral step length asymmetry, double support time asymmetry, and unilateral fast and slow leg relative step length and relative double support time. Twenty-six participants performed a four-week SBT training program, with gait adaptation assessed again post-training and after a 4-week follow-up. Linear mixed models assessed the impact of SIDE at baseline (BSR vs. WSR, N=51), and SIDE with TIME over the three assessments (pre-training, post-training, follow-up, N=26).Results: At baseline, higher step length asymmetry was observed at late adaptation with BSR compared to WSR ($p = 0.041$), the most affected side taking smaller steps compared to the least affected side on the fast belt ($p = 0.003$) (see Figure 1 for details). Long-term SBT training improved early and late adaptation step length asymmetry, double support time asymmetry and most unilateral outcomes irrespective of the side which was reduced ($p < 0.001$). Interestingly, double support time asymmetry at late adaptation during WSR showed an overcorrected adaptation pattern post-training, but this reverted at follow-up ($p = 0.016$). Using step length to determine the best and worst sides exhibited similar but non-significant patterns, and also revealed a trend for persistent worst side scaling on the fast belt over time ($p = 0.073$).Conclusions: Impaired amplitude scaling when the worst side is on the fast belt contributes to impaired gait adaptation on the SBT in PD. Spatial and temporal adaptation improvements with training were observed in both legs, however worst side spatial limitations tended to persist.

P03-N-106 - Preliminary assessment of upper limb engagement and motor strategies in stroke patients using inertial sensors

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Background and Aim:Standard gait assessments in stroke patients (ST) often neglect upper-lower limb interaction, particularly how gait adapts when everyday manual tasks are associated. Literature shows a notable lack of studies analysing changes in motor patterns in response to upper limb motor tasks in ST during locomotion and, particularly, during everyday activities1. Therefore, the aim of this preliminary study is to analyse

changes in the spatiotemporal parameters when STs walk with free or engaged upper limbs. Methods and Material:Seventeen Healthy Subjects (HS, 60 ± 11 years, 8M, 9F), 1 severe ST (S_ST, 63, male, left ischemic stroke, Dynamic Gait Index - DGI=11), and 1 mild ST (M_ST, 43, male, right ischemic stroke, DGI=24) were equipped with a set of 16 inertial measurement units (IMUs, Captiks srl., 100Hz, Italy) and asked to perform a Real-TUG (RTUG), a proposed more complex version of the Timed Up and Go test that includes grasping an object with the hands before turning, once with the hemiparetic and once with the healthy limb, as in Graphs A and B, respectively.The following parameters were extracted using customized algorithms2: Duration, Average Speed and before/after-turn data such as Speed, Cadence, Stance/Swing Ratio, Arm Swing Velocity and Range of Motion (RoM) of the free arm.Results:In Graph A (hemiparetic arm engaged), M_ST and S_ST showed similar values compared to HS for Arm Swing Velocity and Range of Motion (RoM) of the free arm, while a decrement in the performance in lower limb parameters (e.g., walking speed and Stance/Swing Ratio), especially for the S_ST.In contrast, Graph B (healthy arm engaged), revealed specific differences between ST in Arm Swing Velocity and RoM. S_ST showed lower values in both upper and lower limb parameters, indicating an overall decreased performance. M_ST, on the other hand, showed a marked increase in Arm Swing Velocity and Range of Motion (RoM) following the grasping of the object, even exceeding the average of HS; this could suggest good mobility, but potentially suboptimal motor control of the paretic side. The lower limb data for M_ST remained essentially unchanged. Conclusions:These preliminary results suggest that engaging the upper limb during walking involves distinct motor adaptations in STs, which vary according to the severity of residual impairments. In particular, upper limb activity may hinder gait performances by influencing spatiotemporal parameters associated with fall risk3. These findings, which need to be further explored, emphasise the need to incorporate upper limb tasks into gait assessment and rehabilitation protocols to more accurately identify subjects' difficulties and improve their life quality.References:1. Wüest S et al. J Rehabil Res Dev. 2016;53(5):599-610;2. Antenucci, L. et al. 2019. In Proceedings of the 20th SIAMOC Conference (pp. 38–39). AMS Acta.3. Greene, B. R et al. 2010; IEEE transactions on bio-medical engineering, 57(12), 2918–2926.

P03-N-107 - Investigating the link between movement perception, sensory feedback, and anxiety in Parkinson's disease

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Background: Movement is complex and integrates cognitive, sensory-perceptual, and affective information; yet it is unclear to what extent these systems interact. A mismatch between an internally planned movement goal and its execution can result in conflict, which generates a constant error signal. If unresolved, anxiousness can increase, and as such movement may be impacted. Individuals with Parkinson's disease (PD) have

impaired perception of their movements, as well as sensory feedback degradation with disease progression, which may result in constant error. It is unknown if errors in sensory feedback are associated with movement perception error and moreover if errors are impacted by anxiety. This study evaluated i) the relationship between self-motion perception and sensory errors between PD and age-matched controls (HC), and ii) whether this relationship could be explained further by anxiety levels.Methods: Using a repeated measures design, 18 participants with PD and eight HC completed a movement perception task and proprioception task. The movement perception task timed the difference for participants to walk various distances (3m, 4.5m, 6m), and then imagine walking the same distance to measure movement perception error. The proprioception task required matching positions of one ankle joint to another while seated and without vision at three target angles (20° plantarflexed (20PF), 10° plantarflexed (10PF), 10° dorsiflexed (10DF)) twice per foot. Sensory error was the differences between target and matched position. For each task, absolute (AE), constant (CE), and variable error (VE) were calculated. Parkinson's Anxiety Scale (PAS), Gait Specific Attention Profile (GSAP), and MoCA exams determined anxious and cognitive behaviours relevant to walking, and general cognitive ability respectively. Results: Current independent t-tests confirmed that PD and HC were matched for age (69.8(6.74)years; p=0.127) and cognitive status (26.6(2.06) MoCA; p= 0.103). Mixed measures ANOVAs showed a group and target interaction (p=0.005) such that sensory AE was larger in PD compared to HC as plantarflexion increased. There were no significant effects of group, distance, or interactions for AE, CE or VE in the movement perception tasks. However, AE in proprioception tasks was correlated to AE in movement perception (R=0.25, p=0.001). Additionally, greater AE in movement perception was related to more anxious, task-irrelevant ruminations (GSAP) (p=0.027) and higher age (R= 0.18, p=0.026), with no relations to PAS.Conclusions: Preliminary findings suggest that sensory errors are related to movement perceptual errors, but only movement perception errors are influenced by anxiety. This relationship suggests a potential relationship where disruptions in sensory feedback impairs motor execution, contributing to heightened affective responses. Future rehabilitation may focus on addressing sensory integration and affective factors to enhance motor outcomes in PD.

P03-N-108 - Ability of the figure-of-eight test to detect balance impairment in individuals after stroke

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Background and aim: Dynamic balance is often impaired after stroke, increasing the risk for falls. The figure-of-eight test (F8T) [1], which combines straight-ahead and curved

walking, may be a promising clinical test to evaluate dynamic balance. Due to its increased complexity, the F8T could potentially reveal balance deficits not evident during regular walking. This study evaluated the ability of the F8T to detect balance impairments in individuals after stroke based on 1) discriminatory ability, 2) independence of gait speed, and 3) differences in turning performance with the paretic vs. non-paretic leg placed inwards.Methods: Individuals with self-reported balance problems after unilateral stroke (n=16) and healthy individuals (n=20) performed an adapted version of the F8T at comfortable speed, completing 4 laps around two hula hoops (d=0.95m) placed 3m apart. F8T performance was assessed using 3D motion capture, extracting the following parameters: 1) time to complete the F8T, 2) center of mass (CoM) trajectory length, 3) minimum mediolateral margin of stability (MoS) during turning [2], 4) turn duration, 5) ratio in CoM trajectory length between turns with the paretic or non-dominant leg inwards (i.e. numerator) vs. the non-paretic or dominant leg placed inwards (denominator). Straight-line gait speed was derived from a 2-minute walking test. Discriminatory ability was assessed using linear models with and without gait speed as covariate. Effect sizes were reported as mean differences with 95% confidence intervals and Cohen's d.Results: CoM trajectories during the F8T are shown in Figure 1A for a representative healthy individual and an individual after stroke. Individuals after stroke had a longer F8T time (mean diff = 17.2 s [11.8, 22.7], d=2.1), larger CoM trajectory length (mean diff = 4.5 m [3.4, 5.7], d=2.8), and a longer turn duration (mean diff = 1.4 s [1.0, 1.8], d=2.4) (all p<0.001) compared to healthy controls. Minimum mediolateral MoS during turning was 0.07 m [0.05, 0.10] higher in individuals after stroke (p<0.001, d=2.2). Between-group differences on these parameters remained statistically significant (p<0.012) after adjusting for gait speed (Figure 1B). There was no difference between groups in the ratio of the CoM trajectory length between turns with the affected vs. the unaffected leg placed inwards (mean diff = -0.00 [-0.03, 0.03], p=0.909). Conclusions: The F8T showed good discriminatory ability for individuals after stroke. Longer time to complete the F8T, larger CoM trajectory length, and a larger minimum MoS during turning suggests a more cautious walking strategy aimed at avoiding instantaneous instability during turns. Notably, turning difficulty was independent of the direction. Finally, the F8T showed added value over the evaluation of gait speed, as indicated by remaining group differences after correction for gait speed.References: [1] Hess RJ, et al. Phys Ther. 2010. [2] Ho TK, et al. J Biomech. 2023.

P03-N-109 - Visual perturbation treadmill training improves gait and reduces visual dependency in people with Parkinson's disease

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Background and aim: Decreased gait automaticity is common in people with Parkinson's disease (PD) and often leads to increased reliance on visual input to enable stable gait1-3. However, this increased visual dependency can cause a mismatch in perceived and actual self-motion during dynamic balance challenges, leading to increased fall risk4. Visual perturbation training (VPT) is a novel rehabilitation method that utilizes movements of virtual reality (VR) environments during treadmill walking. In this randomized controlled trial we assessed if 6 weeks of VPT could reduce visual dependency and improve gait parameters related to fall risk in people with PD.Methods: Twenty-five participants with PD (Hoehn & Yahr I-III, age 50-67y) were randomly assigned to either the experimental VPT or treadmill training-only control group. VPT consisted of self-paced treadmill walking in a 3D projected VR environment of the Gait Real-time Analysis Interactive Lab (GRAIL) system. Visual perturbations were applied as rotations around the sagittal axis and medio-lateral translations of the projected virtual reality environment. Each group received 12 training sessions of 20 minutes over 6 weeks. Primary outcomes included visual dependency during visual perturbations (correlations between mediolateral center of mass movements and angle of screen movements) and steady-state spatiotemporal gait parameters (gait speed, step time/length/width/frequency, and cadence) assessed pre- and post-intervention, as well as self-reported (near) falls.Results: Group x time interaction effects revealed that VPT significantly decreased visual dependency (from $r = 0.90$ to 0.71, $p < 0.001$) and improved temporal gait characteristics such as step time (-0.04s, $p = 0.012$) and stance time (-0.07s, $p = 0.018$), as well as cadence (+9 steps/m, $p = 0.018$), compared to controls receiving only treadmill training. However, no significant effects were found for spatial gait characteristics and (near) falls. Improvements in visual dependency were negatively correlated to disease progression ($p = 0.004$).Conclusions: Six weeks of VPT decreases visual dependency and improves gait parameters in people with PD. These results suggest that the capacity to decrease visual dependency is preserved in people with PD and that VPT may be a viable approach to reduce fall risk. Additionally, people in earlier disease stages appear to benefit most from VPT but additional research is needed to elucidate the long-term effects on falls. References:Wu, T. & Hallett, M. Brain, 2005. Clark, DJ. Frontiers in Human Neuroscience, 2015.Beylergil, SB. et al. Movement Disorders, 2021. Yakubovich, S. et al. Brain Communications, 2020.

P03-N-110 - A smartphone app for falls reporting in Parkinson's: Feedback from people with Parkinson's and healthcare professionals

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Background and Aim: Falls commonly occur in people with Parkinson's (PwP), which lead to reduced quality of life, and increased caregiver burden. Self-report falls diaries provide the current gold standard methodology for reporting prospective falls incidence in PwP, and are used both in research and clinical practice. Although the gold standard, the current method of falls reporting requires a significant number of resources and relies on subjective retrospective reporting. Therefore, a more cost-effective and less burdensome method of falls reporting is required. Stakeholder involvement in the design process is required to ensure the app is fit for purpose for the end-user, including people with Parkinson's, healthcare professionals and researchers. This project aimed to get feedback from PwP and healthcare professionals (with expertise in Parkinson's) on a co-designed smartphone application for falls reporting in PwP.Methods: 10 PwP and 11 healthcare professionals were invited to take part in separate online focus groups (via Microsoft Teams) to review and provide feedback on the co-designed app prototype. For PwP, interview structures were used to determine 1) usability of the app, 2) user experience and 3) clinical implications. In healthcare professionals, interview structures were used to determine 1) applicability for practice, 2) the future of a falls app in research, and 3) future developments. Thematic analysis was undertaken to determine common themes and sub-themes amongst the groups.Results: Overall, the relevance, value and applicability to clinical practice was captured within both the PwP and healthcare professionals findings. In 10 PwP (7M and 3F), two focus groups took place and three main themes emerged. The first theme was Usability, with subthemes of i) usability in PD, ii) technology usability, and iii) challenges. The second theme was Enhancing/understanding management of falls with subthemes of i) ease of reporting, ii) pattern awareness, iii) context, iv) Application to clinical practice. The third theme was Recommendations/future developments with subthemes of i) logistics and ii) relevance to PD falls. In 11 healthcare professionals (n=6 Physiotherapists, n=4 nurses, n=1 Geriatrician), 3 focus groups took place, ranging 57 to 85 minutes. Three main themes emerged: the first theme was applicability to clinical practice, with subthemes of i) enhancing clinical understanding of falls and ii) implementation challenges. The second theme was the future of the falls app in research, and the third theme was Future developments with subthemes of i) future additions to the app, and ii) further developments of current app functions. Conclusions: Overall, the app was found to be a useful tool for reporting falls both amongst healthcare professionals and PwP. The app was thought to be beneficial for supporting self-management, clinical care and research outcomes. However, several challenges remain including use on Android and IoS and allowing for voice recording before the app is ready for implementation into research and clinical practice.

