2015 POSTER ABSTRACTS

P1-A-1 The Waveforms Extraction By Wavelet Approach For The Auto Segmentation Of Daily Living Activities Using Multiple Inertial Sensors

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BACKGROUND & AIM:The use of inertial sensors-based systems (ISS) to capture human movement is relatively recent. Still, the development of methods and algorithms for clinical purpose is currently limited. Several clinical applications may be of value in the future; such as the follow-up of patients suffering from neurological impairment, drug evaluation, and so on. In this context, the segmentation of activities of daily living (ADL) tasks is crucial step if such systems are to be used for remote mobility monitoring and performance evaluation. Here, we are examining the ability of wavelet transform and discrete-time analyis to automatically detect tasks associated with ADL. METHODS:Four healthy subjects (73± 4 years) were asked to perform ADL tasks such as walking, sit to stand and reaching to the ground to pick objects, this randomly during 3 trials (3, 4, and 5-min) at their own pace in free space (25m2), while wearing a set of 17 inertial sensors (Animazoo IGS-180) positioned strategically on body segments. The proposed method is based on DWT and discrete-time detection of events. It consists of three step: i) sensor selection & preprocessing of the signal x(t) using DWT, ii) Automatic pattern detection and segmentation iii) defining the tasks transition. The DWT (dMeyer) is used to decompose the signal (8-levels), then we chose the approximation/detail which allowing separation of the relevant waveforms morphology from the noise and the amplitude variation of the original signal. The automatic segmentation was performed by an algorithm based on selection of the pattern by setting of a threshold (50% of the higher Amplitude) to detect Stand-to-sit-to-stand (Trunk Sensor: Acceleration), for Walking detection (Shin Sensor: Gyratory Velocity) & Reach-Ground (Trunk Sensor: Acceleration) the extraction of the pattern is based on the peaks detection: Minimum peak high & Minimum peak distance for each a specific task.Then, transitions of the tasks are determined by generating a rectangular function (the same length of x(t)) , where the null values (intervals determined by the previous step) indicate no-tasks. Subsequently, this function was derived and normalized to get a flag with: (1,-1) = (beginning, end) of the task. To evaluate the performance, the accuracy, the sensitivity and the specificity measurements were used. RESULTS:The proposed algorithm exhibited a significant sensitivity and specificity, even though the variation in the occurrences of the performed tasks (random execution): Walking (N=378 events, Sens. = 100%, Spec. = 97%), Stand-to-sit-to-stand (N=56, Sens. = 100%, Spec. = 100%), Reach Ground (N=164, Sens. = 99%, Spec. = 98%). CONCLUSION:The high accuracy of detection for the proposed methods is encouraging. This work lays the foundation for automatic segmentation of more complex ADL, and will eventually allow for the assessment of mobility performance; specifically how well the person is moving in his/her environment.

P1-A-2 Validation of the Actigraph GT3X+ activity monitor in individuals with recent stroke

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Background: Following stroke, many individuals experience gait dysfunction and reduced walking activity. Although it is common practice to assess walking ability using standardized tests, accurate quantification of actual walking participation is also essential in research and clinical settings. The Actigraph GT3X%2B(AG) is an activity monitor used widely in healthy population research. The low frequency extension (LFE) algorithm has been developed for the AG to increase accuracy of step detection in individuals who walk slowly. The purpose of this study was to validate the AG using the standard and LFE step detection algorithm in individuals with sub-acute stroke. AG step-count values were compared to values collected using a stroke-validated accelerometer and step-detection system (ABLE)(1). Methods: Ambulatory adults with subacute stroke (n=24; 67.4±13.6 years old; 47±65 days post-stroke) were recruited consecutively from an inpatient rehabilitation unit. Participants wore 3 devices for 7 hours. The ABLE and one AG were worn at the ankle on the less-affected limb. A second AG was worn at the waist. Gait velocity, balance, and stroke recovery were also assessed. The AG data were processed using the standard and LFE algorithms resulting in 2 daily step-count values for each wear position. Level of agreement between the ABLE and the 4 AG step-count values were determined using intraclass correlation coefficients (ICC). ABLE and AG step-count values were also compared using paired t-tests. Results: Participants took 3788±2073 steps over the 7 hour period, and walked at 0.82±0.24 m/s. Using the standard step detection algorithm there was good agreement between ABLE and the AG-Ankle ($ICC_{3,1}$=0.86; 95% CI 0.71, 0.94), and poor agreement between the ABLE and the AG-Waist ($ICC_{3,1}$=0.45; 95% CI -0.11, 0.79). While there was no significant difference between ABLE and AG Ankle (standard) step-count values p=0.381), the AG Waist (standard) undercounted by 1961±1418 steps ($p<0.001$). Using the LFE algorithm, agreement between the AG waist and the ABLE improved (ICC 3,1=0.89; 95% CI 0.12, 0.97), while agreement between AG Ankle and the ABLE decreased ($ICC_{3,1}$=0.66; 95% CI -0.08, 0.90). Using the LFE, the AG Ankle over-counted by 1532±908 steps ($p<0.001$), and the AG Waist over-counted by 799±571 steps ($p<0.001$). Conclusions: Based on these results, the accuracy of the AG activity monitor in ambulatory individuals with stroke appears to be dependent on wear location and step-detection processing algorithm. Further analysis will explore the relationship between gait velocity, motor impairment and step-detection accuracy. Recommendations will be made regarding the optimal use of the AG and LFE step-detection algorithm in this population. Reference 1. Prajapati S, et al. A novel approach to ambulatory monitoring: Investigation into the quantity and control of everyday walking in patients with sub-acute stroke. Neurorehab Neural Repair 2011;25:6-14.

P1-A-3 Do Postural Sway Measures tell us something about Quality and Quantity of Physical Activity Performed at Home? A Smartphone-based Study on Community-Dwelling Older People

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BACKGROUND AND AIM: Within the framework of the FARSEEING project (farseeingresearch.eu), Smartphones (SPs) are used for long-term monitoring of physical activity at home and for instrumenting clinical tests for functional assessment providing instrumental measures of the motor performance in addition to the traditional clinical outcomes. The use of SPs as a clinical tool was assessed within the InChianti study (inchiantistudy.net), a cohort study of factors contributing to loss of mobility in late life. In this study we aimed to investigate the association between features derived from daily living activities of elderly people and quiet stance measures, assessed in the lab. METHODS: The study included 170 elderly subjects (80±6.5 years old, 96 females) wearing a SP at home for at least 5 days (up to 9). SP was equipped with a custom Android application designed for long-term monitoring of physical activity. A set of sensor-based features was extracted from the signals including the percentage of sedentary, active, and walking time, duration of the activities, and mean gait and turning characteristics. Another Android application was used for instrumenting the modified Romberg test: subjects stood with feet shoulder-width apart for 30 seconds with eyes closed. Sway measures extracted from the signals were related to the Center of Mass (CoM) displacement in analogy to those computed from the Center of Pressure (Palmerini et al, 2011). The SP was placed on the lower back by means of an elastic belt for both the quiet standing trials and the at-home monitoring. Multiple Linear Regression models confounded by age, gender, and BMI were used for investigating the association between postural sway measures and the outcomes of the monitoring at home. RESULTS: High mean velocity of the CoM displacement in Antero-Posterior (AP) direction was associated to increased sedentary time and to decreased walking time (R^2=0.158-0.166). High mean velocity of the CoM displacement in AP and Medio-Lateral (ML) directions and high values of the AP and ML sway path were associated to an increased gait variability (R^2=0.138-0.181), a lower gait smoothness (R^2=0.137-0.198), and changes of direction while walking were slower (R^2=0.141-0.15) and smaller (R^2=0.081). High values of AP sway RMS were also associated to a reduced number of steps (R^2=0.104) and to shorter walking periods (R^2=0.107). CONCLUSIONS: This study provides novel evidence on the influence of the effectiveness of balance control, quantified by postural sway measures in the lab, on the daily activities of community-dwelling older persons. Presented results supports the hypothesis that balance performance in quiet stance may find significant correlates in mobility patterns at home. ACKNOWLEDGEMENTS: The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement FARSEEING n° 288940