P03-N-111 - Non-invasive brain stimulation to alleviate freezing of gait in Parkinson's Disease: An investigation into Neuroanatomical influences

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Background: Freezing of gait (FOG) is a disabling symptom in Parkinson's disease that causes an individual to feel stuck and unable to walk despite the intention to move. While some therapeutic strategies transiently improve FOG, such as cueing or action-observation training, effects are inconsistent and may not be retained long-term. Non-invasive brain stimulation (NIBS) has emerged as a treatment option with the potential to induce long-lasting improvements in FOG severity. Recently, our laboratory demonstrated that upregulating the excitability of the right posterior parietal cortex (PPC) through excitatory NIBS improves FOG. However, it is unknown if the stimulation parameters previously used are optimal for individuals with FOG. Specifically, changes in neuroanatomical characteristics such as cortical thickness and skull-to-cortex distance can influence the efficacy of NIBS. The aim of this study was to determine if cortical thickness and skull-to-cortex distance differ in the PPC in individuals with FOG in comparison to healthy individuals. Methods: Pre-existing T1-weighted magnetic resonance imaging (MRI) scans from 22 participants with FOG (mean age = 67±7 years, 15 males, Hoehn and Yahr score of 2-3, score > 1 on New Freezing of Gait Questionnaire) and 21 healthy control participants (68±7 years) from four different studies were analyzed. All MRI scans were acquired with a Siemens 3T Trio or Prisma scanner with 1mm3 isotropic voxels. Cortical thickness was extracted from the MRI scans using CIVET 2.1.1 and averaged over the right PPC (MNI coordinates: 60, -52, 43; 10mm radius). Cortical thickness values were harmonized across studies using ComBat-GAM to remove study-related variation while controlling for biological variation. A secondary analysis examined sex-based differences in the cortical thickness of the PPC among the participants with FOG. The skull-to-cortex distance of the PPC is currently being analyzed using BrainCalculator. Results: Preliminary results reveal that there was no significant difference in the mean cortical thickness of the PPC between healthy controls (3.21±0.18mm) and those with FOG (3.23±0.24mm), $t(38.46) = -0.24$, $p = 0.81$. In participants with FOG, the mean cortical thickness of the PPC did not differ significantly between males (3.21±0.28mm) and females (3.28±0.16mm), $t(18.96) = -0.80$, $p = 0.44$. Conclusion: Preliminary results suggest that the cortical thickness of the PPC may not be different between individuals with FOG and healthy controls, nor between males and females with FOG. These findings suggest that NIBS parameters for the PPC based on healthy controls may be suitable for those with FOG. Further, similar stimulation parameters may be appropriate for both males and females when stimulating the PPC to alleviate FOG in Parkinson's disease.

P03-N-112 - Longitudinal changes in effective connectivity and structural integrity underlying freezing of gait in Parkinson's disease

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BACKGROUND AND AIMFreezing of gait (FOG) is one of the most disturbing motor symptoms of Parkinson's disease (PD). We previously identified increased top-down excitatory directional functional connectivity (i.e. effective connectivity) from the left dorsolateral prefrontal cortex (DLPFC) to bilateral mesencephalic locomotor region (MLR) and an independent self-inhibitory connectivity within the left DLPFC that suggested a compensatory role in PD freezers versus non-freezers (Taniguchi et al., 2024). The aim of this study was to identify effective connectivity and structural changes associated with worsening FOG over time in PD freezers, and to examine whether structural changes contributed to observed effective connectivity. METHODSFifty-two people with PD were screened for the presence of FOG and underwent resting-state functional and structural MRI at baseline and again after at least 1 year follow-up. An additional 37 participants from the Parkinson's Progression Markers Initiative PD cohort with repeated structural scans were included for voxel-based analysis. We categorized the cohort into two groups, namely persistent freezers with FOG at baseline and follow-up, and persistent non-freezers without FOG at baseline and follow-up (i.e. non-converters). To determine regions where longitudinal functional connectivity changes occurred in freezers compared to non-converters, we performed seed-based analysis with the MLR as the seed region. Subsequently, we estimated effective connectivity between these regions using spectral dynamic causal modeling within a parametric empirical Bayesian framework. Structural changes within these regions were assessed with voxel-based analysis. Partial correlation analysis with bootstrapping was performed between FOG severity measures and effective connectivity ($n = 52$) and structural changes ($n = 88$). RESULTSThe resting-state functional MRI cohort consisted of 27 freezers and 25 non-converters with an average follow-up of two years. At follow-up, freezers exhibited significantly worsened self-reported FOG compared to baseline. Longitudinally, abnormally increased functional connectivity between the bilateral cerebellar lobule VIIb and the bilateral MLR was identified in freezers compared with non-converters (false discovery rate (FDR)-adjusted $p < 0.05$). Spectral DCM analysis identified an increased inhibitory effective connectivity from the left VIIb to right MLR in freezers at follow-up (> 99% posterior probability threshold), which was positively associated with the severity of FOG: with total FOG-Q score (partial $r = 0.592$, FDR-adjusted $p < 0.05$, bootstrap 95% CI: 0.310 to 0.759) and postural instability and gait difficulty score (partial $r = 0.542$, FDR-adjusted $p < 0.05$, bootstrap 95% CI: 0.307 to 0.632). For structural changes, non-converters showed a greater decrease compared to freezers in the left DLPFC and left cerebellar lobule VIIb ($p < 0.05$), while no significant between-group differences were observed in the other regions. Notably, there was no relationship between identified effective connectivity and local gray matter volume. CONCLUSIONSWe have identified the effective connectivity and structural changes that occur over time that underly worsening FOG severity in PD freezers, suggesting subcortical compensation. Additionally, the identified effective connectivity was not associated with structural changes. Surprisingly, local gray matter volume in the DLPFC and cerebellar lobule VIIb seemed to reduce over time in non-converters, and future work with a longer follow-up is needed to know if this could possibly predict future gait difficulties, such as FOG.ACKNOWLEDGEMENTS AND FUNDINGThis work was partially supported by JSPS KAKENHI (JP23KJ1539).

P03-N-113 - Freezing of gait in people with Parkinson's disease measured in the home setting:do FOG- provoking tests reflect daily living?

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Authors:Valeri Sandler*, Amit Salomon*, Talia Herman, Jeffrey M. Hausdorff, Eran Gazit*equal contributionsAffiliation: Center for the Study of Movement, Cognition, and MobilityBackground and aim: Freezing of gait is a common, debilitating problem that affects many but not all patients with PD. FOG is mysterious; sometimes, seemingly the same conditions will trigger FOG, but other times not. Self-report and FOG-provoking tests are used to assess FOG severity. The latter has shown that turning is a strong trigger of FOG. However, less is known about FOG in the home setting. We aimed to address that gap by objectively and directly quantifying FOG in the home using cameras placed in public areas. We hypothesized that out of 3 trigger of FOG turns would be the most common and that FOG would be less common during gait initiation and Straight-line walking. Methods: Subjects were videotaped in their homes using 3 cameras connected to a security system that recorded continuously for up to 7 days (Dahua security system). The recordings were restricted to public areas of the home, such as the living room, dining room and kitchen, and did not include audio. An expert reviewed the videos and annotated them using the ELAN annotation tool. A second expert reviewed the data afterwards to verify all the identified episodes of FOG. Only 1-2 days, per subject, have been annotated so far. 7 patients with PD and FOG were included in the study (age: 71.8 ± 5.0 yrs, 5 men, disease duration: 8.9 ± 3.5 yrs, NFOG-O score: 21.9 ± 5.4, MoCA: 25.6 ± 3.3, MDS-UPDRS part III: 37.9 ± 9.0). Data analyses and statistical tests were performed in Python 3.9 using the Pandas and Scipy packages. Non-gait segments were filtered out. The duration of FOG episodes and the percentage of the time spent frozen (%TF) were extracted for each subject. The %TF of the 3 FOG triggers was compared using a Friedman test followed by a Wilcoxon signed-rank test. Results: We capture 476 episodes of FOG (average 68±50 per subject). In contrast to our hypothesis, FOG was most common during start hesitation (207 episodes), then during walking (199 episodes), and then during turning (70 episodes). There was a significant difference between the %TF of the 3 different FOG triggers ($p=0.0032$), mainly driven by the difference between the %TF of turning and start hesitation episodes ($p=0.016$) (see also Fig. 1). The average duration of each FOG episode tended to be lowest in turns (4.2±3.0 sec), intermediate during walking (4.9±3.6 sec) and highest during start hesitation (7.3±5.5 sec).Conclusions: To our surprise, interim results of this pilot study suggest that FOG during turning is less common and less impactful (duration of episodes) than FOG during walking and gait

initiation. In addition, we found that FOG during gait initiation and walking were relatively frequent, in contrast to what is typically observed in FOG-provoking tests. These initial findings suggest that home-based assessment is needed to more fully evaluate FOG severity and its impact on daily living and independence.Acknowledgements and funding: N.A

P03-N-114 - A machine learning approach to guide optimal gait tasks and measures to identify de-novo people with Parkinson's disease

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Background and AimIndividuals with PD experience gait and balance impairments which can emerge as early as the initial stages of the condition [1]. Since wearable sensors have been shown to have great potential in identifying objective digital mobility biomarkers in PD [2], [3], gait assessment is a valuable method for the early identification and ongoing monitoring of PD [4]. In this study, we aim i) to identify the best gait task to distinguish participants with de novo PD from age-matched healthy control (HC) participants in the laboratory and ii) to identify the gait metric most sensitive to early PD diagnosis. We hypothesize that fast-walking tasks may not be critical for analysis, while based on existing literature[5], we expect that arm swing will be the most discriminative metric for identifying de novo PD.MethodsWe recruited 36 people with PD (age: [52-81] 70.16 ± 6.73 years; disease duration: [0.04-2.66] 0.92 ± 0.75 years; MDS-UPDRS-III total score: [15-46] 28.97 ± 8.7) and 21 age-matched healthy controls (age: [46-79] 67.61 ± 9.01 years). Participants completed 1) 2-minute walk test, 2) 2-minute walk test with a cognitive dual task, and 3) 6-minute walk test, fast pace, while wearing seven OPAL inertial sensors (APDM Wearable Technologies, a Clario company, Portland). We extracted 24 gait metrics using APDM Mobility Lab Software and the dataset was split 70% for training and 30% for testing. We assessed the performance of five machine learning models—GradientBoostClassifier, XGBoost, Random Forest, Support Vector Classifier, and KNeighborsClassifier—using grid search hyperparameter optimization with 5-fold cross-validation with the three different gait conditions. Evaluation metrics included Receiver Operating Characteristic – Area Under the Curve ROC-AUC, accuracy, F1 score and Matthews Correlation Coefficient (MCC). Feature importance was analyzed using the SHAP (SHapley Additive exPlanations) approach.ResultsResults suggest that single-task walking performed the best for distinguishing de-novo PD from age-matched controls via a Random Forest algorithm with a ROC-AUC of 0.84, an accuracy of 0.83, an F1 score of 0.83 and MCC of 0.66. SHAP value analysis showed that aspects of gait variability are important in discriminating de-novo PD from healthy controls because of 3 of the top 5 metrics, where the most sensitive is arm Range of motion variability.ConclusionsMachine learning approaches can provide valuable insight into identifying the most appropriate gait task to perform and the best gait metrics to discriminate between de-novo PD and healthy controls. Our study showed that in the early stage of PD, a simple 2-minute walking test can distinguish between the two groups. Our findings confirm previous literature where gait variability and arm range of motion variability have been shown to be good estimators of PD onset. Reference[1] A. Mirelman et al., "Gait impairments in Parkinson's disease," Lancet Neurol, vol. 18, no. 7, pp. 697–708, Jul. 2019, doi: 10.1016/S1474-4422(19)30044-4.[2] F. B. Horak and M. Mancini, "Objective biomarkers of balance and gait for Parkinson's disease using body-worn sensors," Movement Disorders, vol. 28, no. 11, pp. 1544–1551, 2013, doi: 10.1002/mds.25684.[3] J. C. M. Schlachetzki et al., "Wearable sensors objectively measure gait parameters in Parkinson's disease," PLoS One, vol. 12, no. 10, p. e0183989, 2017, doi: 10.1371/journal.pone.0183989.[4] W. Yin et al., "Gait analysis in the early stage of Parkinson's disease with a machine learning approach," Front Neurol, vol. 15, p. 1472956, 2024, doi: 10.3389/fneur.2024.1472956.[5] A. Mirelman et al., "Arm swing as a potential new prodromal marker of Parkinson's disease," Mov Disord, vol. 31, no. 10, pp. 1527–1534, Oct. 2016, doi: 10.1002/mds.26720.

P03-N-115 - Outcome measures of instrumented gait analysis in hereditary Spastic Paraplegia: A systematic review

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Background and AIMHereditary spastic paraplegias (HSPs) comprise a group of genetic movement disorders characterized by progressive spasticity and weakness of the lower limbs, leading to gait deficits. Disease severity and gait deficits are assessed using established clinical scales and functional gait tests. Instrumented gait measures are applied to objectively quantify gait patterns in HSP. However, there is no consensus on the most relevant HSP-specific digital outcome measures for clinical studies. Therefore, we reviewed and analysed the existing literature over the past 20 years. This systematic review aims to summarize outcome measures of instrumented gait analysis in HSP patients, focusing on both, traditional motion capture (MOCAP) and inertial sensor systems. MethodsFollowing PRISMA-2020 guidelines, a comprehensive literature search was conducted by two independent researchers in PubMed, Scopus, and Web of Science to identify studies using instrumented gait analysis in HSP. Data on participant characteristics, measurement systems, outcome measures, results, and risk of bias were systematically extracted. The extracted gait metrics were classified into various categories based on their type: spatiotemporal parameters, kinetics, kinematics, EMG, and others. Additionally, it was assessed whether these gait parameters significantly distinguished HSP patients from healthy individuals in observational studies and if gait metrics reflected changes after treatment in interventional studies.ResultsIn total, 35 studies published between 2004 and 2023 including 27 observational studies and 8 interventional studies met the inclusion criteria. Various gait parameters were used including spatio-temporal, kinematic, kinetic, and EMG measures. In total, 334 parameters in observational studies and 39 parameters in interventional studies were extracted and analysed. Walking speed and knee range of motion were identified as important parameters for characterizing HSP-specific gait patterns. In contrast, a deeper understanding of kinetics, EMG, and upper body parameters is necessary. Few studies explored sub-cohorts that exhibit different HSP gait characteristics.ConclusionThis review underlines the important role of digital outcome measures from instrumented gait analysis in understanding and characterizing gait patterns in HSP. While MOCAP provides valuable data in controlled environments, there is a need for validated mobile sensor systems capturing gait patterns of HSP patients in real-life. Future research should focus on longitudinal multicenter studies with larger sample sizes to establish robust digital outcomes and monitor disease progression and therapy response in HSP.

P03-N-116 - Sensor-based assessment of gait and balance in aging and neurological disorders: Exploring biomarkers through progressively complex tasks

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Background and aimClinical assessment of balance and gait in controlled and standardized settings often involves simple measurement protocols (such as walking along a 10-meter straight path). While these methods capture important gait characteristics, they may not effectively detect motor impairments in real-world environments, as they do not adequately challenge the individuals1. Sensor-based assessments of gait patterns through progressively complex motor tasks may give deepest and more comprehensive information about the functional status of those under exam2. The aim of this study is to explore the feasibility of biomarkers that can reveal subtle motor instability by using wearable technology and employing a range of tasks that progress from controlled, standardized and simple movements to more complex, real-world scenarios. Methods17 Healthy Elderly (HE), 9 Parkinson (PD), (Hoen and Yahr: 2), and 9 chronic Stroke patients (ST), (Fugl-Meyer_LowerExtremity: 23), known to be at high risk of falling, were asked to perform 3 motor tasks in different conditions: 1) linear walking: standard clinical evaluation (10-meter walking test, 10MWT), linear walk (LMW) on a led floor surrounded by a mountain landscape, and on a mat with no elastic resistance (MatW); 2) curvilinear walking: standard clinical evaluation (Figure-of-eight walking test, Fo8WT), curvilinear walk (CMW) with the mountain landscape, and a dual-task grocery shopping (DT); 3) timed up and go test (TUG): standard clinical TUG, and mimicking kitchen activities (RTUG). A set of spatio-temporal parameters was extracted from 16 Inertial Measurement Units (Captiks srl, Italy, 100Hz) through Motion Analyzer

validated algorithms3.ResultsColoured dots of the plots in the Figure1 show the participants presenting atypical performance (outliers) with respect to the relevant group for different spatio-temporal parameters. Outliers are more evident in walking cadence, stance/swing ratio, for both condition linear and curvilinear, and TUG duration, while elsewhere the data distribution is more scattered, thus distinct trends are not observed (e.g., gait speed, step length, TUG sit-to-stand trunk flexion, TUG stand-to-sit trunk flexion). It should also be noted that deviations become increasingly apparent as tasks progress toward curvilinear and real-world scenarios, aligning with the observation that gait performance generally decreases as task complexity increases across all measured parameters and evaluated populations.ConclusionsPreliminary results suggest that the highlighted metrics could provide useful insights for identifying specific gait patterns or performance anomalies, reinforcing the need to introduce more complex tasks, which mirror real-life challenges, to better understand patients' functional status. Further research is needed to determine if real-world motor tasks and identified biomarkers can reliably distinguish fallers from non-fallers.BibliographyVienne A et al. Frontiers in psychology, 2017; 8:817. Belluscio V et al. Sensors 2019;19(23):5315.Ricci M et al. Journal of biomechanics, 2019; 83:243–252.

P03-N-117 - The added value of training gait stability on an instrumented treadmill in persons with a brain lesion

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Background and aimPersons with a brain lesion present with a range of motor symptoms (paresis, changes in muscle tone, ...) which contribute to an impaired motor control and potential fall risk. Since history and fear of falling are strong predictors of recurrent falls during gait which may lead to major health consequences, increased dependency and a rise in the economic costs, training gait stability is a common and important rehabilitation goal.MethodsTwenty-four persons after a stroke or acquired brain injury (45 ± 13 years old, 5 ± 4 months post onset) who were able to walk independently for at least six minutes participated in this randomized controlled trial. They were randomly assigned to an intervention or control group. The intervention group received five weeks of gait stability training (2x30 min per week) on an instrumented treadmill in a virtual environment (GRAIL, Motek). The control group received dose-matched standard balance and gait training during physiotherapy. Primary outcome measures were balance confidence (ABC questionnaire), functional balance (Community Balance and Mobility Scale (CBMS)), gait speed (10 meter walk test) and spatiotemporal parameters. Intervention effects were assessed using a paired t-test or Wilcoxon signed-rank test. Effect sizes were estimated by calculating Cohen's d.ResultsAfter five weeks of training, only participants of the GRAIL group showed a significant improvement of their functional

balance (CBMS; p=0.012, d=0.3) and balance confidence (ABC; p=0.020, d=1.0). The spatiotemporal parameters improved for participants in both groups significantly as did overground walking speed (GRAIL p<0.001, d=0.4; Control p=0.006, d=0.6), walking speed on the treadmill (GRAIL p<0.001, d=1.2 ; Control p=0.003, d=0.5) and (non-)paretic step length (GRAIL both sides, p<0.001, d=1.1; Control paretic side p=0.010, d=0.6; non-paretic side p=0.004, d=0.3). Only participants of the GRAIL group showed a significant reduction in double support time (p=0.002, d=0.8).ConclusionsGRAIL training seems to improve gait parameters measured on the treadmill, but also functional balance and balance confidence measured outside the treadmill-based lab. These effects are potentially the result of a more intensive gait and balance training compared to standard physiotherapy due to the integration of an instrumented treadmill in a safe virtual reality environment. However, these results need to be confirmed in a larger sample. Additionally, margins of stability will be calculated on this dataset to have a more objective measure of dynamic stability.Acknowledgements and fundingNo funding was obtained for this study.

P03-N-118 - To combine or not to combine – can smart algorithms reliably detect patterns regardless of the input?

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Background and AimGait analysis is an important step in gait rehabilitation to evaluate the treatment and track the progess1,2. While joint angle assessment is a central part of clinical gait analysis3, it results in vast amounts of data and the challenge of selecting the key information from it. This is why Artificial Intelligence (AI) options are being explored. AI algorithms generally require vast amounts of data and techniques such as data fusion can therefore be utilized to combine datasets of different measurement types or clinical origin4,5. The golden standard for estimating joint angles is Optical Motion Capture (OMC)6, but also Inertial Measurement Units (IMU)7 are commonly used. The validity and reliability of joint angle estimation from IMUs has been reported extensively and showing a varying error, mainly in the non-sagittal planes8. However, deep learning algorithms, such as Variational Autoencoders (VAE), aim at capturing the underlying pattern in their most compressed key feature representation (latent space), regardless of small amounts of noise. Therefore, the aim of this study is to explore the reliability of the intraparticipant latent space and thereby test the feasibility of combining data joint angles estimated from OMC and IMUs for future data explorations.MethodsThe 3D lower-limb joint angles during treadmill walking (1 m/s, 1.25 m/s and 1.5 m/s) of 12 able bodies participants (24.5 ± 4.5 years) were derived from IMU (MVN Link Suit (Movella Technologies B.V, Enschede, the Netherlands) and OMC data (QTM 2024.1, Qualisys, Göteborg, Sweden). The joint angle data was segmented into four second windows, all initiated from a right heel strike and presented as input data to a VAE pretrained on joint angles from 29 stroke survivors9 and 42 healthy participants10. The VAE was symmetrical with 3 convolutional layers, a flatten and dense layer, used Kullback-Leibler divergence loss and was trained for 40 epochs. To test the level of agreement, Bland Altmann statistics were calculated between the 3 latent features derived from the OMC and IMU inputs.ResultsThe Bland Altmann statistics reveal a high level of agreement between the two data sets (figure 1B). Visual inspection confirmed that the data of the same participant and speed is located in the same area of the latent space (figure 1A), thereby showing, that the VAE identified the same gait pattern from both data sets. INSERT FIGURE HERE Figure 1 A: Visual representation of the latent space, with two participants' data clusters, separated into the IMU and OMC data for each of the 3 speeds. Grey circles: original test data. B: The Bland Altmann plot with a linear regression to access the agreement between the 3 latent features (blue, red and green respectively) derived from the OMC and IMU dataConclusionThis study shows that a VAE can extract the individual gait pattern of a person independent from the data collection systems, allowing future fusion of data of various clinical origin. Further, they motivate to expand this analysis to other commonly used systems such as 2D video analysis or markerless motion capturing. 1) Whittle, M. W. Clinical gait analysis: A review. (1996)2) Prajapati, N., Kaur, A. & Sethi, D. A Review on Clinical Gait Analysis. (2021)3) Hulleck, A. A., Menoth Mohan, D., Abdallah, N., El Rich, M. & Khalaf, K. Present and future of gait assessment in clinical practice: Towards the application of novel trends and technologies. (2022)4) Castanedo, F. A Review of Data Fusion Techniques. (2023)5) Hazra, S., Pratap, A. A., Tripathy, D. & Nandy, A. Novel data fusion strategy for human gait analysis using multiple kinect sensors. (2021)6) Baker, R. Gait analysis methods in rehabilitation. (2006)7) Caldas, R., Mundt, M., Potthast, W., Buarque de Lima Neto, F. & Markert, B. A systematic review of gait analysis methods based on inertial sensors and adaptive algorithms. (2017)8) Poitras, I. et al. Validity and Reliability of Wearable Sensors for Joint Angle Estimation: A Systematic Review. (2019)9) Punt, M. et al. Responses to gait perturbations in stroke survivors who prospectively experienced falls or no falls. (2017)10) Fukuchi, C. A., Fukuchi, R. K. & Duarte, M. A public dataset of overground and treadmill walking kinematics and kinetics in healthy individuals. (2018)

P03-N-119 - Testing inter-effort recovery hypoxia in people with Parkinson's disease: Acute responses on gait parameters

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Background and aim: Hypoxia exposure is a potential complementary strategy for treating Parkinson's disease (PD). However, due to the significant decrease in oxygen availability, the practical use of hypoxia may mitigate established treatment strategies for people with PD, such as treadmill-based exercise. Therefore, this study investigated the effects of inter-effort recovery hypoxia (IEH) during treadmill sessions on gait in people

with PD. Methods: Nineteen participants (Hoehn and Yahr scale < 3) underwent this randomized, double-blind, controlled trial. The experimental session consisted of two periods of hypoxia or placebo exposure (2x10 minutes), interspersed with treadmill exercise at preferred speed (2x10 minutes). The hypoxia generator (ACT-12 Air Unit - Everest Summit II TM) was set to deliver either 13.6% O2 during IEH or 20.9% O2 during the control condition (CON). Gait was assessed at a comfortable speed both before and immediately after the session (GAITRite system; 5.74-m platform, CIR Systems Inc, Clifton, USA). Results: The hypoxia doses increased throughout the IHE session (median [IQR]: 6.0 [4.7] %.h). Speed and step length improved following the experimental sessions (p-value < 0.005; moderate to large effect sizes), with no significant differences between IEH and CON (p-value > 0.302; small effect sizes). No significant effects were observed for cadence (p-value > 0.189 small effect size), single support (p-value = 0.222; Negligible effect size) and double support (p-value = 0.281; Negligible effect size). Conclusions: Therefore, IEH did not negatively affect the acute impact of treadmill exercise on gait in people with PD. These findings enhance our understanding of hypoxia exposure as a treatment option for PD, demonstrating that the IEH approach can be applied during exercise sessions without adverse effects. ACKNOWLEDGEMENTS AND FUNDING: This study was funded by the São Paulo Research Foundation (FAPESP: #23/06865-5 and #2022/02971-2), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001, National Council for Scientific and Technological Development (CNPq) and São Paulo State University (PROPe: 13/2022).

P03-N-96 - Translating outcomes of gait interventions to real-world gait in Parkinson‘s disease

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Gait impairments are among the most disabling symptoms in Parkinson’s disease (PD), limiting mobility and increasing fall risk. Falls often occur during walking, due to difficulties in adapting to environmental demands. Real-world gait is influenced by distractions, multitasking, and environmental complexity, differing significantly from laboratory settings. Wearable sensors have facilitated real-world gait monitoring, revealing differences in gait quality, such as variations in gait speed and stride length, between laboratory and daily life. While laboratory-based interventions such as treadmill training show efficacy in improving gait quality in the laboratory, limited research examines how these effects translate to real-world walking. Understanding the factors influencing this translation is critical for optimizing interventions and enhancing daily-life mobility in people with PD. Therefore, the aim was to investigate the complexities and challenges of real-world gait assessments in people with PD and the factors that may influence the translation from laboratory-based interventions to real-world gait.We present an in-depth analysis of current methodological approaches to real-world gait assessments in PD and the challenges that may influence the translation of an

intervention's success from lab-based outcomes to improved walking during daily life. A comprehensive literature search was conducted using terms such as "real-world," "daily life," "Parkinson's disease," "intervention," "rehabilitation," "IMU," "wearable sensor," and "gait." Approaches to minimize disparities between laboratory and real-world gait assessments will be discussed, with the goal of optimizing interventions and enabling effective evaluation of their impact on daily-life gait in PD.Currently, a direct translation from interventions conducted in laboratory settings to real-life scenarios is lacking, and a noticeable disparity between laboratory and real-world settings is evident. We identified six key factors that may influence the translation of intervention success into real-world environments at different stages of the process (Figure 1). These factors comprise the gait intervention, parameters analysed, sensor setup, assessment protocols, characteristics of walking bouts, and medication status.This study emphasizes the importance of measuring intervention success outside of the laboratory environment. Our findings support the need for future studies to bridge the gap between proven efficacy for gait as assessed in controlled laboratory environments and real-world impact for people with PD. Furthermore, integrating patient-reported outcomes with objective gait data is essential for connecting measurable improvements to meaningful functional impacts, emphasizing the importance of a patient-centred approach in optimizing treatments and enhancing quality of life.AcknowledgementsThanks to Dr. Deepak Ravi for his support and supervision throughout this project.

P03-N-97 - The design and training process for a novel freezing of gait clinician rated outcome assessment

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Introduction: Freezing of gait (FOG) in people with Parkinson's (PwP) is a prevalent and debilitating symptom that has yet to have effective therapeutic remedies. Progress has been thwarted in part due to a lack of standardized and reliable measures of FOG severity. Recently, a clinician-reported outcome measure (ClinRO) was developed by a working group in the International Consortium of FOG (IC-FOG) to standardize a measurement of FOG severity. Through an iterative process, the beta version of the FOG ClinRO is currently being validated across 7 centers globally. This work aims to describe the ClinRO tool development and training protocol evaluation for raters.Methods: Phase 1 of the ClinRO development involved using regulatory roadmaps and reviewing existing FOG assessments to draft an initial 8-item version. Phase 2 of development piloted the draft ClinRO in 20 PwP with FOG. Scored by 13 FOG experts, inter-rater reliability was moderate to good. To improve reliability, a training program for ClinRO raters was developed to prepare for Phase 3, which is currently validating the ClinRO. Training included an online tutorial that described the clinical FOG definition, scoring explanation, and representative FOG severity examples. Raters independently scored examples, and discussion with experts refined their approach. Raters were certified using a test with curated videos of various FOG severities. Training evaluation provided feedback on the burden, confidence, difficulty, and feasibility of ClinRO use. Pilot and training scores were evaluated for inter-rater reliability using intraclass correlation coefficients (ICCs). Results: The ClinRO was designed to maximally provoke and accurately rate FOG severity for use in clinical trials to reduce FOG. As such, the tool needed to take under 10 minutes to complete, with minimal setup, is scored live and is suitable for clinical settings. The 13 rater's ICC in Phase 2 ICC was 0.81 (95% CI: 0.72-0.88). The 34 raters in Phase 3 (clinicians & researchers) across the 7 sites completed the ClinRO training program. Experience with PwP and FOG varied. 35% of raters had less than 2 yrs of experience working with PwP, and 44% observed FOG in < 20 PwP. Of the group, 25 (78%) passed the certification testing on the first attempt. Failed attempts only had an error of 1.25% greater than the acceptable score range and all passed on the second attempt. ICC of ClinRO scores was 0.925 (95% CI: 0.868-0.967; $F_{15,472}$ = 460, $p<0.001$), showing excellent inter-rater reliability in the trained raters. Feedback from raters revealed appropriate burden, the implementation somewhat to very feasible and the confidence somewhat to very high after training. Conclusion: The training of ClinRO scoring improved the inter-rater reliability of the ClinRO and it was beneficial to align FOG severity scoring even in a relatively inexperienced group of raters. Rater feedback provided useful insights for the ongoing validation of the FOG ClinRO.

P03-N-98 - Can a deep learning algorithm assess freezing of gait during a turning task in people with Parkinson's disease?