P1-A-4 Variability in processing Sémont liberatory maneuver

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Background and aim Benign paroxysmal positional vertigo (BPPV) is the most common cause of episodic vertigo. Patophysiology is described by the otoconia which are dislodged from their position within the utricle and moved to the semicircular canal (most often to the posterior one PSC). For the treatment we use besides others Sémont liberatory maneuver (SM). Success of the SM depends on the correct setting of the PSC relative to the axis of movement and on the rate of change in body position, which will ensure sufficient acceleration endolymph and released otoconia (Faldon 2008). These two principles provide the basis for an ideal implementation of the SM. The aim of the study was to observe ability to respect the body position principle by the therapist and determine the inter-individual and intra-individual variability in the processing of maneuver and attempt to define the parameters that most affect it. Methods Three experienced therapists with equal success rate in treatment of patients with BPPV applied the maneuver bilaterally in 10 healthy probands. The observed sensorial axis copied the anatomical placement of the PSC. Maintaining of the sensorial axis was measured by the Inertial measurement unit consisting of the accelerometer and gyroscope recorded the trajectory and speed. Angle changes were placed in the coordinate reference system. Accuracy of the maneuver was evaluated due to the deviations from the intended sensory plane. Results Parameters affecting the accuracy of the maneuver are height of proband ($p = 0.0252$), phase of the movement ($p <0.0001$), therapist and side of the movement. These factors have influence especially in their interaction. Assessed interactions where phase of the movement with height of the probands ($p = 0.0130$), the therapist with phase of movement ($p = 0.0001$), therapist with the height of the probands ($p < 0.0252$). The largest magnitude deviation from the sensory plane was observed in the range -37.17 ° to 31 ° with a standard deviation of 16.6 °. Conclusions The data highlight high variability in the implementation of the Sémont liberatory maneuver, whether in the comparison between the particular measurements of the single therapist or inter-individually between the therapists. This variability can be partly compensated by the variability of the anatomical variations in position of the PSC. Analysis of the impact of these deviations on the therapeutic efficacy in patients with benign paroxysmal positional vertigo and detailed analysis of influencing parameters should be the subject of further research.

P1-B-5 Using transcranial magnetic stimulation to probe effects of visual motion adaptation on primary visual cortex (V1) excitability in Bilateral Vestibular Failure patients

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H. Ahmad1, R.E. Roberts1, M. Patel1, Q. Arshad1, A.M. Bronstein1 1. Neuro-otology Unit, Division of Brain Sciences, Charing Cross Hospital, Imperial College London, London, UK Background and Aim: A complete loss of vestibular function leads to adaptation through increased reliance on visual and somatosensory systems. Patients report oscillopsia due to a defective vestibulo-ocular reflex causing retinal slip. Previous work by Arshad et al (Clin. Neurophysiology, 2014) has shown that V1 excitability decreased whilst viewing motion in the adapted direction. There have not, however, been any previous studies probing visual cortical excitability using TMS and visual motion in these patients. We investigated effects of visual motion adaptation on V1 excitability in BVF patients and correlated this with psychophysical parameters. We proposed that constant exposure to visual motion and subsequent central adaptation may show a reduction in the perception of TMS-elicited phosphenes following visual motion adaptation. Methods: 12 BVF patients (7 males) aged 29-65 (mean 54.5,SD 11.9) and 12 controls (6 males) aged 42-73 (mean 55,SD11.1) were recruited. Subjects were positioned in a chair surrounded by an optokinetic drum viewed through binoculars. Biphasic TMS pulses were applied at V1 and baseline phosphene threshold (PT) was estimated using modified binary search method. There were 4 phases: 1)Baseline: 20 pulses no motion 2)Baseline motion: 20 pulses with optokinetic stimulation (OKS) rightwards 3)Adaptation: OKS rightwards 5 minutes; no TMS 4)Post adaptation: 20 pulses during motion. All subjects completed questionnaires. Results were analysed by calculating probability of phosphene perception. Independent t-test was used for analysis of baseline phase, ANOVA for motion and post-adaptation phase and Pearson's correlation coefficient for phosphene probability and questionnaires. Results: Baseline PT were found to be significantly higher in patients with bilateral vestibular failure ($p=0.024$) reflecting significantly reduced visual cortical excitability. Lower oscillopsia scores correlated with reduced baseline visual cortical excitability ($p=0.009$). There was no significant difference found between baseline motion and post-adaptation phase in either group ($p=0.06$). 6 patients were unable to continue to perceive phosphenes ("disappearing phosphenes") with exposure to motion. Conclusions: This novel finding acts as a neurophysiological correlate for clinical observations of reduced (adaptive) visual motion perception in these patients and is also correlated with psychophysical parameters. This may be related to V1 and V5 (motion area) exhibiting an inhibitory-excitatory loop; the continual motion leading to V5's inhibitory effect on V1 which results in higher PT's and potentially explains the phenomenon of "disappearing phosphenes". These findings provide evidence for adaptive visuo-cortical mechanisms leading to cortical plasticity following BVF.

P1-B-6 Adaptation to perturbations reduces difficulty to maintain balance during unpredictable gait perturbations in healthy individuals

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Background and aim: Perturbations are a promising approach to improve balance during gait. Balance tends to improve when a perturbation is repeated, except if the direction and intensity of the perturbations are unpredictable, as we recently showed during gait. Our aim was to test whether prior adaptation to repeated perturbations can improve balance difficulty when the same perturbations are presented randomly. Methods: Whole-body 3D kinematics (NDI Certus) and ground reaction forces (Bertec Fit®, split-belt treadmill) were recorded during treadmill walking in 13 young healthy adults. Perturbations were generated by faster (125, 150 and 175% of control speed) or slower (80, 65 and 50%) belt speed under one foot during one single stance phase. After a control trial without perturbation, one adaptation trial was performed for each type of perturbation, with 15 repeated perturbations on the right foot, every 8 to 16 steps. Then 4 trials were performed with 20 unpredictable perturbations applied every 10 to 20 steps. Under the right foot, each type of perturbation was delivered randomly, 2 times, while under the left foot, to increase unpredictability, only the 150 and 65% perturbations were applied, 4 times. The stabilizing force (i.e. the theoretical force necessary to cancel body velocity) and destabilizing force (i.e. the theoretical force necessary to place the body into an unstable position) were calculated, to evaluate balance difficulty, from kinematic and kinetic data. They were compared, using ANOVAs, between control steps and the beginning and the end of both the adaptation trials and the unpredictable perturbation trials to show how balance difficulty changed with repeated or unpredictable perturbations. Only the right foot step perturbations and the next, recovery step were analyzed. Results: Slower-belt perturbations increased the stabilizing force and decreased the destabilizing force (i.e. increased balance difficulty) during the recovery step compared to control gait. However, the stabilizing force decreased and destabilizing force increased (i.e. lower difficulty) with the repetition of perturbations. No effect was seen on the perturbation step, during which balance difficulty was lower than for control gait. During faster-belt perturbations, the stabilizing force increased and the destabilizing force decreased (i.e. higher difficulty) during the perturbation step and with the repetition of the perturbations, while difficulty reduced during the recovery steps. The forces did not change significantly during the following unpredictable perturbations. Conclusions: Balance adaptation occurred with the repetition of faster and slower-belt perturbations and was maintained for the subsequent unpredictable perturbations. These results show the strategies required to keep up with the velocity of the treadmill after perturbations and how adaptation can improve balance during unpredictable perturbations.