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Background: Freezing of gait (FOG) is a disabling symptom of Parkinson's disease (PD), often triggered by turning tasks such as one-minute 360° dual-task turning (360 turn). Accurately classifying patients as freezers and assessing their FOG severity during this task is proven challenging and algorithms based on threshold-based methods show limited accuracy for FOG detection. Deep learning (DL) algorithms have been developed that offer potential for improved FOG detection. This study aims to evaluate the accuracy of a wearable sensor-based DL algorithm to classify freezers and assess its validity to quantify FOG severity.Methods: 154 people with PD (Age:63.21±9.71 years, Disease duration:7.81±4.9 years, MDS-UPDRS-III:30.27±12.50) performed the 360 turn in their

ON medication state while wearing IMU sensors at the feet, shins, and lower back. Self-reported FOG was determined via the NFOGQ. Expert FOG assessment was based on post-hoc video analysis by two independent raters. The Algorithm was trained to detect FOG on another dataset of 29 people with PD with severe FOG and 9 without FOG, performing several gait tasks and voluntary stops (1). Afterwards, it was tested on the 154 included participants. Agreement of the algorithm's classification (FOG/non-FOG) with expert ratings and self-reports was assessed using Cohen's kappa statistics. Absolute agreement in percentage time frozen (%TF) scored by experts versus algorithm-extracted %TF was evaluated using the intraclass correlation coefficient (ICC). ROC curves were used to evaluate sensitivity and specificity of the DL algorithm.Results: The algorithm showed moderate agreement with expert ratings for FOG classification ($\kappa=0.428$, $p<0.001$) and weak agreement with self-reports ($\kappa=0.112$, $p=0.036$). For all participants, the ICC between expert and algorithm for %TF was 0.628 (95% CI=0.522–0.715, $p<0.001$). Among the 26 self-reported freezers, the ICC for %TF was 0.591 (95% CI=0.280–0.790, $p<0.001$), and among the 98 clinically rated freezers, it was 0.576 (95%CI=0.427–0.694, $p<0.001$). The algorithm provided a sensitivity of 65.3% and specificity of 80.4% when compared to expert FOG classification (AUC=0.78, $p<0.001$, Threshold=1.24). Against self-report, the algorithm achieved a sensitivity of 57.5% and specificity of 83.6% (AUC=0.70, $p=0.001$, cutoff=5.59). Examples of agreement in Figure 1. Conclusion: Automated FOG classification remains a challenge, with moderate agreement of the DL algorithm with clinical ratings and poor agreement with self-reports. However, when considering FOG severity as a continuum and expressed as %TF, the model's performance improved. The study participants ranged from non-FOG to severe FOG, while the model was trained mostly on severe FOG cases. This may explain the lower performance for less severe cases compared to previous work. For clinical implementation, it is crucial that DL algorithms perform effectively across the full spectrum of freezing severity.Funding: Mobilise-D Funding from the Innovative Medicines Initiative 2 JointUndertaking (JU) under grant agreement No. 820820. KU Leuven internally funded FOG-ITproject (C3/20/109). M. Goris is supported by a fellowship of the Research Foundation Flanders (FWO) (1SHEK24N). The other authors do not have funding to declare.1. 1. Yang PK, Filtjens B, Ginis P, Goris M, Nieuwboer A, Gilat M, et al. Freezing of gait assessment with inertial measurement units and deep learning: effect of tasks, medication states, and stops. J Neuroeng Rehabil. 2024 Dec 1;21(1).

P03-N-99 - Turning performance in Parkinson's disease: classification of prospective fallers and freezers using wearable inertial sensors

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Background and aimTurning while walking is often impaired in individuals with Parkinson's disease (PD) and is a key contributor to freezing of gait (FOG), leading to reduced quality of life and a higher risk of falls [1]. The present study aims to analyse turning performances in PD using a single wearable sensor to classify prospective fallers vs non-fallers and individuals with or without prospective FOG events (freezers vs non-freezers) [2].Methods The cohort of participants was obtained by merging the data collected within the ICICLE-GAIT [3], GAITDEM [4], and InCHIANTI [5] studies which involved older adults and individuals with PD. Turning performances were extracted from inertial data recorded using a single wearable device placed on the lower back during walking tests, including 10 meters straight walking ending with a 180° turn and Timed Up and Go [6]. The inertial data was processed using a validated turning algorithm [7] to extract signal-based (e.g., Root Mean Square (RMS)) and spatio-temporal turning features (e.g., turn duration). In addition to turning-focused Digital Mobility Outcomes (DMOs), demographic information (e.g., age) and clinical evaluation scores (e.g., Hohen and Yahr (H&Y), MDS-UPDRS III, Activities-specific Balance Confidence Scale (ABC)) were analyzed. Univariate and multivariate Receiver Operating Characteristics (ROC) curve analysis and Machine Learning (ML) algorithms (e.g., Support Vector Machine, K-Nearest Neighbour algorithms) were used to perform two distinct classifications: fallers vs non-fallers (n=297, age: 79±8 y/o) and freezers vs non-freezers (n=133, age: 73±9 y/o). Area Under the Curve (AUC) was used to assess the discriminative power of turning DMOs and clinical scores in discriminating between groups.ResultsJerk measures of angular velocity in the antero-posterior direction exhibited moderate accuracy (AUC=0.67) in discriminating between fallers and non-fallers, serving as a discriminative metric of the ability to control motion. Adding demographic information resulted in a similar predictive performance (AUC=0.68). The RMS of acceleration and angular velocity in the vertical direction achieved a good accuracy (AUC=0.81) in differentiating between freezers and non-freezers. Adding demographic information and clinical scores (H&Y, ABC scale and MDS-UPDRS III) to the model led to a substantial enhancement in the accuracy (AUC=0.97). RMS was 9% lower in PD freezers, indicating a reduced smoothness in the turning movement. For both classification tasks, similar results in terms of accuracy were achieved by ML models.ConclusionThe present study emphasizes the importance of measuring smoothness and intensity turning DMOs to differentiate PD fallers from non-fallers, and PD freezers from non-freezers, respectively. Turning-focused DMOs provide quantitative measures of motor performance, thereby assisting clinicians in objectively monitoring individuals in both clinical and real-world settings.References1. Mancini, M., et al., Frontiers in Neurology, 2018. 9.2. Bloem, B.R., et al., Mov Disord, 2004. 19(8): p. 871-84.3. Yarnall, A.J., et al., Neurology, 2014. 82(4): p. 308-16.4. Mc Ardle, R., et al., J Alzheimers Dis, 2017. 60(4): p. 1295-1312.5. Ferrucci, L., et al., Journal of the American Geriatrics Society, 2000. 48(12): p. 1618-1625.6. Salarian, A., et al., IEEE Trans Neural Syst Rehabil Eng, 2010. 18(3): p. 303-10.7. Rehman, R.Z.U., et al., Sensors (Basel), 2020. 20(18).

P03-O-120 - Minimal important difference of digital mobility outcomes (DMOS) in older adults after hip fracture

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Background and Aim: Mobility and especially walking ability are a major priority for older adults after hip fracture, but also for clinicians since they have been shown to predict future incident hip fracture risk and long-term survivorship. Hence, the adoption of walking parameters as clinical endpoints is crucial to mitigate walking disability in older adults with impaired gait and loss of function. Through movement sensor technology, walking can now be assessed under unsupervised, real-world conditions and consequently with much higher ecological validity. The aim of this study is to provide Minimal Important Difference (MID) values of walking-based digital mobility outcomes (DMOs) in older adults recruited within one year after hip fracture surgery.Methods: This is a multicentre, prospective cohort study including the 1st and 2nd (6-month) study visit of the hip fracture cohort (n=380) in the Mobilise-D Clinical Validation Study. DMOs were calculated on walking bout level by running the raw sensor data through the Mobilise-D processing pipeline. Several DMO dimensions were included: walking volume, walking activity pattern, pace, rhythm, and bout-to-bout variability. For the calculation of the MID values, we employed distribution-based methods (half of SD) and, if a priori criteria were fulfilled, anchor-based methods (receiver operating curves and linear models). We used a global impression of change (GIC) question and the following mobility-related outcome measures with established MIDs as anchors: Late-Life Function and Disability Instrument (MID of 2 points); Short Physical Performance Battery score (MID of 1 point); 4-meter walk test (comfortable gait speed; MID of 0.1m/s). The triangulation process included a narrative evaluation of the single MID estimates by 3 experts who provided individual MID estimates based on an a priori set of evaluation criteria. Experts then agreed on a MID point estimate for each DMO possible.Results: Triangulated estimates of MIDs for walking volume were: walking duration of 12 minutes and 1,000 steps per day. MIDs for walking activity pattern: 55 walking bouts per day and 16 walking bouts >10s duration per day. MIDs for pace: habitual walking speed of 0.04m/s in walking bouts of 10-30s and 0.08m/s in walking bouts >30s; maximum walking speed of 0.07m/s and 0.08 m/s in the respective walking bouts. MIDs for rhythm: average cadence of 4.5 steps/min and maximum cadence of 5.5 steps/min in walking bouts >30s. No MIDs could be identified for bout-to-bout variability DMOs (not enough estimates).Conclusion: The present study provides first and preliminary estimates of MIDs in older adults after hip fracture. This is a crucial step towards the acceptability by regulators (EMA and FDA) but also for an informed dialogue with patients and their representatives. In clinical practice, this knowledge on MIDs will support clinical guidance, the evaluation of interventional studies, and shared decision-making processes.

P03-P-122 - Region-dependent proprioceptive reweighting when standing on an unstable surface

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Background and aim – Although proprioceptive information is crucial to the control of standing balance, its contribution remains poorly understood. During standing, proprioceptive information is modulated according to stability demands. Thus, in an unstable situation, global postural responses (position of the centre of pressure) to proprioceptive stimulations at the ankle are reduced, while those to lumbar proprioceptive stimuli are enhanced. Yet, the way in which proprioceptive information from other regions of the body is modulated in an unstable situation has not been documented. The aim of this study was to explore how instability modulates global and segmental (isolated joint angles) postural responses to proprioceptive stimuli in healthy adults.Methods – Fourteen healthy individuals were instructed to stand on a stable surface or an unstable foam, with their eyes open or closed. To produce proprioceptive stimulations, muscle vibration was applied bilaterally to the Achilles tendon of the triceps surae (TS), quadriceps femoris (QF), hamstrings (HS), the lumbar portion erector spinae (ES) and neck extensors (NE). Global postural responses were collected with AMTI platforms and segmental postural responses were collected with a Vicon system based on 24 passive markers placed on the feet, shanks, pelvis, trunk, and head. Conditions were compared in the sagittal plane with Wilcoxon signed rank t-tests. Here, only global postural responses are reported, but both global and segmental postural responses will be presented at the congress.Results – On a stable surface, TS vibration led to posterior global postural responses ($p < 0.001$) whereas it led to anterior global postural responses when applied to other muscles ($p \leq 0.005$). Instability reduced global postural responses to vibrations applied to the TS ($p = 0.025$) and the QF ($p = 0.049$) with eyes open but did not modify them in any other condition ($p \geq 0.097$). Having the eyes open or closed had no impact on the influence of instability on global postural responses to vibration for any of the locations to which vibrations were applied ($p \geq 0.173$).Conclusions – As reflected by the amplitude of global postural responses, the relative salience of proprioceptive information from TS and QF appears to be diminished on an unstable surface, while that of HS, ES and NE remains unchanged, although global postural responses to ES vibration were reported to be increases in previous studies. The lack of impact of vision on the influence that instability has on global postural responses to vibration could suggest that vestibular information is favoured over proprioceptive information from TS and QF in an unstable situation.

P03-P-123 - Early detection of postural instability in individuals with diabetic peripheral neuropathy using a custom smartphone application

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Aims: Diabetic Peripheral Neuropathy (DPN), a complication of Type 2 Diabetes (T2D), damages peripheral nerves causing a higher risk of postural instability and falls. Current DPN diagnostics require a clinical expert, costly equipment, and typically focus on peripheral testing of the somatosensory system, rather than postural assessments. While using posturography could provide insight into somatosensory loss, it can also be inaccessible and expensive. As smartphone technology has become more accessible and the built-in inertial measurement units (IMUs) have become more sensitive, it is emerging as a promising tool for measuring postural control and could be a valuable for high-fall risk populations or those with limited access to clinical care. The aim of this study is to validate a custom smartphone app relative to research-grade posturography instrumentation to establish its applicability as a tool for early detection of postural instability in DPN.Methods: N=27 participants, including 21 individuals with diabetes (8 with and 13 without a clinical diagnosis of DPN) and 8 healthy age-matched adults were tested under varying conditions of quiet stance [eyes open (EO) Firm and Foam, eyes closed (EC) Firm and Foam] for three 30-second trials in each condition for a total of 12 trials. Visual and surface conditions were used to assess visual, vestibular, and somatosensory contributions to balance. The sensitivity and accuracy of the smartphone IMUs were determine by synchronously collecting data with a force plate (FP), a motion capture (MC) system, and the smartphone on each participant. A mixed-model repeated-measures ANOVA tested the effects of surface (Firm vs. Foam), device (MC, Phone, and FP), and visual condition (EO vs. EC) and cohort (Healthy, T2D, DPN) on postural variables (sway area and velocity). Pearson correlations of the time series data compared postural variables between the research-grade instruments and the smartphone app.Results: The smartphone app showed strong, positive correlations with the research-grade equipment ($r=0.994-0.998$, $p<0.001$). The smartphone sensitivity for all conditions and both postural variables was not significantly different from the gold-standards ($p>0.05$). A main effect of condition was found ($p<0.05$) as well as a significant interaction between T2D and DPN cohorts ($p<0.043$), indicating greater sway in the DPN cohort, which increases during EC (Fig. 1).Conclusion: Results provide preliminary insight of the validity, sensitivity, and accuracy of the smartphone across postural challenges and cohorts. The smartphone revealed significant decline in balance in individuals with DPN, especially in the eyes closed conditions. In diabetic populations with limited access to care, this smartphone app could help detect DPN early, before outcomes worsen.

P03-P-124 - Back-to-back, a proof of concept study investigating the role of back muscle characteristics to tailor exercise therapy for recurrent non-specific low

back pain: Study protocol and preliminary analysis of proprioceptive postural control result

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BACKGROUND AND AIMNon-specific low back pain (NSLBP) is the main cause of disability worldwide and current treatments have limited effects. Alterations in macroscopic, microscopic, electrophysiological and hemodynamic lumbar muscle characteristics and proprioceptive postural control (PPC) are found in people with NSLBP and directing treatment based on shared underlying mechanisms (phenotypes), could improve its effects. Therefore, this study aims to determine the most discriminating lumbar muscle characteristics between patients with NSLBP and healthy controls, investigate their interrelatedness and relationship with PPC and delineate NSLBP phenotypes based on them. Additionally, to investigate whether proprioceptive exercises have a greater effect on specific NSLBP phenotypes.METHODSLumbar multifidus and erector spinae muscle characteristics will be evaluated and compared in 53 people with recurrent NSLBP and 47 healthy controls. For PPC, the COP displacements in response to vibration to the ankle and back muscles are measured on a force plate, while standing on stable and unstable surface with vision occluded. Proprioceptive dominance is evaluated by the Relative Proprioceptive Weighting (RPW) ratio, with lower RPW values indicating more lumbar proprioceptive reliance. Muscle volume is investigated with 3D freehand ultrasound, and muscle activation and oxygenation with electromyography and near-infrared spectroscopy, respectively. The 53 people with NSLBP also receive a 16-week intervention focusing on improving their ability to sense and discriminate low back position, muscle activation and lumbar movement. These proprioceptive exercises are integrated into the patients' daily lives and comprise a high-load lifting exercise. Their effects are evaluated at 8 weeks, 16 weeks and 16 weeks after the end of the intervention. RESULTSRecruitment is ongoing, currently five people with recurrent NSLBP are enrolled and analyzed descriptively. Preliminary results on PPC include increased lumbar proprioceptive reliance after eight (Pre: 0.69 ± 0.04; Post: 0.46 ± 0.30 stable and Pre: 0.58 ± 0.13; Post: 0.44 ± 0.31 unstable) and 16 weeks (Post: 0.40 ± 0.30 stable and Post: 0.34 ± 0.16 unstable) and increased COP displacement in response to lumbar vibration on stable (Pre: 0.018 ± 0.011; Post: 0.020 ±0.012) and unstable (Pre: 0.015 ± 0.013; Post: 0.021 ± 0.009) after 16 weeks of intervention.CONCLUSIONSPreliminary results show increased lumbar proprioceptive use and a switch in dominant reliance from ankle to lumbar proprioception in response to this proprioceptive intervention, translating to improved PPC. Further effects on the different lumbar muscle characteristics and their correlation with PPC will be investigated. Phenotypes of people with NSLBP will be delineated and the effects of this intervention on them will be examined. Results may

improve patient-tailored exercise therapy for people with NSLBP.ACKNOWLEDGEMENTS AND FUNDING: FWO (grant G072122N)

P03-Q-125 - Improving the synchronization between human movements and a motorized exoskeleton

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BACKGROUND AND AIM ReWalk is a wearable robotic exoskeleton enabling individuals with spinal cord injury (SCI) to stand and walk, controlled via smartwatch and trunk movements. Recent research indicates its potential for safe ambulation in real-world settings and health benefits through sustained physical activity. However, there is a significant gap in understanding the learning process of users to adapt to exoskeletons. The learning curve for operating an exoskeleton like ReWalk can vary significantly between users. This variability is not well understood or quantified in the current literature. The research aims to enhance understanding of human-exoskeleton interactions and improve the synchronization and motor learning of new users with the ReWalk system.METHODS A certified physiotherapist fitted each participant with a ReWalk and elbow crutches to perform mobility tasks, focusing on walking and stopping in front of obstacles. The protocol inlcuded five training sessions with the ReWalk. Each session consisted of two tasks: five continuous overground walks along a 10 meter pre-marked path and five walks with stops in front of an obstacle. A total of 73 reflective markers were placed on anatomical landmarks of both the participants and the exoskeleton. Marker trajectories were recorded at 300 Hz using a 12 infrared camera optical motion captures system. Interaction between the robot and users was analyzed using motion analysis software and CAD modeling software. Recruitment is ongoing, with plans to enroll 15 healthy participants and individuals with SCI. Preliminary findings are based on data from one healthy participant with no history of musculoskeletal, neurological, or movement disorders.RESULTS This study examines the learning process of exoskeleton use by analyzing hip angle, thorax angle, crutch position, and the exoskeleton's battery angle. Dynamic Time Warping was applied to align walking patterns. Variations in segment data were compared between the first and third sessions. Results showed a reduction in variance across all segments: Hip angle reduced by 25%, Thorax angle by 40%, Crutch position by 61%, and Battery angle by 47% (Fig.1). These findings demonstrate reduced sparsity in walking patterns by the third session, suggesting users‘ adaptation to the exoskeleton, achieving more consistent walking patterns. Data collection is ongoing, with additional results to be presented at the upcoming conference.CONCLUSION Crutches emerge as the primary control interface in exoskeleton use, exhibiting the highest movement variability among analyzed segments. Users demonstrated a clear learning curve, with improved walking proficiency and crutch stability across trials. These findings suggest that users adapt to the exoskeleton over time, achieving more consistent and stable walking patterns. Further

analysis of additional participants is needed to validate these and expand upon the initial insights.