P1-B-7 Kinematic and kinetic analysis of human grounded running with and without heel contact

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BACKGROUND AND AIM: Walking is a mode of locomotion that is characterized by mutual exchange of gravitational potential and kinetic energy (PE and KE, respectively) of the body center of mass (COM) by the inverted pendulum mechanism. Running, on the other hand, utilizes the spring-like bouncing mechanics involving the mutual exchange of elastic strain energy with the PE and KE. In humans, the transition from a pendular walking to bouncing running gait abruptly occurs in the absence of an aerial phase. Grounded running, i.e. bipedal gait utilizing running mechanics even though the duty factor is > 0.5, is not usually observed. However, for terrestrial birds and non-human primates, a grounded running is a common mode of bipedal locomotion. Understanding why humans do not use a grounded-running gait may provide profound implications on the evolution of human bipedal walking. In the present study, therefore, we investigated the kinematics and kinetics of human grounded running to clarify biomechanical and morphological factors behind general absence of the grounded running in humans. METHODS: Adult male participants were asked to walk, grounded-run, and run across two force platforms set in a wooden walkway and ground reaction forces were measured. The subjects were asked to make contact with the ground from their heels (rear-foot strike: RFS) and then from their soles (mid-foot strike: MFS) to investigate how the difference in the foot-ground contact affects the mechanics of locomotion. The body kinematics was also quantified simultaneously using a motion capture system. The location of COM was also estimated based on the measured joint positions and published mass and COM fractions for each segment to calculate instantaneous PE and KE of the COM. RESULTS: Our results demonstrated that the vertical ground reaction force exhibited a characteristic two-peaked pattern in walking with both RFS and MFS, but in grounded running, the force pattern is single-peaked with its peak shifted in the early stance phase. An impact peak at touch-down was observed in both walking and grounded running with a RFS, but it was diminished in locomotion with a MFS. The hip and knee joints were more flexed during the stance phase in grounded running than in walking, indicating that the leg was relatively more compliant in grounded running. In walking, the PE is highest at the double support phase and lowest at the mid-stance phase, and vice versa in grounded and aerial running. However, we noticed that the amplitude of the fluctuation of the PE was smaller in grounded running than in aerial running of the same speed, particularly with a RFS. CONCLUSIONS: To effectively utilize the spring-like bouncing mechanics of running, large fluctuation of the PE seems to be necessary. However, generating large vertical oscillation of the COM is probably difficult for humans if the duty factor is > 0.5 due to the mechanical constraints imposed on the human lower limb.

P1-B-8 Assessing Variances After A Freezing of Gait Intervention: A Dual Motor-Cognitive Task in a Virtual Environment

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BACKGROUND:Freezing of Gait, FOG, is an episodic phenomenon where gait is halted, feet feel glued to the ground. It occurs at gait initiation, turning and in narrow spaces. Two thirds of patients with Parkinson's Disease(PD) will experience FOG. It is associated with falling, disease progression, mental loading and dopamine[1]. The basal ganglia is thought to be one of the essential sites of dysfunction[2] and attention may play a central role. Our aim was to examine the effect of a dual motor-cognitive Virtual Environment (VE) on FOG. METHODS:20 community dwelling participants with PD participated in a pre-assessment, 8 twenty minute intervention sessions and a post-assessment:15 FOG, 5 no FOG (Age:64.2±7.3yrs, Hoehn&Yahr:2.4±0.74, UPDRS:29±10). During assessments and intervention participants were asked to perform a number of tasks in VE environments[DFKI, Germany] which involved stepping-in-place on a balance board through corridors and doorways while pressing a remote (Nintendo, Japan) to navigate turns and to answer cognitive tasks (Stroop Test). Both assessments consisted of (i)a single cognitive task,(ii)a single motor task and (iii)a dual motor-cognitive task. During the intervention participants were asked to step-in-place through increasingly more complex mazes. Behavioural measures and standard clinical measures were also taken at both assessments: Montreal Cognitive Assessment (MOCA), Frontal Assessment Battery (FAB), Quality of life (PDQ39), Freezing of Gait Questionnaire (nFOGQ), Unified PD Rating Scale Motor Examination (UPDRS III), cognitive tasks Reaction Time (RT) and Dual Task Effect (DTE: cognitive - single/single). Both within participant (pre-to-post intervention) and between participant (FOG, no FOG) variances were investigated through a repeated measures ANOVA. RESULTS: Overall those with FOG had a lower MOCA Trails score ($p=0.072$) and significantly greater DTE RT ($p<0.05$, 28.25±8.2%) than those with PD alone (5.92±9.27%). For all participants there was a significant pre-to-post intervention improvement ($p<0.05$) in Dual Task RT and to lesser degree with MOCA trails ($p=0.097$), effect sizes: -88.08±54.11ms, 0.33±0.11 points respectively. Those with FOG had statistically significantly greater pre-to-post intervention improvement ($p<0.05$) in DTE RT (-21.3±5.9%) than those with PD alone (-3.65%), who in turn had greater improvement in PDQ39 (Q23: Felt a need to conceal PD?) and Single RT (-169.84±86.62ms) than those with FOG. CONCLUSIONS:Results from this pilot study support the introduction of dual motor-cognitive VE interventions in the clinical setting. Anecdotal evidence suggest significant improvements were gained. Further research is required on a larger cohort to extract the mechanisms of improvement. These results have shown that the benefit of attention training through dual motor-cognitive VE intervention can transfer to other modalities such as in a cognitive trail task. REFERENCES: 1. Giladi (2007) 2. Bloem (2010)

P1-B-9 Postural control during cascade ball juggling: Effects of expertise and support basis

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Background and Aim: Cascade ball juggling is a complex perceptual-motor skill, which involves the contribution of visual, proprioceptive and haptic systems to keep the balls simultaneously moving in the air by tossing and catching them; the juggler must throw each ball sufficiently high to provide time to dealing with the other balls. Previous studies have focused on learning and dynamical properties of controlling cascade juggling (Huys et al., 2003; 2004). The postural stabilization occurring during juggling has rarely been investigated (e.g., Leroy et al., 2008); in particular, little is known about the effects of ball juggling on body sway in jugglers of distinct skill levels, especially in different support bases. The aim of this study was to investigate the effects of experience and feet distance on body sway in expert and intermediate jugglers during three ball juggling. Methods: Six expert jugglers and six intermediate jugglers participated in this study. Criteria for defining the groups were being able to comfortably maintain juggling with at least five balls (experts) or three balls (intermediate). Each participant stood barefoot on the force plate (AccuGait, AMTI, 100 Hz), with feet maintained parallel to each other but aligned with the shoulder (wide condition) or together (narrow condition), performing three 40 seconds trials of the three-ball juggling task; the first 10 seconds of each recording was systematically ignored to avoid potential disturbances when participants started juggling. Each trial was videotaped for monitoring performance. Participants were instructed to self-select juggling speed, throwing the balls at the height of their eyes and keeping the hands horizontally aligned to the shoulders. Results: The analysis of variance revealed significant main effects of group and basis of support on the dependent variables in the time domain. Experts' body sway was characterized by smaller displacement, lower velocity, smaller amplitude (AP and ML) and smaller area as compared to intermediate group (Table 1). Interestingly, the more challenging (wide) basis of support caused significant attenuation in body sway for both groups, except for ML amplitude. However, this attenuation was greater for intermediate jugglers as shown by the significant interactions for displacement, mean velocity and AP amplitude. Mean frequency of sway was significantly higher in the wide stance for both groups in both axes; experts presented lower mean frequency only in the ML axis. Conclusions: Expertise in cascade juggling seems to be associated with improved postural control. Overall, experts had a reduced sway as compared to intermediate jugglers. Additionally, experts' smaller attenuation of body sway due to increased stance difficulty was sufficient to control juggling successfully. References Huys R. et al. (2003) Biol Cybern, 88: 302-318. Huys R. et al. (2004) Motor Control, 8: 188-212. Leroy, D. et al (2008) Gait Post, 28: 265-270.

P1-C-10 The effect of age on improvements in balance control after acute unilateral peripheral vestibular loss

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Background and aim It is well known that people who suffer from an acute unilateral peripheral vestibular loss (aUVL) due to vestibular neuritis initially have problems with their balance control, but generally acquire nearly normal vestibular ocular (VOR) and spinal (VSR) reflexes 3 months later through mechanisms of peripheral recovery and central compensation. Previous studies (Allum and Adkin, 2003) have indicated that aUVL patients tend to separate into two age groups those aged over 60 years or under 36. It is however not known if the improvements in VOR and VSR function over time are different between the age groups due to differences in peripheral recovery and central compensation. The aim of this study was to investigate possible differences in improvement due to age. Method 14 aUVL patients were included in this study (5 with mean age 28.4 years, range 23-35 and 9 with mean age 64.7 years, range 61-73). To test horizontal VOR function caloric irrigation, rotating chair (ROT) and head impulse tests (HIT) were used. To measure balance control 7 stance and 7 gait balance tests were performed in a standardized order. A gyroscope system (SwaystarTM) mounted at lumbar 1-3 was used to measure trunk angle and velocity in pitch and roll planes. Measurements were performed at onset of the deficit, and 3, 6, and 12 weeks after onset. Analysis of the data was concentrated on values at onset and at 3 months. Results There were no differences in changes in caloric test and deficit side ROT and HIT responses between the age groups indicating that peripheral recovery was similar between groups. However changes in normal side ROT responses were less in the elderly group ($p<0.05$) indicating that central compensation in this group was reduced. The largest effect of the aUVL on balance control was found for the tasks standing on two legs on foam with eyes closed, a semi-stance task walking eight tandem steps, walking 3 m with head pitching up and down, walking 3 m with head rotating side to side. As expected, these four tests generally showed higher sway for the elderly at onset and at 3 months. The differences between groups were largest for stance and semi-stance tasks at 3 months. However, pitch velocity during gait tended to be less in the elderly than the young at 3 months due to reduced gait speed. This led to a significantly greater decrease in pitch velocity in the elderly compared to the young ($p<0.05$) between onset and at 3 months due to reduced gait speed in the elderly. Conclusion: These results indicate that an aUVL due to vestibular neuritis causes a relative worsening of stance balance control in the elderly compared to the young. However pitch velocity during gait is reduced by slowing gait. Based on VOR changes it appears these differences are due to differences in the effectiveness of central compensation. It is recommended that these differences with age be taken into account when planning rehabilitation strategies for the elderly.

P1-C-11 Two-year changes in muscle strength and walking smoothness in community-dwelling older people

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Background and aim It is well known that the aging process is very heterogeneous and non-deterministic: There are centenarians who participate in sports, and 70-year olds with severe mobility limitations. Loss of muscle strength is associated with aging, and research has shown that muscle strength is more closely related to biological age, than chronological age is. The interplay between muscle strength and movement quality in older people has not been researched extensively, but an association between muscle strength and movement quality has been demonstrated. In this study, we aim to investigate changes in muscle strength and walking smoothness over two years, and hypothesize that muscle strength at baseline is associated with muscle strength after two years and may therefore predict impaired walking smoothness after two years. Methods Community-dwelling volunteers between 70-81 years were invited to be examined at a movement lab. Participants were tested for grip strength, isometric knee extension strength and the 30 second chair rise-test. In addition, they walked back and forth for a distance of 6.5 meters under different conditions, wearing a tri-axial accelerometer fixed to their lower backs. The acceleration signal was analyzed in the frequency domain, returning harmonic ratios in the AP, ML and V directions (HRAP, HRML, HRV); the harmonic ratio is a global indicator of rhythmicity and fluidity during walking. Results Data from 55 older persons who were tested both at baseline and at the two-year follow-up was available for an initial and preliminary analysis (mean age 76, 61 percent women). At two years, HRAP had decreased significantly (mean difference 0.57, 95% CI 0.06-1.08), along with grip strength (mean difference 1.14, 95% CI 0.22-2.05) and isometric knee extension strength (mean difference 22.47, 95% CI 2.25-42.69). In a bivariate analysis muscle strength demonstrated very high correlations between baseline and follow-up, (0.79-0.94) while HR demonstrated moderate correlations (see table 1). Conclusions Initial analysis of these longitudinal data suggest that the participants have changed with regards to some strength and walking smoothness variables, that the strength variables at baseline were highly correlated with follow up values, and that therefore baseline strength may predict impaired walking smoothness at follow up. Further regression analyses will shed light on the interplay between muscle strength and walking smoothness in a longitudinal perspective and will be presented at the ISPGR 2015 meeting.

P1-C-12 Reliability, measurement error and minimum detectable change of TUG and usual gait speed in community-dwelling adults aged 50 years and over

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Background and Aim: Timed Up-and-Go (TUG) and usual gait speed (UGS) are commonly used to assess mobility in older adults. However, all tests are subject to measurement error due to within-subject, day-to-day and inter-rater variation and other external factors. Clinically, this makes it difficult to discern a genuine change in performance over time. In a research setting, unreliable measures can lead to regression dilution bias or false positive associations when testing predictors of longitudinal change. In this study, we examine the reliability and effects of rater and time of day on TUG and UGS. We report the intra-class correlation (ICC), standard error of measurement (SEM) and minimum detectable change (MDC) for TUG and UGS using a sample of relatively healthy, community-dwelling adults aged 50 years and over. Methods: Participants (58 men, 69 women) from the Survey for Health, Ageing and Retirement in Europe (SHARE) Ireland study were invited to participate in the SHARE Ireland / The Irish Longitudinal Study on Ageing (TILDA) collaboration. They underwent a comprehensive health assessment administered by one of two research nurses (raters). Tests included TUG and UGS measured using a GAITRite mat. Repeat assessments were conducted between 2 and 4 months later. Participants were randomised with respect to time of assessment (morning, afternoon) and rater. The mean mobility performance scores were compared (i) between baseline and repeat assessments, (ii) between raters, and (iii) at different times of day using paired t-tests. Within- and between- participant variance was estimated using mixed effects models. ICC, SEM and MDC were calculated. Results: There was no difference between TUG and UGS tests at baseline and repeat assessments or when tests were completed at different times of day ($p>0.05$). However, there was a significant rater effect for both TUG (difference=1.22 s, $p<0.001$) and UGS (difference=7.36 cm/s, $p<0.001$). Reliability was questionable for TUG (ICC=0.75), moderate for UGS (ICC=0.88) and did not depend on the lag between assessments in either case. Within-participant SEM was 0.75 s for TUG and 7.03 cm/s for UGS. MDC at the 95% confidence interval level was 2.08 s for TUG and 19.49 cm/s for UGS. Conclusions: These mobility tests are reasonably reliable when measurements are obtained over 2-4 months and at different times of the day with the main variation being due to rater effects. These differences were evident with two highly trained and experienced research nurses which highlights the importance of providing appropriate training to ensure accurate and consistent measurements across multiple raters. The MDC values presented here will provide guidance as to whether longitudinal change in a similar group represents a genuine change or if it could be attributed to measurement error or natural variation. The SEM and reliability estimates will find application when estimating determinants of longitudinal change.