P03-Q-126 - The effects of ankle assistive robot on toe clearance during stair climbing in healthy adults

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Background and aimStair climbing requires complex neuromuscular control and coordinated joint movements of the lower extremities. Falls during stair climbing occur due to insufficient toe clearance. Patients with cerebral vascular accident (CVA) often experience impaired toe clearance due to dysfunction of knee flexion and ankle dorsiflexion on the paralyzed side. In addition, dropping foot resulting from spasticity of the triceps surae muscles and/or weakness of the ankle dorsiflexor strength increases the risk of falling during stair climbing.Ankle assistive robots, such as RE-Gait®, are effective for treating for foot drop, therefore could be useful for stair climbing. While robotic devices are widely used in gait rehabilitation, previous studies using robots have not examined the kinematic and kinetic effects during stair climbing. Thus, it remains unclear whether stair-climbing practice using robots can increase clearance and aid in fall prevention. This study aims to investigate the effects of stair climbing exercises using a robot. MethodsTen healthy volunteers participated in this study. Practice was conducted using RE-Gait®, a robotic device, and measurements were taken at pre and post training. Participants practiced with the robot to the right lower limb and performed stair climbing training for 10 minutes. Measurements were conducted using a 20 cm step, focusing on the right lower limb during the step-up motion with the left lower limb as the leading leg. RE-Gait® was not worn during the measurements; participants wore regular shoes instead. RE-Gait® was configured without stance phase control, and dorsiflexion assistance began immediately after Heel Off. The practice effects were assessed by recording lower limb vertical clearance and joint angles. Vertical clearance was calculated as the vertical distance between the toe and the stair edge marker. Additionally, electromyographic (EMG) data were recorded for the right-side soleus (SOL), medial head of the gastrocnemius (MG), and tibialis anterior (TA). ResultsCompared to pre-training, the vertical clearance showed a significant increase in post-training. Similarly, the ankle plantar flexion angle significantly decreased, while the hip flexion angle increased. Additionally, both the peak amplitude and area of the TA and MG exhibited significant reductions following the practice. ConclusionsPracticing using a robot that prompts early phase dorsiflexion resulted in changes in joint angles and muscle activities, leading to an increase in vertical clearance. These results suggest that robotic assistance may be useful for preventing falls and effective in the rehabilitation of stair climbing in patients with CVA.

P03-Q-127 - Investigation of cortical activity changes induced by gait training with an ancle assistive robot

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Background and aims Gait is controlled by multiple central nervous system regions. While the brainstem and spinal cord generate basic patterns for automatic gait, higher centers like the cerebral cortex and basal ganglia are critical for voluntary gait and adjustments. In the process of regaining walking ability for stroke patients, the involvement of the cerebral cortex is considered significant. In recent years, the use of rehabilitation robots has gained traction in stroke gait therapy. Rehabilitation robots, such as RE-Gait® (Space Bio Laboratories Co., Ltd., Japan), assist ankle dorsiflexion and plantarflexion in the process, enhancing toe clearance and walking function. However, the neurophysiological effects of the use of ankle assistive robots are not fully understood. Therefore, we aimed to investigate kinematic changes and associated cortical activity alterations during gait with an ankle assistive robot.Methods Twelve young healthy subjects participated in this study. They were asked to walk on a treadmill wearing a full-head electroencephalogram (EEG) cap. Each of the following two conditions was performed in sequence for 5 minutes: 1. Wearing the RE-Gait® without assistance (OFF), 2. Wearing the RE-Gait® with assistance (ON). During the tasks, cortical activity was measured using the EEG system, along with kinematic and EMG data. For all parameters, comparisons were made between the OFF and ON conditions. The results for the angles of the left hip, knee, and ankle joints were examined. EEG data were collected from six channels: FC1, FC2, Fz, CP1, CP2, and Cz. Event-related desynchronization (ERD) and event-related synchronization (ERS) values of each channel occurring at the timing of the left push-off were calculated.Results The left ankle plantarflexion and dorsiflexion angle were significantly increased under the ON condition. In the alpha band, the ERD values significantly increased under the ON condition at FC1, Fz, and CP1. In the beta band, the ERD values significantly increased under the ON condition at FC1, CP1, and CP2. No significant differences were observed in the ERS values across all channels.Conclusion Under the ON condition, both plantar flexion and dorsiflexion angles of the ankle increased, along with cortical activity during the terminal stance phases and initial swing phases. This increase in cortical activity may reflect the learning process of walking with robotic assistance. These findings suggest that gait training with ankle-assistive gait robots may enhance cortical activity.

P03-R-128 - Effect of arm sway and vision on gait fractal properties

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BACKGROUND AND AIM: Recent research has focused on the nature of non-linear analyses, such as detrended fluctuation analysis (DFA), to examine complexity and variability in human gait [1-3]. These methods provide a depth of understanding of gait function beyond traditional peak-based, linear measures, by assessing underlying variability structure. This study aimed to better understand the implications of arm swing, vision, and wearing a head mounted AR/VR display (HMD) on gait parameters, specifically using DFA to examine the variability structure of the inter-stride duration timeseries. We hypothesized significant differences between visual and arm swing conditions in all gait parameters. The results we have presented are related to a preliminary study designed to explore potential confounding variables (such as light touch on treadmill guardrails and the presence and weight of an HMD) on DFA output.METHODS: Six participants (3F/3M; age 21.8 ± 4.9 years) completed four 8-minute treadmill walking trials at their preferred walking speed (PWS). PWS was the average of two speeds obtained by (1) gradually increasing from a slow pace until the participant reported comfort, then (2) decreasing from a fast pace until comfort was reported again. The four walking trials, completed in randomized order, were: (A) normal arm swing, eyes open; (B) hands holding the treadmill, eyes open; (C) hands holding the treadmill, eyes closed; and (D) normal arm swing, eyes open, and wearing the head-mounted display. The HMD was set in passthrough mode, in which participants could view the lab space in real time, albeit through the lenses of the HMD. Retro-reflective markers were placed on participants' shoes over the posterior aspect of the heels, and their 3D positions were recorded using a Vicon motion capture system. The analyzed variables included average inter-stride interval (ISI, time between consecutive heel strikes), fractal scaling index (FSI, determined via DFA), and average cadence. Planned comparisons were conducted for trials A and B (effect of arm swing), B vs. C (effect of eyes open vs. closed), and A vs. D (effect of wearing HMD). A repeated measures ANOVA ($\alpha=0.05$) was conducted for each variable.RESULTS AND CONCLUSIONS: Results related to these preliminary data revealed no significant differences in FSI ($F(3,23)=1.62$, $p=0.21$), ISI ($F(3,23)=0.40$, $p=0.75$), or cadence ($F(3,23)=0.34$, $p=0.80$) across trials. These initial findings suggest that neither arm swing, vision, or wearing an HMD significantly affect FSI, ISI, or cadence. While additional data are needed to further explore and confirm these early results, they provide support for future research on the effects of full VR immersion and visual stimuli during treadmill walking given the findings that wearing the HMD, vision, and arm position are unlikely to confound results.REFERENCES: [1] Di Bacco & Gage (2024) Gait & Posture; [2] Koo & Lee (2016) Phys Ther Rehabil Sci; [3] Patla (1998) Ecol Psychol

P03-R-129 - The effects of dynamic visual cues on perceived movement and postural responses during dynamic stance

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BACKGROUND AND AIM: Maintaining upright stance requires the interaction between one's environment and sensory systems [1]. The perception of self-motion with respect to the environment mediates an individual's postural responses [2]. The visual system provides sensory cues that the nervous system utilizes to perceive self-motion relative to the environment [3]. The relationship between perceived self-motion and visual perturbations during a dynamic balance task and associated postural responses is unknown. The purpose of this study was to assess the relationship between postural responses and perceived movement during a dynamic postural task with dynamic visual stimuli. METHODS: Thirty young adults stood on a platform for 90 seconds that pseudorandomly translated in the anteroposterior (AP) direction. Subjects were asked to track their AP trunk position. Virtual reality was used to induce 1 second (s) visual perturbations with velocities of 0.5m/s, 1m/s or 1.5m/s in the anterior (away from the participant) and posterior (towards the participant) directions. Centre of pressure (COP) displacement was calculated using a force plate, trunk displacement was collected using 3D motion capture, and perceived displacement was collected using a handheld controller. Postural and perceived responses were analyzed in 3 windows post-stimulus onset (0-1s, 1-2s and 2-3s). Trunk and perceived displacements were normalized to a percentage of the subject's maximum voluntary lean. The relationship between perceived and postural responses was quantified using amplitude, cross-correlations, and quotient measures which were calculated by dividing perceived displacement by trunk displacement. RESULTS: The amplitude of postural responses was greater in the anterior compared to posterior conditions across all windows, and strongest in the 1-2s window. The perceived amplitude increased in the anterior and posterior conditions during the 1-2s and 2-3s windows and was greatest at the highest velocity. Quotient amplitude was greater in posterior conditions, and strongest in the 1-2s window. The perceived position lagged behind the actual position in the 0-1s and 2-3s windows but led the actual position in the 1-2s window. CONCLUSIONS: While postural and perceived responses increased across windows, the quotient amplitude was greatest during the 1-2s window when the perceived movement led the actual movement. The visually evoked postural response and its interaction with the perception of self-motion relative to the dynamic visual cues may be strongest 1-2s post-stimulus. Biomechanical constraints, threat-modulated behaviour, and an interaction between visually evoked postural responses and perceived self-motion may explain these findings.
ACKNOWLEDGEMENTS AND FUNDING: Funded by VISTA, NSERC, CFI.
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P03-R-130 - The role of modified optic flow gain during static and dynamic balance control

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BACKGROUND AND AIM: Vision provides critical feedback to maintain upright stance. One method to study visual contributions to balance control is by altering the gain of optic flow, which is the amount of visual motion relative to head movement, manipulated using virtual reality (VR) [1]. When optic flow-related visual feedback is amplified, a tighter control of upright stance is observed [1]. Additionally, when optic flow-related visual feedback is reduced, the amplitude of postural sway increases [2]. The minimum amount of optic flow-related visual feedback required to sustain movement amplitudes similar to baseline conditions (optic flow gain of 1) during upright stance remains unknown. Therefore, the purpose of this study was to examine how much optic flow-related visual feedback is required during static and dynamic stance to maintain similar levels of stability. METHODS: Two experiments were used to examine changes in optic flow gain during static and dynamic stance. In experiment 1, 36 young adults stood on firm (directly on a force plate) and foam (a foam pad on top of a force plate) surfaces for 60 seconds. In experiment 2, 26 young adults stood on a force plate mounted on a platform that pseudorandomly translated in the anteroposterior (AP) direction (± 5cm, below 1Hz) for 60 seconds. Participants wore a VR head-mounted display that modified optic flow gain (reduced virtual scene motion relative to head motion) ranging from 0 to 1 in 0.1x increments (experiment 1) or 0.25x increments (experiment 2). Center of pressure (COP) displacements were calculated in both experiments and analyzed using linear measures (root mean square (RMS) and mean power frequency (MPF)), and nonlinear measures (sample entropy (SE) and detrended fluctuation analysis (DFA)-derived scaling exponent (α)). RESULTS: In experiment 1, AP COP RMS, MPF, and SE increased, while DFA-α decreased on foam compared to firm surfaces. A main effect of gain was observed for DFA-α on foam surfaces, where a gain of 1 resulted in the lowest DFA-α. No effects of gain were found for RMS, MPF, and SE. In experiment 2, AP COP RMS decreased when optic flow gain was less than 0.5x, while DFA-αdecreased as optic flow gain increased. No effects of gain were observed for MPF and SE. CONCLUSIONS: Optic flow gain influences postural control in both static and dynamic stance. In dynamic stance, movement amplitude was larger when optic flow gain was below 0.5x and not different at or above 0.5x, demonstrating that 0.5x is enough to sustain baseline amplitudes. In both experiments, frequency or regularity (SE) were unaffected by gain; however, DFA-α was lowest at baseline conditions, indicating weaker long-term correlations in sway fluctuations. These findings signify the importance of optic flow-related visual feedback in postural control. ACKNOWLEDGEMENTS AND FUNDING: Funded by VISTA, NSERC, CFI. REFERENCES: [1] Lavalle & Cleworth (2023) Neurosci Lett; [2] Phu et al. (2023) Exp Gerontol

P03-R-131 - The utility of the eye-height to shoulder width ratio when determining the passability of an aperture

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Background: Aperture crossing tasks are commonly used to test an individual's perception-action integration capabilities. Multiple studies have demonstrated that young adults use body-scaled information to guide behaviors while completing a static aperture task. However, it remains unclear as to what visual information young adults are using to determine the passability of a static aperture. One theory proposed by Fajen (2013), is that young adults use a ratio of their eye-height to shoulder width. To test this theory, eye-height manipulations studies have asked participants to make perceptual judgments, which may not reflect actions or had them walk on blocks, which altered their biomechanics. The purpose of the study was to determine if eye-height information is the driving factor which dictates actions during a static aperture crossing task. It was hypothesized that an increase in eye-height would lead to participants perceiving they were wider and require larger apertures to pass through, while a decrease in eye-height would have the opposite effect. Methods: Fifteen young adults (9 male, 22.3 +/- 1.5) walked along a 7.5m long pathway in virtual reality (VR), towards a goal with an aperture created out of two vertical poles (20cm in diameter) located along the path 5m from the start. Participants completed three conditions: 1) Normal; 2) Tall +30cm to normal height; and 3) Small -30cms from normal height. Eye-height changes were artificially manipulated in VR. Participants performed 4 trials of each of the 9 various aperture sizes (ranging from 0.8-1.8x SW), for a total of 36 trials per condition. Participants were instructed to reach the goal safely without bodily manipulation, however, path selection was non-confined. HTC Vive Pro 2 recorded head position in VR space (90Hz) and aided in the calculation of critical point (CP) (aperture size in which participants switched from walking through the aperture and went around), medial-lateral (M-L) position at the time of crossing and, anterior-posterior (A-P) spatial margin. Results: There was a significant main effect of height on CP [p<.001], such that during the Small condition (0.95x SW) participants walked through narrower aperture sizes compared to the Normal (1.02x SW) and Tall (1.06x SW) conditions (Fig 1). There was a significant main effect of height on M-L position at the time of crossing [p=.007] and A-P spatial margin [p=.035] at door size 0.8x SW. Such that, in the Small condition, participants would deviate from the path closer to the aperture in the A-P and M-L direction than compared to the Tall condition which saw the opposite effect. Conclusions: The results of the study support the theory that body-scaled information about passability of an aperture is based on the ratio of their eye-height to shoulder width. Participants avoidance behaviors were scaled in the direction of the perceptual height change (i.e., taller acted wider, smaller acted narrower).

P03-R-132 - Characteristics of dynamic balance function in healthy individuals

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Backgrounds: Appropriate diagnosis and treatment of problems leading to balance dysfunction requires accurate information on the balance of the population at all ages, but little data are available.Objective: To test the dynamic balance function in normal individuals and gather baseline data and performance characteristics across various age groups.Methods: 100 healthy subjects were divided into three age groups: youth (20-39 years), middle age (40-59 years), and elderly (over 60 years). They underwent Sensory Organization Tests (SOT), Motor Control Tests (MCT), Adaptation Tests (ADT), and Limits of Stability (LOS) using computerized dynamic posturography (CDP).Results: Results showed that the scores for balance function and strategy in the SOT test decreased as the difficulty level increased. During the MCT test, the postural and total latencies of the young group's limbs were lower than those of the elderly and middle-aged groups ($P < 0.05$). In the ADT test, the swinging energy (SE) of ankle flexion and extension decreased progressively with repeated stimulation. SE during ankle stretching varied significantly among the young, middle-aged, and elderly groups ($P < 0.05$). In the LOS test, the young and middle-aged groups had significantly lower average reaction times than the middle-aged and elderly groups. Their average movement rates were also higher, with statistically significant differences when moving in the right posterior, left posterior, and left anterior directions ($P < 0.05$).Conclusion: Compared to other age groups, the elderly exhibit poor dynamic balance, slow recovery from balance disturbances, limited exercise adaptability, and require more time to react to maintain balance.

P03-S-133 - Comparing marker and markerless motion capture systems in healthy older adults performing reactive balance assessments

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Comparing marker and markerless motion capture systems in healthy older adults performing reactive balance assessments.Background and PurposeMotion capture technology is a valid tool for measuring both static and dynamic movements which helps increase understanding of potential movement-related injuries or limitations. Two types of motion capture systems have been compared in this study: marker-based and markerless. Marker-based motion capture systems have been used to analyze stability following balance perturbations. However, setting up the markers and post-processing can be time-consuming, costly in terms of resources (markers, adhesive, elastic bands, and personal protective equipment), and potentially change the way participants behave. Recent developments in markerless motion capture could be a way to alter these potential problems and reduce associated resource costs. Additionally, markerless motion capture systems are more efficient since the lack of markers greatly reduces set-up time requirements. However, its accuracy for capturing centre of mass motion (COM) during balance tasks has not been fully tested. Therefore, the purpose of this study is to compare the COM between marker-based and markerless systems among older adults performing reactive balance assessments. MethodsEight healthy older adults (60-75 years old, height = 1.57 m – 1.79 m, mass = 47 kg – 81.5 kg), performed reactive balance testing on a motion platform. The 3-D kinematic data were collected concurrently using both markerless (Theia Markerless, Inc., Kingston, ON) and marker-based (Vicon Nexus, Vicon, Oxford, UK) motion capture systems. The COM measurements were calculated by Visual3D software (C-motion, Germantown, USA, v2021.11.3) using two biomechanical models (one markerless and one marker-based). The correlation (R) and root mean square difference (RMSD) between the COM measurements (between marker and markerless) in the X (forward/back), Y (left/right), and Z (up/down) planes of motion. ResultsThe correlation coefficient (R) in each direction were: X (forward/backward) = 0.124 – 1 (SD = 0.0996 +/-), Y (left/right) = 0.903 – 1 (SD = 0.010 +/-), and Z (up/down) = 0.381 – 0.998 (SD = 0.095 +/-). The root mean square difference (RMSD) in each direction was: X = 0.0121m, Y = 0.004m, and Z = 0.0728m. Figure 1, shows the results taken from a sample of participants. The results were consistent between both marker and markerless models. ConclusionOur findings suggest that there was consistency between the COM measurements for the two motion capture systems. However, the largest difference was found in the Z direction (up/down) (0.0728m). Previous studies have also reported a similar discrepancy in COM position in the vertical Z. direction. Although more data are needed to support these findings, this study provides further evidence that markerless motion capture is a valid way to measure human movement.

P03-S-134 - Clinical vs real-world assessment of gait and balance deficits in neurological populations: A preliminary protocol study

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Background and aimUnderstanding different aspects of mobility disability associated with neurological disorders is critical, since alterations in gait and balance can lead to physical disability, reduced life quality, and a greater risk of falls1. Wearable inertial measurement units (IMUs) provide objective metrics that can be employed to characterize locomotor patterns2, which can be applied to make well-informed clinical decisions. Clinical motor assessments are usually performed in situations that do not reflect the complex contextual factors of functional mobility in everyday life, which may result in underestimating results3. Consequently, it is essential to provide clinical evaluations that reflect the daily challenges faced by neurological patients. This exploratory research compares conventional clinical protocols with a real-life protocol that simulates daily activities to find mobility characteristics that are clinically important to detect motor deficits that standardized testing may underestimate. MethodsSixteen Healthy Subjects (HS), (10 females, 58.9±10.5y), 9 people with Stroke (PwST) (4 females, 57.8±15.4y, Fugl-Meyer_LowerExtremity:24) and 9 people with Parkinson's Disease (PwPD), (3 females, 71.5±6.8y, Hoehn & Yahr:2), performed 3 different motor tasks repeated in two different protocols, indoor and simulated real-life, respectively. The motor tasks consisted in: 1) linear walking: standard clinical evaluation (10-meter walking test, 10mWT), straight mountain walk (SMW) on a led floor surrounded by a mountain landscape; 2) timed up and go test (TUG): standard clinical TUG and TUG mirroring kitchen chores (RTUG) and 3) 60s of posturography (eyes open): standard task on the floor and on 3 distinct real- life surfaces: foam, cobblestones and dunes. A set of spatio-temporal parameters was extracted from 16 IMUs (Captiks srl, Italy, 100Hz) through Motion Analyzer validated algorithms4.ResultsFigure 1 includes merely linear walking and TUG findings from each protocol for the purpose of readability. Consistent with posturography conditions, PwPD (blue) and PwST (red) appear to experience the escalating complexity of the activity, resulting in a decline in the motor performance. Nonetheless, in all three tasks, PwST showed the lowest motor performance relative to PwPD. Interestingly, real-life tasks bring out motor impairments of PwPD, as evidenced by linear and TUG data, consistently across all tasks. ConclusionsA more profound understanding of the distinctive functional impairments among individuals and the identification of biomarkers that represent disease-specific motor deficits is essential in clinical practice. These preliminary results appear to emphasize the necessity of incorporating more elaborate tasks based on real-world situations which could better reflect real-life impairments. This knowledge could be crucial for tailoring personalized treatments and increasing the overall quality of life of patients. ReferencesNonnekes, J. et al. Nat. Rev. Neurol, 2018;14:183–189.Belluscio, V. et al.Sensors, 2019;19,5315.Mikolaizak, A. S. et al. PLOS ONE, 2022;17,e0269615.Ricci, M. et al. J. Biomech. 83, 2019; 243–252.

P03-S-135 - Improved accuracy of the Center of Mass position through Kalman filtering of kinematic and kinetic information

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1) Background and aimThe trajectory of the body center of mass (CoM) is critical for evaluating balance. The position of the CoM can be calculated using either kinematic or kinetic methods. Each of these methods has its limitations, and it is difficult to evaluate their accuracy as there is no ground truth to which the CoM trajectory can be compared. In this paper, we use as ground truth the fact that, during the flight phase of running, the acceleration of the CoM is equal to gravity. We evaluate the accuracy of kinematic models of different complexity, and propose a novel method for calculating the CoM by combining kinematic and forceplate measurements.2) MethodsTwo open access datasets of human treadmill running were used. The first (1) contains full-body marker data of two subjects running for one minute at 3 m/s and 4 m/s. The second (2) contains lower-body marker data of eight subjects running for 3.5 minutes at 2.5, 2.7 and 2.9 m/s. The CoM was calculated for three kinematic models of increasing complexity. A novel method is proposed to estimate the CoM position using a Kalman filter combining kinematic and kinetic information.For each model, the acceleration during flight was

compared to gravity to determine the Acceleration Bias. The Position Error was obtained by comparing the position to an indirect estimate of position obtained from kinetics.A linear regression was used to predict foot placement from the CoM state during the previous flight phase.3) Results We evaluate the accuracy of kinematic models of different complexity and find that the Acceleration Bias ranges from 14 % of gravity for the most complex model to 36 % for the simplest model. Position Error ranges from 6 to 12 mm (27 % to 56 % of the CoM movement over a gait cycle).When using the novel method, the Acceleration Bias drops to 1.1 to 3.1 % and Position Error to 2.6 to 3.2% for all kinematic models. Moreover, the proposed method provides a more reliable evaluation of foot placement control.4) ConclusionsState-of-the-art kinematic models of the CoM were found to have very low accuracy. The novel method greatly improves the accuracy of CoM measurements. This can provide a more reliable evaluation of balance indicators during locomotion, such as foot placement control.The code for calculating this optimal combination is available in both Python and Matlab at: https://github.com/charlotte-lemouel/center_of_mass The documentation is available at: https://center-of-mass.readthedocs.io 5) References 1. J. Wojtusch, O. von Stryk, in 2015 IEEE-RAS 15th International Conference on Humanoid Robots (Humanoids) (IEEE Press, Seoul, South Korea, 2015; https://doi.org/10.1109/HUMANOIDS.2015.7363534), pp. 74–79.2. M. Srinivasan, N. Seethapathi, Data from: Step-to-step variations in human running reveal how humans run without falling (2019), doi:10.5061/DRYAD.1NT24M0.

P03-S-136 - Spinal reflex modulation as a biomarker for postural and gait problems in Parkinson’s disease

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BACKGROUND AND AIM: Postural Instability and Gait Difficulty (PIGD) are amongst most disabling motor symptoms of Parkinson’s Disease (PD), that leads to frequent falls. A recent study shows increased interest in the relevance of spinal circuits for treating PIGD in PD (Milekovic et al., 2023). Spinal reflex, such as H-reflex, provides insights into spinal circuits and inputs from periphery and supraspinal centers (Zehr et al., 2002). H-reflex modulation may provide insights into PIGD, likely due to the changes in the supraspinal inputs (Lira et al., 2020). Thus, H-reflex modulation may be a potential objective electrophysiological biomarker in PIGD in PD, crucial for early PIGD diagnosis, disease progression tracking, and precise intervention evaluation in clinical trials. The study investigates the potential use of H-reflex as an electrophysiological biomarker for PIGD in PD. Specifically, we investigate if H-reflex modulation during different postural tasks can differentiate between those with and without balance problems. Furthermore, we will explore if H-reflex modulation correlates with dynamic balance scores. METHODS: This cross-sectional study takes place at Oslo University Hospital (OUH), Norway. We aim to recruit 12 participants with PD, equally divided into non-PIGD and PIGD groups, and 6 age-matched healthy controls (HC). We collect H-reflex from the soleus muscle on the more affected or nondominant side. H-reflex modulation is assessed under five conditions: varying vision (eyes open or closed), surface conformity (soft or firm), or cognitive challenge (dual task). The participants undergo clinical evaluations of dynamic balance (Mini-Balance Evaluation Systems Test; Mini-BESTest), motor impairment ("on state Movement Disorders Society Unified Parkinson's Disease Rating Scale" part III; MDS-UPDRS), cognition (Montreal Cognitive Assessment; MoCA), freezing of gait (New Freezing of Gait Questionnaire; NFOGQ), and balance confidence (Activities-Specific Balance Confidence scale; ABC). RESULTS: This is an ongoing work. We have collected data (age,sex) from six HC (62.33±7.03; 2F,4M), six participants without PIGD (66.83±7.36; 1F,5M), and four with PIGD (64.25±3.52; 3F,1M). The mean±SD scores of the groups were: mini-BESTest (/28) (HC = 27± 1.1; nonPIGD =26.17±1.33; PIGD = 20±2.16), MDS-UPDRS (/132) (nonPIGD = 20.5±5.61; PIGD = 31±11.92), MoCA (/30) (HC = 27.67±1.37; nonPIGD = 26±1.55; PIGD = 25.75±1.71), ABC (/100)(HC = 97.1±5.28; nonPIGD = 95.13±2.95; PIGD = 76.25±14.38), NFOGQ (/28) (nonPIGD = 0.83±2.04; PIGD = 0±0). The inferential statistics will be conducted upon completion of data collection. CONCLUSIONS: The study will elucidate the potential use of H-reflex as electrophysiological biomarker for PIGD in PD. It will enhance our understanding of PIGD pathophysiology in PD, which is vital for devising more effective PIGD management strategies. ACKNOWLEDGEMENTS AND FUNDING: We thank all participants. This project receives no funding.

P03-S-137 - Validity and reliability of wrist sensor-based measures of the arm swing during free-living gait in Parkinson's disease

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Background and aim: Previously, we developed a modular pipeline using wrist-worn sensor data to (1) detect free-living gait, (2) filter out gait segments with other arm activities, and (3) quantify the arm swing range of motion (RoM) of individuals with Parkinson's disease (PD). Here, we assessed the construct validity and reliability of the extracted arm swing parameters in a larger, free-living PD cohort.Methods: We used the first two weeks of wrist accelerometer and gyroscope data of 415 participants with early-stage PD from the Personalized Parkinson Project. We validated the weekly median and 95th percentile arm swing RoM in three ways: in the first week, (1) the difference between the most and least affected side, and (2) the Spearman correlation with the MDS-UPDRS part III; and between the first and the second week, (3) the test-retest reliability using the Intraclass correlation coefficient (ICC).Results: Participants wearing the watch on the most affected side had a smaller median (Δ degrees = -0.65, $p < 0.0001$) and 95th

percentile (Δ degrees = -2.67, $p < 0.0001$) RoM. Similarly, participants with a higher MDS-UPDRS part III showed a smaller median (rs = -0.40, $p < 0.0001$) and 95th percentile (rs = -0.47, $p < 0.0001$) RoM. The reliability was high for both the median (ICC = 0.86, 95% CI [0.83-0.88]) and the 95th percentile (ICC = 0.91, 95% CI [0.89-0.93]) RoM.Conclusions: Both the median and the 95th percentile arm swing RoM demonstrate construct validity and reliability. Future work will assess their sensitivity to disease progression, to inform the use in clinical trials.