P1-C-13 Sedentary behaviour, physical activity and physical function in older people. The Generation 100 study

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Background: Physical activity prevents loss of function and disease at old age. Sedentary behaviour has been found to be an independent risk factor for disease and early death, but the relation to physical function is less clear. Aims: The study aims to assess if relatively fit older people with high and low sedentary behaviour have different physical activity and physical function. Methods: This cross sectional study uses baseline data from a population based clinical controlled trial including home-dwelling older people between 70 and 76 years of age. 833 women and 759 men (mean age 72.5¡À2.1 years, mean body mass index (BMI) 25.5¡À3.5kg/m2) were included. Sedentary behaviour and physical activity was assessed as daily self-reported sitting timeand self-reported frequency of physical activity and by activity-monitoring (actigraph); percentage daily time spent in sedentary and moderate to vigorous activity (MVA). Gait speed was assessed by an electronic gait mat (GaitRite), and muscle strength as grip-strength (Jamar), isometric leg-press (HUR) and peak speed when rising from a chair (Ergotest). Percentage of muscle mass was assessed by bioelectric impedance (BIOSPACE). Median sitting time for

the total sample (5 hours) was used to distinguish between sedentary and non-sedentary. Results: Mean daily sitting time for women was 5.5¡À3.7 hours and for men 6.5¡À5.0 hours. The non-sedentary group had lower BMI (p=0.003), more muscle mass (p=0.001), better grip strength (p=0.011) and better leg press strength (p=0.031) than the sedentary group. There was no difference in gait speed, speed when rising from a chair or in self-reported or monitored physical activity between the groups. The association between sitting time and self-reported or monitored physical activity was r ¡Ü 0.007. Conclusion: Muscle strength and mass was associated with sedentary behaviour, while gait speed and speed when rising from a chair was not. There was no association between sedentary behaviour and physical activity. The results underline the need for focusing separately on sedentary behaviour and its role for physical function through longitudinal studies.

P1-C-14 Investigating the relationship between gait speed and other indicators of older adults' health and wellbeing

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BACKGROUND AND AIM: Physical activity contributes to health and well-being in later life. Specifically, gait speed is associated with survival rates in older adults (1). Other important domains, such as cognitive function, nutrition and mood add to our understanding of how well people age. Existing individual measures do not provide a complete picture of the older adult nor account for co-occurring changes between domains. The aim of this study was to investigate the relationship between gait speed and other key factors that contribute to older adults' current health and well-being status. This holistic approach reflects a novel assessment of the ageing adult. METHODS: In this study, the preferred walking speed of 40 older adults (aged 64-88 years, mean age 72 years) living independently in the community, was timed over 10m under clinical conditions, as part of the Novel Assessment of Nutrition and Ageing (NANA) tool kit (2), a touch-screen data collection system installed in participants' homes to assess different aspects of their health and wellbeing over time. Participants' gait-speed results were divided into 4 groups according to gender- and age-specific cut-off speeds indicating likely survival over the next 10 years (1). Each of the 4 groups' separate measures were compared under the broader categories of physical function: Timed-Up and Go (TUG); grip strength; gait-speed; Community Healthy Activities Model Program for Seniors (CHAMPS), cognitive function: Mini Mental-state Examination(MMSE); National Adult Reading Test(NART); Symbol Digit Modalities Test(SDMT), nutrition: (energy intake in kilo/calories) and mood (Geriatric Depression Scale). RESULTS: Comparisons between group outcomes showed a significant difference in gait speed ($p < 0.001$) across all groups. In addition, the slowest walkers (0.8 - 0.99 m/s) scored below standardised normative data for grip-strength and SDMT.

Compared to the group with the quickest speed, the slowest walkers also had significantly lower scores in physical function (TUG; $p < 0.05$, grip strength; $p < 0.05$, CHAMPS; $p < 0.05$), cognitive function (SDMT; processing speed; $p < 0.05$), energy intake ($p < 0.05$) and mood ($p < 0.05$). CONCLUSIONS: Slow gait speed distinguished between the worst and best groups for physical function, cognitive function (specifically processing speed), energy intake and mood. The findings from the NANA study suggest that gait speed could indicate cause for concern in the current status of older adult's overall functioning and prompt the investigation of other specific factors of their health and well being. References: 1.Studenski S, P. S. P. K., & et al. (2011). Gait speed and survival in older adults. JAMA: The Journal of the American Medical Association, 305(1), 50-58. 2. Astell et al., (2014), Validation of the NANA (Novel Assessment of Nutrition and Ageing) touch screen system for use at home by older adults, Experimental Gerontology 60, 100-107.

P1-C-15 Effects of aging on arm swing and trunk rotation during walking

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BACKGROUND AND AIM: Healthy walking is characterized by pronounced arm swing and trunk rotation. The arm swinging motion in an opposing direction to the lower limbs, reduces the angular momentum of the body produced during walking. Much debate has been focused on the passive and active attributes of arm swing during gait and their relation to different gait properties. Aging effects on gait speed, stride length and stride time variability have been previously reported, however, less is known about changes in arm swing and trunk rotation. The aim of this study was to evaluate arm swing and trunk rotation in healthy young and older adults. METHODS: Sixty healthy adults between the ages of 30-77 were included in the study. All subjects were generally healthy, free of orthopedic or neurologic problems that could affect gait or arm swing and were cognitively intact (MoCA >26). Lightweight body fixed sensors (Opal APDM) were placed on each wrist and lower back. Participants walked at their comfortable speed for 1 minute. Ageing effects on arm swing amplitude, range, symmetry, jerk, the phase coordination index (PCI) of arm swing as well as trunk rotation amplitude and jerk were compared between decades of age (30-40; 41-50; 51-60; 61-77 years). RESULTS: Twelve subjects were in the first age group (mean 33.3±3.4yrs; 66% females), 20 subjects were between 41-50 years of age (mean 45.4±3.6yrs; 45% females), 14 subjects were between 51-60 years of age (mean 56.3±3.6yrs; 71% females) and 14 were between 61-77 years of age (64.6±4.4yrs; 71% females). As expected, significant differences between the groups were observed in gait speed ($p=0.02$) and stride time variability ($p=0.02$) with older adults walking slower and with increased variability. Arm swing range of the dominant hand was significantly lower with age (50.9±23.7deg; 29.1±12.8deg; 26.5±8.3deg; 20.1±10.7deg, by age group, respectively, $p<0.001$). Similar results were observed in the arm swing range of the non-dominant hand

(35.5±10.6deg; 27.3±12.9deg; 25.8±9.2deg; 22.4±9.5deg; p=0.04) and in mean arm swing jerk (0.22±0.2m/s3; 0.11±0.08m/s3; 0.07±0.04m/s3; 0.04±0.2m/s3; p=0.04). Arm swing asymmetry and PCI during usual walking did not differ between the groups whereas axial rotation declined with age (p=0.01). Inverse correlations were found between age and arm swing amplitude of both the dominant (r=-0.33; p=0.012) and non-dominant hands (r=-0.30; p=0.024), arm swing symmetry (r=-0.37; p=0.005), axial rotation (r=-0.25; p=0.034) and gait speed (r=-0.32; p=0.016). DISCUSSION: Aging effects were observed in arm swing amplitude and jerk as well as trunk rotation pointing to a scaling down of movement. These findings are in agreement with previous findings about ageing effects on the lower limbs. The present findings support the passive attributes of arm swing during gait and their dependence on trunk axial rotation and provide insight into the impact of aging on mobility.

P1-C-16 Maintenance of physical and cognitive function late in life: a shared neuroimaging signature?

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BACKGROUND: Physical and cognitive decline have complex and bidirectional interrelationships, but the underlying mechanisms are not clear. This study examines the association between maintenance of higher physical function as measured by gait speed (m/sec), and of higher global cognition as measured by the Modified Mini Mental State Test (3MS) score, over a period of 10 years and the neuroimaging correlates that explain these associations. METHODS. Repeated 3MS and gait speed measures from 1997-98 through 2006-07 and magnetic resonance imaging with diffusion tensor in 2006-07 were obtained in a biracial cohort of 246 adults with 3MS>80 at study entry (mean age 72.0 years, 58%women, 39% blacks). Participants were classified as having shown either maintenance (3MS slope> 0) or decline (3MS slope < 1 SD below the mean) of cognition using linear mixed models. Gait speed decline was computed using Bayesian slopes corrected for intercepts. Neuroimaging measures of interest were microstructure (mean diffusivity, MD) of regions known to be associated to cognitive maintenance in this cohort and also known to be related to spatial orientation, navigation and memory in the medial temporal (hippocampus, parahippocampus, entorhinal and cingulate cortex), prefronto-parietal (dorsolateral prefrontal and posterior parietal cortex) and subcortical areas (basal ganglia). RESULTS. Gait speed decline was slower (p=0.003) for the cognitive maintainers (n=146) as compared to the non-maintainers (n=100) and it was related to better MD of hippocampus, amygdale, thalamus, caudate, entorhinal and anterior cingulate cortex (p<0.009). Associations were independent of age, race, gender, smoking, physical activity, prevalent cardiovascular diseases, hypertension and obesity. The association between gait speed decline and cognitive decline was attenuated by worse MD of these regions. CONCLUSIONS. Maintenance of cognitive and physical function late in life appears to have a common or shared neuroimaging signature, localized within hippocampal and basal ganglia areas.