P03-S-138 - Objective mobility assessment with wearable sensors for clinical application in Parkinson's disease: From validation to fall prediction

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Background and aimMobility impairments are common in Parkinson's disease (PD) and increase the risk of falling. Data derived from wearable inertial measurement units can provide useful information regarding gait in different situations and environments, which may help to identify those at risk of falling. However, rigorous testing is required to evaluate whether new devices are fit for purpose. DANU Sport System is a multi-modal system for movement analysis, containing 15 silicone based capacitive pressure sensors and an IMU pod, with tri-axal accelerometers, gyroscope and magnetometers, currently at use within a sporting context. Potential has been highlighted for clinical use in people with Parkinsons (PwP). This study protocol aims to evaluate the validity, reliability and usability of the DANU Sport System in PwP for balance and gait assessment. The V3+ framework for determining fit-for-purpose biometric monitoring devices will be employed, evaluating verification, usability, analytical and clinical validation.MethodsParticipants will include PwP (Hoehn & Yahr I-III, n=60), age-matched healthy controls (n=60) and a group of healthcare professionals (n=10) through four studies. Testing procedures include a 2-minute walk test, timed up and go, 2-minute balance tests [(1) eyes-open, firm surface (2) eyes-closed, firm surface (3) eyes-open, foam surface (4) eyes-closed, foam surface] and the Mini-BESTest. Clinical and cognitive measures include the Movement Disorders Society's-Unified Parkinsons Disease Rating Scale, Montreal Cognitive Assessment, Falls Efficacy Scale. Reference systems will include Axivity, Vicon 3D Motion Capture, Mobility Lab, GAITRite and force plates. Verification: A cross-sectional observational study involving PwP, evaluating the agreement between the raw data from DANU's accelerometer, magnetometer and gyroscope and a reference inertial sensor (Axivity). Analytical Validation: A concurrent validation study of PwP with DANU and gold standard laboratory references (Vicon, GAITRite, Force Plates). Test-retest reliability will be assessed over two laboratory visits, one week apart. Clinical Validation: A cross-sectional study comparing PwP and age-matched controls and investigating associations between DANU's metrics and clinical/cognitive assessments. A follow-up on fall occurrence will be conducted 6-

month post visit to assess ability of gait and balance metrics to predict falls in PwP. Usability Validation: A mixed-methods approach with 10 PwP and 10 clinicians. PwP will complete 2-days free-living data collection, and two semi-structured interviews (pre and post). Usability will be assessed with System Usability Scale, Tele-healthcare Satisfaction Questionnaire, and semi-structured interviews in PwP and clinicians.ConclusionResults will examine validity through assessing correlations of both output metrics, raw data and qualitative findings. It is hypothesised that DANU will present agreeable data in comparison to verified inertial sensors and laboratory references in PwP, with appropriate test-retest reliability values. It is hypothesised that gait and balance metrics obtained with the DANU Sport System will be able to differentiate PwP from healthy individuals, correlate with clinical measures of PD severity/cognition, classify fallers/non fallers and predict future falls. A final hypothesis is that DANU will be rated as usable and feasible, in both clinical practice and the home environment.

P03-S-139 - Postural transfers and balance in real-world and laboratory settings

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Background and Aim: Walking, postural transfers (sit-to-stand and stand-to-sit) and static balance, are vital components of mobility that influence fall risk and overall function in older adults. While real-world walking has been investigated and received significant attention, postural transfers and static balance have not been extensively studied in real-world settings. This study aimed to evaluate real-world digital mobility outcomes (DMOs) of postural transfers and balance compared with laboratory measures and explore associations with diverse clinical outcomes.Methods: A subset of 168 community-dwelling older adults from the InChianti dataset performed lab-based tests, including the Romberg test and repeated chair stands, while wearing an inertial sensor on the lower back. They then went home and wore the sensor for a week. Two pipelines were designed, implemented, validated, and applied to identify postural transfers and static balance (standing static periods) in the real world. Real-world DMOs were assessed through correlations with lab-based outcomes and associations with prospective falls, SPPB, depression, and polypharmacy.Results: Significant associations were observed between lab-based and real-world DMOs in both postural and static balance DMOs. Real-world postural transfers and static balance DMOs showed significant associations with prospective falls and depression, while laboratory DMOs did not show associations with prospective falls. Duration and smoothness in postural transfer DMOs and mean distance and mean frequency in real-world balance DMOs were associated with prospective falls. Conclusions:This study assessed the potential of using real-world DMOs to evaluate postural transfers and balance. Preliminary results

demonstrated significant associations of real-world DMOs with lab-based measures and clinically relevant outcomes. These findings support the integration of these real-world DMOs into assessments for fall prevention and mobility monitoring.Acknowledgements and Funding: The study has been funded in part by the European Union (Seventh Framework Program (FP7/2007-2013) under grant agreement No.: 288940 (FARSEEING project)), and in part by the Mobilise-D project that has received funding from the Innovative Medicines Initiative 2 Joint Undertaking (JU) under grant agreement No. 820820. This JU receives support from the European Union's Horizon 2020 research and innovation program and the European Federation of Pharmaceutical Industries and Associations (EFPIA). The InCHIANTI study was supported by the Agency for Regional Health Care of Tuscany.

P03-S-140 - Are we able to predict the energy expenditure from just a single shank IMU for both overground and treadmill walking? A replication attempt of the Stanford Open-Metabolics project and new insights in wearable activity monitoring

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Background and Aim: Sedentarism, obesity and physical inactivity are on the rise and is mainly due to the urban lifestyle. This leads to many lifestyle-based diseases (like metabolic syndrome), muscle disuse and early death. One of the key tools to measure physical (in)activity is energy expenditure and the gold-standard to measure it is indirect calorimetry. However, it is impractical to use this in daily-life activity monitoring. Other methods like smartwatches and activity monitors have poorer accuracy (Slade et al., 2021) and so are unreliable. The aim of this study was to replicate and extend the easy-to-use Open Metabolics system from (Slade et al., 2021) for a Japanese young female population, a group which has elevated levels of inactivity (Wakui et al., 2002). Our study is a replication attempt along with an extension to overground walking. Methods: In this study, we used a 3-axes IMU (Movella Inc.) on the thigh and shank on both the legs of the participants and evaluated them at three walking speeds, Slow (1.0 m/s), Comfortable (1.3 m/s) and Fast (1.5 m/s). We measured resting (seated), overground (OG) and treadmill (TM) oxygen consumption rates in 10 young females using a Minato Medical (Japan) indirect calorimetry system (mean age 21 ± 1.9 years, mean height 1.58 ± 0.04 m, mean weight 49.6 ± 5.4 kg). After a treadmill familiarization of 10 minutes, half of the participants first walked overground and then on a floor-level treadmill (with normal arm swing) and the other half followed the reverse pattern. The walking speeds were randomized for both overground and treadmill walking. Gross Energy Expenditure (EE) was calculated from the rates of oxygen consumption and Respiratory Quotient. The shoe-type was controlled in this study. Results: The EE predictions from the right shank IMU varied in accuracy across the participants. The average median error was 58% for Slow, 36% for Comfortable and 34% for fast speeds, across both overground and

treadmill. For walking surface, the average median error was 57% for overground and 28% for treadmill, across the speeds. The model overestimated the EE for slow and underestimated the EE for comfortable and fast speeds. Additional details are in the attached pdf. Conclusions: This study shows that the IMU based system can predict EE and be a practical solution for daily activity monitoring. However, currently the system has large errors. So we conclude that we have not been able to fully replicate the results of (Slade et al., 2021). We speculate that this could be due to multifactorial reasons, such as few participants in the original model, anthropometric differences between the participants' pool, differences in walking surfaces and due to a simple linear regression-based model, among others. As future work, we intend to use a deep learning-based approach to train our own model and test new predictions from other participants based on our model. Funding: Personal grant of the last author

P03-S-141 - An MRI-compatible balance simulation using visual feedback: A validation study

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Background & Aim: Maintaining balance during quiet stance involves regulating the position of the center of mass (COM) using center of pressure (COP) displacements [1]. The COP oscillates around the COM to maintain its position within the base of support, a task controlled by a complex sensorimotor process in which vision plays an important role. Developing a novel assessment technique can support the growing body of work examining subcortical and cortical networks involved in postural control [2]. Therefore, this study validated the use of a novel MRI-compatible force plate and visual-feedback balance simulation by comparing balance-related measures during real upright balance to those obtained using a supine-based balance simulation. Methods: Twenty-two young adults participated in real upright balance trials (RB) during which they stood upright on a custom-built force plate, and simulated balance trials (SB) where they laid supine with their feet planted on the same force plate placed vertically while looking at a monitor above them. There were three SB conditions assessed: the COP and simulated COM moved in the 1) anteroposterior (AP-only), 2) mediolateral (ML-only), or 3) combined AP-ML directions. During SB, both COM and COP position were represented as circles and displayed on the screen. Participants controlled the COP position using plantar-/dorsiflexion to move the COP up and down and shifted pressure between the left and right foot to move the COP left and right. Participants used the COP to control the position of the simulated COM in accordance with the inverted pendulum model. To quantify balance behaviour, amplitude (root mean square, RMS) and frequency (mean power frequency, MPF) of AP and ML COP displacements were compared between SB and RB. Results: No differences in AP COP RMS or MPF were found between AP-only SB, combined AP-ML SB, and RB. Similarly, there was no difference in ML COP MPF between ML-only SB, combined AP-ML SB, and RB trials; however, there was a significant

difference in ML COP RMS, with greater amplitude for simulated conditions than real balance conditions. Conclusions: The MRI-compatible force plate was validated for use in the balance simulation for the AP direction only. The biomechanical constraints of lying supine likely influenced the ability to control ML COP displacements and was therefore not validated in this balance simulation. The validated methods are currently being used to examine the cortical networks involved in a visual-feedback balance simulation using fMRI. References:[1] Winter et. al. (1998) Gait Posture[2] Bolton (2015) Neurosci Biobehav Rev

P03-S-142 - Test-retest reliability and validity of augmented-reality glasses for gait and balance assessments in persons with Parkinson's disease

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Background and Aim: Augmented reality (AR) glasses, such as HoloLens 2 and Magic Leap 2, offer a novel approach to assessing gait and balance in clinical settings by capturing unique 3D positional and 3D orientation data. This study aimed to evaluate the concurrent validity and test-retest reliability of AR glasses in three common clinical gait and balance tests: the 10-meter walk test (10MWT), the Five Times Sit To Stand (FTSTS) test and the Timed Up and Go (TUG) tests. Methods:Twenty participants with Parkinson's disease performed the 10MWT, FTSTS and TUG tests while wearing AR glasses. Data on position and orientation were used to derive test completion times, durations of sub-parts (e.g., sit to stand, turning) and gait parameters, which were compared with reference systems (Interactive Walkway (IWW), lower-back IMU, and a stopwatch). The 10MWT was performed at comfortable and fast-but-safe walking speeds. All tests were performed twice. Test-retest reliability, concurrent validity, and face validity (for 10MWT) were evaluated.Results:For FTSTS and TUG tests, excellent concurrent validity was found for position and orientation time series (ICC(C,1) > 0.933) and test completion durations (ICC(A,1) > 0.984). Sub-durations for FTSTS showed excellent agreement (ICC(A,1) > 0.921), while TUG turning sub-durations showed excellent agreement for turn 1 (ICC(A,1) = 0.913) and moderate agreement for turn 2 (ICC(A,1) = 0.589). Regarding test-retest reliability and concurrent validity, within-system variation over repetitions was greater than between-systems variation for test-completion times and sub-durations, indicating that test outcomes data can be derived interchangeably between systems. For the 10MWT, AR-derived gait parameters demonstrated good-to-excellent test-retest reliability (ICC(A,1) > 0.813). Concurrent validity showed good-to-excellent agreement between AR glasses and reference systems for both test-completion times (ICC(A,1) > 0.879) and gait parameters (ICC(A,1) > 0.942). Face validity was confirmed by significant differences in test-completion times and gait parameters over speed conditions, in a-priori known directions.Conclusions:AR glasses provide reliable and valid data for assessing gait and balance in individuals with Parkinson's disease. Both FTSTS and TUG

tests demonstrated excellent concurrent validity for test-completion times and sub-durations. Additionally, completion times and gait parameters derived from AR glasses during the 10MWT showed good-to-excellent reliability and validity compared to reference systems. These findings support the use of AR glasses as an effective tool for evaluating gait and balance in clinical settings for people with Parkinson’s disease.

P03-T-143 - Human balance discrimination threshold: Violation of weber's law as a function of vestibular stimulus frequencies

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Background: Weber's Law is a widely accepted model in sensory physiology that predicts how well a sensory system can discriminate between stimuli based on their amplitude. Extensive research has been conducted on Weber's law, which states that sensitivity to changes in a stimulus is proportional to its intensity, particularly in sensory and motor tasks. While many studies confirm compliance with Weber’s law, others report deviations. For example, in vestibular processing in humans and non-human primates, these deviations lead to performance that exceeds predictions, particularly at higher stimulus intensities (Carriot et al., 2021; Mallery et al., 2010). In these studies, the participants or the animals were rotated while seated. Thus, the discrimination threshold for vestibular afferents alone was studied. Here, we propose that computing the balance control discrimination threshold during whole-body motion evoked by complex sensory stimuli can help explore the sensorimotor mechanisms involved in whole-body perception. Aim: The current study quantified the balance control discrimination threshold (DT) during whole-body motions evoked by vestibular stimuli of different frequencies. Methods: We tested 15 people aged between 18 and 40. Participants stood upright on aforce platform with their eyes closed. They maintained their head forward and tilted their nose upward by ~18° to maximize vestibular-evoked balance responses along the frontal plane. We measured participants’ head accelerations and ground reaction forces using an accelerometer on the head and the force platform. We used the lateral force data to quantify the balance control DT and the head acceleration along the frontal plane to assess their balance control performance to electrical vestibular stimulation (EVS) delivered in a binaural bipolar configuration. We delivered vestibular stimuli as sinewaves at frequencies of 0.1, 0.2, 0.5, and 1 Hz to evoke whole-body motion. The sinewaves’ amplitude linearly increased for each frequency from 0 to 2 mA within 60 seconds (i.e., the same rate across EVS frequencies). Each frequency condition consisted of 15 trials, with each trial lasting 60 seconds. We computed the balance control DT from the gain and variability of the lateral force as a function of the EVS amplitudes and frequencies. We predicted the head acceleration resulting from a change in the balance control DT by computing the relationship between head acceleration and the lateral force signal envelopes.Results: For the lower EVS frequencies (0.1 and 0.2 Hz), the balance control DT increased linearly with stimulus amplitude, consistent with

Weber's law. However, for higher EVS frequencies (0.5 and 1 Hz), the balance control DT saturated around an EVS amplitude of ~1.5 mA. For these EVS frequencies, the head accelerations were lower than the predicted head acceleration if the balance control DT had followed Weber's Law. Conclusion: The saturation of the balance control DT at higher EVS frequencies (0.5 and 1 Hz) suggests that the sensorimotor system maintained its sensitivity to better detect whole-body motions and control body sways at these frequencies.