P1-C-17 Age-related changes in self-estimation of step-over ability in older adults: A three-year follow-up study

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BACKGROUND AND AIM: Older adults tend to overestimate their step-over ability. This self-overestimation is a potential risk factor for falls. However, it is unclear how older adults' self-estimation of step-over ability has changed through the years. This study examined the age-related changes in older adults' self-estimation of step-over ability. METHODS: In baseline examination, both stepping over ability and its self-estimation were measured in stepping over test (SOT) for 119 older adults. The participants first observed a horizontal bar placed 7 meter in front of them, with the height of the bar being manipulated in a descending/ascending direction; they then verbally reported the maximal height of the bar at which they believed to successfully step over (estimated height, EH) and performed the action. When they failed/succeeded it, an extra trial was repeated at a lower/higher height until they succeeded/failed with a new height; and the final height was registered as the actual height (AH). Three years after the baseline, a follow-up examination was conducted. RESULTS: The number of participants who showed overestimation of SOT ability increased from 10.9% at baseline to 21.0% at follow-up with 3 years of elapsing time. Overall mean EH at follow-up was significantly higher than that at baseline, whereas AH at follow-up was significantly lower than that at baseline. This indicated a shift toward more overestimation or less underestimation of SOT ability with 3 years of elapsing time. Such a typical shift toward overestimation occurred in 40% of the participants, who increased EH whereas decreased AH from baseline to follow-up. Contrary to this, 29% of the participants decreased both AH and EH from baseline to follow-up, indicating a relatively correct self-estimation. CONCLUSIONS: Our results suggest that older adults may have no clear awareness of their age-related decrease in step-over ability, thus resulting in increasing of EH with a large decline of AH for 3 years. Future studies are needed to examine why EH at follow-up have significantly increased from that at baseline while step-over ability (AH) decline with advancing age.

P1-C-18 Gender and walking speed affect models of gait - The Generation 100 study

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BACKGROUND AND AIM: Previous studies have illustrated that gait in both healthy and impaired older adults can be modeled by a limited number of gait domains (1,2). However, previous research has not investigated potential gender differences in models of gait, despite women heavily dominating many populations of older adults. It is thus an open question whether a single gait model is appropriate for both genders. Similarly, although walking speed is applied widely as both a discriminate and predictive measure, the effect of walking speed on models of gait has not been a focus of attention either. Therefore, the aim of the current study was to investigate potential gender effects on gait domains at different walking speeds using factor analysis. METHODS: Baseline data were used from a large intervention study, the Generation 100 study. Participants consisted of 805 men and 823 women, aged 70-76 years, who walked 4 times over a 6.5 m instrumented walkway (GAITRite) at preferred and fast walking speed. Screening of the correlation matrix of 53 spatiotemporal gait parameters for redundant (r >.9) and uncorrelated (p<.05) parameters resulted in the selection of 21 gait parameters. These were submitted to an explorative factor analysis using principal component analysis for factor extraction, with varimax rotation. RESULTS: The study sample consisted of relatively fit older men and women, as indicated by high preferred (men: M=132.50 %2B- 20.18 m/s; women: 128.80 %2B- 20.37 m/s) and fast (men: 195.55 %2B- 28.51 m/s; women: 179.65 %2B- 26.59 m/s) walking speeds. For men walking at preferred speed, factor analysis revealed a 5-domain gait model: Pace, Variability, Rhythm, Asymmetry, and Stability, together explaining 72.2% of the total variance. For women walking at preferred speed, the same 5 domains were revealed plus an additional 6th domain, Postural Control, with total variance explained being 78.1%. When men walked at fast speed, the gait model and domains changed. Gait parameters that at preferred speed loaded on the domain Stability loaded on Variability at fast speed instead, Variability thereby becoming the domain explaining most of the variance (34.6%). In addition, a new 5th domain emerged on which only step width loaded. The gait model and domains did not remain constant for women walking at fast speed either. Gait parameters loading on the domain Postural Control at preferred speed loaded on Stability instead, resulting in the same 5-domain gait model as for men at preferred speed. CONCLUSIONS: In a relatively fit group of older adults, different models containing different domains are needed to best describe gait in men versus women. Likewise, gait models and domains are not constant when walking at preferred versus fast speed. These differences need to be taken into account when employing gait models in research on elderly. References: 1) Lord et al. J Gerontol 2013. 2) Verghese et al. J Am Geriatr Soc 2008.

P1-C-19 Cholinergic dysfunction: a common substrate for gait disturbances among fallers in older adults and people affected by Parkinson?s disease

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Background and aim Older adults and patients with Parkinson's disease (PD) share a heightened risk of falls and a reduced ability to allocate attention. Deficits in the cholinergic system may contribute to both of these common problems. To address this question, we assessed cortical cholinergic activity in elderly fallers and patients with PD who reported at least 2 falls in the previous 6 months. Methods This cross-sectional study involved 50 participants (33 PD and 17 elderly matched for age and gender) with a history of 2 or more falls recruited for the V-TIME study. Cholinergic activity in the brain was estimated with short latency afferent inhibition (SAI), a TMS technique that assesses an inhibitory circuit in the sensorimotor cortex that is dependent on cholinergic activity. Short-latency afferent inhibition was measured by conditioning motor evoked potentials, elicited by TMS of the motor cortex, with electrical stimuli delivered to the contralateral median nerve at intervals ranging from 18 to 26 ms. Short-latency afferent inhibition was determined as the percentage difference between test and conditioned response for all intervals and was described as the group mean. Global cognitive function was assessed with the Montreal Cognitive Assessment (MoCA); visual attention and task switching was evaluated with the Trail Making Test (TMT A-B). Gait speed (GS) and stride time variability (STV) under single and dual-task conditions were measured using an electronic walkway. In the PD patients, disease severity was evaluated with the Unified Parkinson Disease Rating Scale part III. Results: The mean value of SAI was significantly higher in PD than in elderly, indicating less inhibition. In both groups, GS was significantly reduced and STV significantly increased during the dual task condition, compared to the single task condition. Further, in all participants, the mean value of SAI was significantly correlated ($r = -0.5$; $p<0.001$) with, the dual task change in GS whereas any correlation was found with the dual task changes in STV. Linear regression analysis showed that the significant association between the mean value of SAI and the GS change under dual task remained significant when adjusting for TMT-A, TMT-B and MOCA. Further, in PD subjects only, this association remained significant after adjusted for UPDRS III. Conclusions Cortical cholinergic activity was an independent predictor of change in gait characteristics under dual task in these two populations of fallers. Interestingly, this association was independent of cognitive status and was not influenced by disease severity in the PD subjects. Thus, these findings suggest cortical cholinergic dysfunction plays a pivotal pathophysiological role in gait deficits among elderly fallers and patients with PD.

P1-D-20 Adaptability of gait post-stroke requires symmetry of single support time

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Adapting footfall locations in response to environmental demands may be particularly challenging for stroke patients due to the fact that the task imposes step asymmetries on an already asymmetric walking pattern. The ability to modify steps, to support obstacle avoidance and in response to variable auditory cues have been found to differ in healthy adults and stroke patients according to asymmetry of gait and side of paresis [1,2]. This study sought to explore the relationship between the ability to alter footfall location and asymmetry of Single Support Time (SST), Step Length (SL) and Step Width (SW).

Methods: Participants were asked to step to targets (8cm deep x 40cm wide x1mm thick) adhered to a 6m walkway. Instructions were to step on the targets with any part of the foot. The depth of the targets corresponds to the variability in SL reported in stroke patients[3]. Thus, targets should only be missed if the participant was visually observed to be unable to place any part of his foot out of the usual variability. Targets were placed to elicit step adjustments i.e. lengthening, shortening (±25% of baseline step lengths) and narrowing of paretic and non-paretic steps. The number of targets missed in three consecutive passes of the walkway (a total of 48 targets including three attempts of each step adjustment on each side) as well as time taken to complete target stepping was recorded. Symmetry and self-selected walking speed were also assessed using GaitRite in unconstrained walking conditions. Symmetry ratios were calculated by dividing the larger of the paretic or non-paretic value (SL, SW or SST) by the smaller; in accordance with recommendations [4]. A value of >1 is increasingly asymmetrical. Total targets missed as well as number missed on the paretic and non-paretic sides and mean time-to-complete (calculated using times from all 6 passes of the walkway) were regressed, using stepwise multiple linear regression, onto each of the symmetry ratios. Results: Participant (n=38) characteristics, performance on target stepping task and regression results are reported in Table 1. The number of targets missed on either the paretic or non-paretic sides was not significantly related to the asymmetry ratios of SL and SW. However, speed of target stepping is significantly predictive of SST symmetry ($F(1,38)=11.073$, $p=.002$) $r2= 0.245$). Discussion: These results suggest that fast target stepping requires temporal symmetry of gait. This finding is also consistent with previous studies which highlight the importance of single support time in functional mobility and adaptations of gait in stroke survivors i.e. SST has been related to turning ability [5-6] balance control [7] and is an important determinant of gait function post-stroke[8] The relationship between symmetry of SST and ability to alter SL and SW in response to external cues indicates these parameters may be important targets for treatment and measurement.

P1-D-21 The EMG Signal Processing for Estimation of Lower Limb Joint Angle Using ANN

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Many investigations have been performed to understand the biomechanical relationship using biosignal. These have advantage for researching human motion and statement that it's possible to prediction human motion. Human biosignal such as electromyogram(EMG), electroencephalogram(EEG), electrocardiogram(ECG) represents human motion and statement. Among them, EMG signal is particulary interesting part for human rehabilitation system in order to detect the gait intention and widly studied in the field of rehabilitation system. Intention detection of gait initiation unsing EMG for human under dynamic condition is essential to understand mechanisms of movement control, and joint mechanism in areas of clinical research, such as rehabilitation medicine, orthopedic and sports.

Particularly, accurate prediction of joint angle becomes a key point for developments of advanced mechatronic rehabilitation prostheses and orthoses to control human rehabilitation system or robotics for the disables and the elderly. The purpose of this study is development of a joint angle prediction algorithm using adaptive filter and ANN to aware of the various walking environment. When human being walk, most of alll the body part muscle affect to human motion but, among them, EMG signal was acquired on Rectus femoris and Biceps femoris of 5 healthy male adults which appears to largy motion of human body. Walking process was occupied in 5 statement for level walk, stair ascent and descent, slope ascent and descent. Motion data was measured using wireless EMG(Noraxon), 3D motion analysis camera and IMU sensor which was developed our lab embeding to Gyro, acceleration sensor, compass and micro conrol unit module. EMG signal processing was digital filtered and features were extracted before the classification process begins. The classification is divided two distinct phased by training phase and angle prediction phase. EMG amplitude was estimated using adaptive filter through acquiring MA(Moving average) model to estimate coefficient of AR(Autoregressive) model because reject noise effect such as motion artifacts and additive noise. Estimated EMG signal was used to artificial neural network (ANN) input data for training to prediction of joint angle. Training objective data was acquired from Motion analysis and IMU sensor angle data. Each statement data adapt to TDANN(time delayed artificial neural network) algorithm for comparing. Estimating EMG signal using adaptive filter traced well real EMG signal without amplitude loss, and better effect than other filter like moving average filter only or differential filter. After training, time delay under a few milliseconds was exist, trained EMG data predicted well joint angle comparing with Motion analysis IMU output. In this study, a method using adaptive filter and ANN algorithm was applied to predict in knee joint angle from the measured EMG. The prediction was successful, particularly the knee joint angle.

P1-D-22 Evaluation of sagittal spinal parameters during gait before and after high tibial osteotomy in patients with knee osteoarthritis

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BACKGROUND AND AIM: It has recently been reported that patients with medial compartment knee osteoarthritis naturally adopt an altered gait pattern which have higher side sway of the trunk during gait. High tibial osteotomy (HTO) is a common surgical approach for the treatment of medial compartment knee osteoarthritis. Since the aim of the surgery is to transfer the mechanical stress applying to the joint from diseased medial compartment to lateral compartment by adapting the lower extremity alignment, HTO may also affect spinal alignment due to the correlation between spinal and lower extremity alignments. However, the effects of HTO surgery on spinal alignment have still not quantitatively investigated. In this study, recovery in sagittal spinal parameters after high tibial osteotomy in patients with medial compartment knee osteoarthritis was investigated in comparison with the healthy subjects. METHODS: Eight patients and eight healthy controls were participated in this study. HTO surgeries for patients were performed by an experienced surgeon. Patients were recruited two times for gait experiment at approximately one week before and one year after the surgery, and control group was recruited once. With the measured retro-reflective markers data, we evaluated spinal alignments of three groups (pre-operative, post-operative, and control) in the sagittal plane: Cervical lordosis (CL), thoracic kyphosis (TK), lumbar lordosis (LL), sagittal vertical axis (SVA), and pelvic tilt (PT). A statistical comparative study between these three groups was performed. RESULTS: For the validation purpose, spinal parameters of control group were analyzed. The results were consistent with previous reports. Among the aforementioned spinal parameters, CL, TK, SVA, and PT were significantly different between pre-operative and control groups ($p<0.03$) and all significant differences were disappeared after surgery ($p>0.10$). Only SVA was remained still different from control group ($p=0.02$). CONCLUSIONS: Group comparisons showed improvements of sagittal spinal parameters in patients with medial compartment osteoarthritis, which resulted by HTO surgery. The findings indicated that the HTO surgery have positive effects on not only lower extremity but also on spinal sagittal parameters. Therefore, we suggest that spinal alignment in addition to lower extremity alignment should be considered in the pre-operative planning of the surgery.

P1-D-23 Inverse dynamics without force plates

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Analyzing the forces exerted by muscles and other sources during locomotion is essential for understanding how the central nervous system control this complex activity. The standard approach to the inverse dynamics problem is to collect data from force plates in the floor along with kinematic data from an optical motion capture system. These two data streams are then combined to calculate the forces acting on each joint using the Newton-Euler technique. This standard approach has some problems, however. Due to measurement errors, the two data streams cannot always be aligned, leading to misrepresentations of either the ground reaction forces or the kinematic state of the body. For locomotion over ground and beyond simple stepping, the required number of force plates imposes a stiff upper limit on the available range of experimental designs. It is possible to avoid these problems by estimating all terms in the equations of motion based on an anthropometric model and then solving for the joint torques. This technique is based on kinematic data alone and approaches the problem by asking "based on the known distribution of mass along the body, what forces must have been acting to produce the movement that we observed?" Force plates are not required to calculate the joint torques and ground reaction forces. Recent work showed how this can be successfully done using the Newton-Euler method of calculating the dynamic terms (Fluit et al. (2014), J. Biomech. 47(10), 2321-9). We present an alternative technique for this approach based on Lagrangian mechanics. Contact with the ground is expressed by a number of non-slip and roll constraints on points on the foot (Hamner et al. (2013), J. Biomech. 46(10), 1772-6). We show how the Lagrangian equation of motion can be solved for the joint torques, observing the additional constraint that torques can only be applied at degrees of freedoms (DoF) representing anatomical joints, not at DoFs representing the configuration of a free body in space, e.g. the pelvis. One major problem for such kinematics-based approaches to inverse dynamics is the lack of ability to capture work-less forces, i.e. forces that only push against constraints without affecting the kinetic energy of the system. We show how this can be circumvented by solving the inverse dynamics only in the subspace of forces that are not work-less. To validate our method, we calculate the ground reaction forces during stepping on and off a flat surface and compare the results against data measured from a force plate. In general, our method reproduces the force plate data faithfully. Some relatively minor discrepancies remain at the heel-strike and liftoff times. We conclude that our method is a valid way to determine the joint torques applied during locomotion and can be used in situations where force plate data is not available.