P03-T-144 - Assessing vestibular performance across military occupational specialties in naval aviation

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Background/ Aim: Dynamic Visual Acuity (DVA) refers to the ability to recognize moving objects while the head remains stationary or to identify stationary objects while moving the head as a function of the vestibular system [1]. Assessing DVA within a military setting, specifically the aviation community, is particularly relevant due to the critical importance of vestibulo-ocular function and health for their specific occupational demands and performance. It is understood that pilots undergo conditions, such as gravitational forces, vibrations and stress when in the air. Having to exercise the vestibular system and ocular system under these conditions can be very challenging. Specifically, vibrations from a helicopter can decrease the display reading performance, meaning that there may be more reading errors and longer response times [3]. Thus, this study aims to compare DVA function among Naval Aviation pilots, compared to other service members.Methods: A total of 65 United States Navy service members (51 helicopter pilots, 14 non-pilots) underwent a DVA evaluation utilizing methods previously developed as part of the National Institutes of Health Toolbox Norming Study [2]. Briefly, participants' visual acuity in Logarithm of the Minimum Angle of Resolution (LogMAR) was assessed with ETDRS optotypes, with yaw head movement faster than 180 degrees per second. Group differences between pilots and non-pilots were assessed using a general linear model, controlling for static visual acuity and age.Results: There were no significant differences between pilots and non-pilots in age (pilots = 29.3±4.7 years, non-pilots = 27.1±6.7 years) or static visual acuity (pilots = -0.11±0.07 LogMAR, non-pilots = -0.08±0.09 LogMAR). There were significant group differences in DVA scores, which were maintained after controlling for age and static acuity. Pilots' mean DVA scores were 0.16±0.07 LogMAR, whereas non-pilots averaged 0.21±0.10 LogMAR ($p = 0.045$).Conclusions: In this analysis, pilots demonstrated superior vestibulo-ocular performance compared to non-pilots, perhaps as a result of the unique force environment and exposures related to aviation. This information may be valuable to vestibular rehabilitation following injury, as pilots may require higher performance benchmarks than other occupational specialties.Disclaimer: The views expressed herein

do not necessarily reflect those of the Department of the Navy, Department of Defense, DHA or the U.S. Government.

P03-T-145 - Internal models in active self-motion estimation during steering

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Self-motion estimation is thought to depend on the integration of sensory information and sensory predictions derived from motor efference copies. In driving, there is an indirect relationship between the steering motor commands and the sensory feedback. However, the sensory feedback can in principle be predicted based on the steering motor commands if an accurate internal model of the steering dynamics is available. Here, we used two closed-loop steering experiments to examine whether participants can build such an internal model of the steering dynamics. Participants were seated on a motion platform and steered a wheel to align their body with a memorized visual target in darkness. We varied the gain between the steering wheel angle and the velocity of the motion platform across trials in different ways. In the first experiment, the gain changed abruptly twice during the experiment. We found that these gain changes were virtually undetectable in the displacement error, showing that participants made fast corrective responses, and that participants continued to revise their steering behavior in response to the new control dynamics across trials. These results suggest that participants use the inertial sensory feedback to build and update an internal model of the steering dynamics. In the second experiment, we aimed to confirm this by examining whether participants additionally take the across-trial predictability of the gain into account to control their steering. For this, we varied the gain between the steering wheel angle and the velocity of the motion platform from trial to trial in three different ways: unpredictable (white noise), moderately predictable (random walk), or highly predictable (constant gain). Results from a trial series regression analysis suggest that participants took the gain of the previous trial into account more when it followed a random walk across trials than when it varied unpredictably across trials. Together, these findings suggest that the brain constructs an internal model of the steering dynamics during driving with which the sensory consequences of the steering movement can be predicted.

P03-T-146 - Professional baseball players demonstrate superior dynamic visual acuity and differences in vestibulo-ocular reflex performance, compared to similarly aged healthy controls

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Background and aim: Baseball-specific movement paradigms require heightened ocular performance driven by the vestibular system. Gaze stability during rapid head movement is coordinated in large part by the vestibulo-ocular reflex (VOR). While the VOR has been extensively studied in clinical populations exhibiting vestibular impairment, little is known about vestibulo-ocular performance in professional baseball players particularly under conditions that putatively prompt high vestibular demand and mimic sport-like conditions. Additionally, current literature does not thoroughly address athlete performance of dynamic visual acuity (DVA) under conditions in which the head is moving. This comparative cross-sectional study explores the vestibulo-ocular performance of professional baseball players, relative to healthy controls, and aims to establish benchmark data for elite athletes to inform training or rehabilitation in the event of a sports-related concussion or need to improve sport performance.Methods: The computerized dynamic visual acuity (cDVA) test compared visual acuity during active head impulses in both horizontal and vertical planes relative to a static visual acuity measure. The video head impulse test (vHIT) measured the VOR gain (i.e., ratio of eye velocity to head velocity) of passive horizontal head impulses under typical and high velocity conditions (defined as above 250 degrees per second). An ANCOVA approach was then used to determine the differences between a group of professional baseball players (n=24) and a similarly aged control group (n=22).Results: The baseball players had significantly better acuity for each condition -- static (p value = 0.005), horizontal (p value <.001), and vertical (p value = 0.021) -- of the cDVA test relative to the healthy controls. In terms of Snellen acuity, the baseball player's average static acuity, horizontal dynamic acuity and vertical dynamic acuity was 20/15, 20/22 and 20/21 as compared to the control group's averages of 20/20, 20/37 and 20/32, respectively. Additionally, the mean difference in VOR gain between the high velocity and typical velocity head rotations during vHIT testing was significantly greater in the baseball players relative to the healthy controls (p value = 0.036).Conclusion: Through years of sport-specific training, professional baseball players are hypothesized to develop improved dynamic visual acuity as characterized by excellent performance in the cDVA test and disconjugate VOR gains across high velocity vHIT and typical velocity vHIT. The observed difference in VOR gain may potentially be due to greater eye acceleration during the initial milliseconds of a head impulse as an attempt of early target acquisition, a potentially advantageous mechanism in sport. These early eye movements known as anticipatory smooth eye movements (ASEMs) may reduce the gaze position error (GPE), though further research is needed.

P03-T-147 - Characteristics of center of gravity trajectory and balance strategy in patients with vestibular migraine

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Background and aim: Vestibular migraine is a neurological disease with recurrent vertigo or dizziness as the core symptom, often accompanied by migraine symptoms, involving dysfunction of cranial nerves II/V/VIII, and its diagnosis is mainly based on medical history, and there are few reports related to balance, especially in patients with vestibular migraine. There are fewer studies on the change of center of gravity trajectory and balance strategy analysis in patients with vestibular migraine. The purpose of this study was to observe the trajectory of the center of gravity and the characteristics of balance strategy in patients with vestibular migraine.Methods: The results of the sensory organization test (SOT) of the NeuroCom® Balance Manager-SMART EquiTest® (Natus Medical Incorporated, Pleasanton, CA) in 137 patients with confirmed vestibular migraine who were admitted to the Department of Otolaryngology-Head and Neck Surgery, Tianjin First Central Hospital, China from November 2014 to April 2025, aged 11-74 years, were retrospectively analyzed. The average age was (45.0 ± 14.8) years, and the characteristics of the center of gravity trajectory and ankle-hip strategy in maintaining balance in patients with vestibular migraine were observed, and the SOT score below 70 points was rated as abnormal results.Results: Among the 137 patients, 130 had ankle strategy and 7 had hip strategy. Under the 6 test conditions of SOT, there were 45 cases with normal center of gravity trajectories, 92 cases with abnormality, 6 cases with condition 1 abnormality, 4 cases with condition 2 abnormality, 2 cases with condition 3 abnormality, 8 cases with condition 5 abnormality, 8 cases with condition 6 abnormality, 6 cases with condition 1 and condition 2 abnormality, 2 cases with conditions 1-3 abnormality, 1 case with conditions 1-5 abnormality, 7 cases with conditions 1-6 abnormality, and 48 cases with conditions 1-6 abnormality in other combinations. Among the 92 cases with abnormal center of gravity trajectory, 18 cases were abnormal in condition 4, 22 cases were abnormal in condition 5, and 22 cases were abnormal in condition 6. There were 43 cases with abnormal SOT scores, including 4 cases with hip strategy and 39 cases with ankle strategy. Under the 6 test conditions, 10 cases had normal center of gravity trajectory and 33 cases had abnormal gravity trajectory.Conclusions: Vestibular migraine affects the balance function of patients, and the balance strategy and the change of center of gravity trajectory are mainly manifested in the abnormal center of gravity trajectory, and when the center of gravity changes greatly, it is necessary to start the hip strategy to maintain balance, which is related to clinical symptoms, and the SOT strategy and the change of center of gravity trajectory can provide an objective basis for personalized diagnosis and treatment and rehabilitation of vestibular migraine.

P03-T-148 - Balance and gait in patients with acute post-traumatic benign paroxysmal positional vertigo

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BackgroundBenign Paroxysmal Positional vertigo (BPPV) affects approximately a third of acute traumatic brain injury (TBI) patients. Despite the high frequency, current evidence suggests it is not routinely assessed or treated acutely. The objective of this study was to explore whether post-traumatic BPPV was associated with impaired balance, gait speed and/or falls. MethodsThis was a multi-centre randomised feasibility study conducted in London, UK. Acute TBI patients testing positive for BPPV completed bedside tests of static (modified clinical test of sensory integration in balance) and dynamic balance (modified dynamic gait index) which included gait speed, and gait speed with horizontal and vertical head turns. Following completion of balance tests, patients were randomised to one of three interventions (manoeuvres, standard care [advice] or Brandt Daroff exercises). Patients were followed-up at 4 and 12 weeks and were asked to complete falls diaries. Results 58 patients with acute post-traumatic BPPV participated. Gait speed improved significantly from baseline to follow up (p=.04) in patients with resolved (0.61m/s to 0.93m/s) but not unresolved BPPV (0.72m/s to 0.99m/s). Gait speed with vertical (p=.02) and horizontal head turns (p=<.001) also improved in only those with resolved BPPV. 11/58 (18.9%) patients reported a fall during the trial. 7/11 fallers (63.6%) had BPPV at the time of fall. Age or gait speed did not differ between fallers and non-fallers, however non-fallers were able to maintain static balance for a longer duration compared to fallers (95% CI 0.13 – 10.15 p=.04). ConclusionsThis study noted patients with acute post-traumatic BPPV are at risk of falls and do fall, which may have deleterious consequences for their physical, psychological and social wellbeing. BPPV resolution was noted to improve gait speed in this study, although further research is required to verify the mechanistic link between gait speed and falls or risk of falls. Acknowledgements and fundingRebecca Smith was funded by a fellowship NIHR-ICA-CDRF-2017-030. We would like to acknowledge all the patients, therapists and research nurses who participated in the study

P03-U-149 - Investigating the relationship between anxiety, attentional bias in older adults and people with Parkinson's

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Background: Parkinson's disease is a neurodegenerative disorder characterized by motor symptoms such as tremors, rigidity, and bradykinesia, but it also significantly impacts cognitive functions, including attention (Balestrino and Schapira, 2019). Attentional bias, characterized by the preferential allocation of attention towards negative or threatening stimuli, is thought to be exacerbated by anxiety (Eysenck et al., 2007; Bower et al., 2015). The age-related cognitive changes may impact attentional processes and increase

susceptibility to anxiety (Mohlman, Price and Vietri, 2013). People with Parkinson's Disease (PwP) also experience cognitive and emotional dysregulation, which may further compound the effects of anxiety and attentional bias. The differences of attentional bias toward threatening stimuli and emotional images between healthy older adults and Pwp remain largely unexplored, which motivates us to investigate the relationship between anxiety and attentional bias in Pwp. Furthermore, the factors underlying the effects of anxiety and attentional bias in PwP remain unclear, necessitating further investigation. Aim: 1: Investigating the visual search and attention differences between healthy elderly controls (HC) and PwP during a walking task in a complex virtual reality environment with threatening stimuli.2: Examining what factors (anxiety, balance ability, disease severity) are associated with attentional bias towards threatening and emotional stimuli in PwP. Method: 22 HC and 36 PwP performed a VR corridor walking task, during which eye-tracking data were collected. When participants reached the middle points of each corridor, they needed to make two 360 turns in different directions. Each VR corridor contained hazards/obstacles in the walking path as well as visual stimuli presented as framed pictures on the wall, with one positive and one negative facial image positioned side-by-side (Figure 1). The facial images were counterbalanced for gender, ethnicity, and valence score. Participants' attentional processes and anxiety were evaluated using the G-SAP and HADS questionnaires. Heart rate variability was also measured. The extent of attentional bias was quantified by computing the proportion of time participants devoted to viewing threatening stimuli and facial images. Results: PwP devoted more time to the threatening stimuli on the walkway (hazards) compared to HC ($p = 0.019$). As a result, PwP spent less time overall looking at the framed images compared to HC ($p = 0.006$). Additionally, PwP detected threatening stimuli significantly sooner than HC in each corridor ($p = 0.037$). Correlation analysis revealed a significant negative correlation between balance ability and attentional bias towards walking hazards in PwP ($p=0.011$, $r = -0.548$). No significant differences were observed in attentional bias on positive and negative images between HC and PwP. However, attentional bias towards negative images was associated with self-reported gait-related anxiety ($p=0.028$, $r=-0.493$). Conclusion: These findings suggest that PwP exhibit heightened attentional bias towards threatening stimuli, which is related to impaired balance control. This highlights the importance of functional balance and its relationship with attentional control during complex gait tasks. Associations between anxiety and attentional bias towards task-irrelevant threats are reminiscent of anecdotal reports of PwP often being hypervigilant to threats and how this might lead to dysproportionate negative interpretations of their behaviour, and how this is reflected in social interactions.

P03-U-150 - Characteristics of sensory weights in sensory organization tests for patients with vestibular migraine

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Background and aim: Vestibular migraine is a neurological disease characterized by recurrent dizziness or vertigo as the core symptom, often accompanied by migraine symptoms, involving functional abnormalities of the Ⅱ/Ⅴ/Ⅷ cranial nerves. Currently, its diagnosis mainly relies on medical history, and there are few reports related to changes in cranial nerves and balance, especially in patients with vestibular migraine. There is even less research on changes in the balance triad weights. The aim of this study is to observe the weight characteristics of visual, vestibular, proprioceptive, and visual dependence in patients with definite vestibular migraine.Methods: A retrospective analysis was conducted on 140 confirmed vestibular migraine patients who visited the Department of Otolaryngology Head and Neck Surgery at Tianjin First Central Hospital in China from November 2014 to April 2025. The Sensory Organization Test (SOT) were assessed using the NeuroCom® Balance Manager-SMART EquiTest® (Natus Medical Incorporated, Pleasanton, CA) and the results of SOT ranged in age from 11 to 74 years, with an average age of (44.9 ± 14.6) years. The relationship between the weights of visual, visual dependence, vestibular, and proprioceptive perception and the total SOT score was observed and analyzed. A SOT score below 70 points and/or any one of the sensory weights below the reference range was rated as abnormal in the SOT results.Results: Among 140 patients, 76 cases (54.3%) had SOT scores below 70 points and/or any sensory weight abnormality. Among them, 43 cases (30.7%) had SOT scores below 70 points, 75 cases (53.8%) had any sensory weight abnormality, and 1 case (0.7%) had a total SOT score of 67 points but all four items were normal. Among the 75 cases with abnormal sensory weights, the analysis of proprioceptive, visual, vestibular, and visual dependent sensory weights showed that 1 case had four abnormalities, 9 cases had three abnormalities, 17 cases had two abnormalities, and 48 cases had one abnormality. 44 cases (31.4%) had visual weight abnormalities, including 18 cases (12.9%) with pure visual weight abnormalities. There were 34 cases (24.3%) of vestibular weight abnormalities, including 16 cases (11.4%) of pure vestibular weight abnormalities. 32 cases (22.9%) had abnormal visual dependency weights, including 14 cases (10%) with abnormal visual dependency weights alone.Conclusions: The balance function of patients with vestibular migraine is affected, with a more significant impact on visual weight, which can also affect vestibular and visual dependence, and is correlated with clinical symptoms. Sensory Organization Tests can provide objective basis for the diagnosis and classification of vestibular migraine.