P1-D-24 Biomechanical analysis of friction requirement at shoe-floor interface during straight walking and turning

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BACKGROUND AND AIM: The peak value of the traction coefficient (the ratio of the shear force component (fh) to the vertical force component (fz) applied to the floor) obtained shortly after a heel contact is termed the required coefficient of friction (RCOF). RCOF is considered as the minimum static coefficient of friction to prevent slip during stance phase when walking. Relation of RCOF with gait kinematics has gained researchers' attention, as it plays a key role in preventing slips during walking. According to Eq. 3 derived from the analysis model using COM and COP shown in Figure 1, the traction coefficient (fh/ fz) is equal to the summation of the COM-COP angle tangent and a residual term related to moment around the COM, fz and height of the COM. The purpose of this study was to investigate the effect of the COM-COP angle and the residual term on the RCOF during straight walking and turning. METHODS: The study involved eight healthy young adult males with an average age of 22.4 yrs. The gait trials comprised three blocks: straight walking, 90° step turn to the right, 90° spin turn to the right. In turning trials, subjects were instructed to walk at their natural pace in a straight line and turn to the right with their left (step turn) or right foot (spin turn) on the force plate. Two force plates and a three-dimensional motion capture system were used to measure body kinetics and kinematics. The whole body COM position was estimated using a seven-segment model. COP for the stepping foot was collected using the force plate. The traction coefficient was calculated using horizontal and vertical force components. The COM-COP angle tangent (tan) and the residual term [I /(fzzCOM)] when the traction coefficient took RCOF value were calculated according to Eqns. 2 and 3. RESULTS: The RCOF values during step (0.29±0.04) and spin (0.27±0.03) turns were significantly larger than that during straight walking (0.20±0.03) (p's<0.01). The COM-COP angle tangent during step turn (0.33±0.04) was significantly larger than that during straight walking (0.28±0.04) ($p<0.05$); however, the residual terms for spin (0.04±0.01) and step (0.03±0.03) turns were significantly smaller than that during straight walking (0.08±0.02) (p's <0.005). These results indicate that the RCOF during turning is dominantly determined by the COM-COP angle whereas, during straight walking, it is determined by the COM-COP angle as well as other factors such as the moment around the COM and fz. CONCLUSIONS: This study investigated the effect of the COM-COP angle and the residual term on the RCOF during straight walking and turning. We demonstrated that that the COM-COP angle tangent is the dominant factor of the RCOF values during turning, while other factors contribute more during straight walking. Acknowledgement: This work was partially supported by JSPS KAKENHI Grant Number 25420080.

P1-E-25 Self-recognition of one's own fall evoked the right dominant cortical and brainstem activity

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BACKGROUND AND AIM: Bipedalism is the fundamental evolutionary adaptation that sets hominids - and therefore humans - apart from other primates. The human body is arranged vertically some segments, such that the head, trunk, legs, and feet. Some of the most important brain systems are dedicated to the maintenance of balance and to providing an online representation of where the body is located, via the integration of many different exteroceptive/interoceptive inputs (visual, auditory, vestibular, somatosensory, motor, visceral, and so on). Although the neural mechanism for automatically detecting one's own body instability is an important consideration, there have thus far been few functional neuroimaging studies because of the restrictions placed on participants' movements. METHODS: We used functional magnetic resonance imaging to investigate the neural substrate underlying whole body instability, based on the self-recognition paradigm that uses video stimuli consisting of one's own and others' whole bodies depicted in stable and unstable states. After the fMRI scans, the participants were asked to rate their emotional states, and we conducted multiple regression analyses with the eigenvariate values in the spherical region of interest and the subjective ratings. RESULTS: Analyses revealed significant activity in the regions which would be activated during genuine unstable bodily states: The right parieto-insular vestibular cortex (PIVC), inferior frontal junction / ventral premotor cortex (IFJ/PMv), posterior insula and parabrachial nucleus (PBN). In addition, right IFJ/PMv activity was negatively correlated with emotional subjecting ratings "calmness" scores CONCLUSIONS: We argue that these right-lateralized cortical and brainstem regions mediate vestibular information processing for detection of vestibular anomalies, defensive motor responding in which the necessary motor responses are automatically prepared / simulated to protect one's own body, and sympathetic activity as a form of alarm response during whole body instability. Based on these considerations, the self-specific neural processing of body instability consists mainly of three component processes: 1) a vestibular/interoceptive process, which is related to detection of vestibular anomalies and to sympathetic activity as a form of alarm response (the right PBN and posterior insula), 2) an automatic motor-response preparation process (right IFJ/PMv), in which the necessary motor responses are automatically prepared/simulated in the brain to protect one's own body, and 3) a meta-cognitive process (right RLPFC) for self-recognition from the 3rd person perspective view. In addition, this right dominance may be based on lateralization of homeostatic brain structures and functions, which has been evolutionarily driven by a preexisting behavioral and autonomic asymmetry that is present in all vertebrates.

P1-E-26 The neural mechanisms underlying walking in complex situations in healthy older adults and patients with Parkinson's disease: insights from an fMRI study

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Introduction: Behavioral studies suggest that deficits in cognitive domains and sensory-motor processes associated with aging and neurodegeneration impair the ability to walk in complex environments. However, the role of frontal areas such as the supplementary motor area (SMA), parietal areas such as the precuneus, and middle and inferior occipital gyrus (MOG & IOG), in the neural circuits underlying locomotion during complex walking tasks are unclear. Methods: Twenty healthy older adults (mean age 69.7±1.3 yrs, 50% female) and 20 subjects with Parkinson's disease, PD (mean age 72.9±1.1 yrs, 24% female; mean disease duration: 9.5±1.0 yrs; UPDRS: 66.2±4.3) were asked to imagine themselves walking in different environments within the MRI scanner. All tasks included imagined walking in a virtual park: 1) simple walk: walking without interference; 2) walking while negotiating obstacles; and 3) walking while navigating to a specific target shown on a map. Control tasks of watching the same scenes without imagining walking were conducted. Each walking task was contrasted with the control watching task to account for brain activation associated with vision. Whole brain analyses were performed to detect neural activation associated with the imagined walking during these tasks. Results: Compared to the control tasks, both groups increased the activation during imagined walking tasks in MOG and IOG (pFWEcorr<0.001), precuneus (p FWEcorr<0.001), middle temporal gyrus (MTG) (pFWEcorr<0.001), BA 6 & 9 (pFWEcorr<0.049), and cerebellum (pFWEcorr<0.001). Between group comparisons revealed that patients with PD had a significantly higher activation in all three imagined walking tasks compared to the healthy older adults. Increased activation in the middle frontal gyrus (MFG)(p FWEcorr<0.074), precuneus (pFWEcorr<0.067), MOG, IOG, and cerebellum was seen in the patients with PD already in the simple walking task, compared to healthy older adults. Within group comparisons demonstrated that the healthy older adults had significantly higher activation in the precuneus during walking while negotiating obstacles (pFWEcorr<0.049) and in IOG, MOG, and cingulate gyrus during walking while navigating (pFWEcorr<0.014). No task specific changes in activation were observed in the patients with PD. Conclusions: These findings indicate that subjects with PD activate larger brain areas than healthy older adults even during imagined simple task walking, a condition that mostly involves planning of motor function. Perhaps, this increased activation is a compensatory strategy to enhance performance. The increased activation already during simple walking tasks may limit the ability to increase activation or recruit additional brain areas during more complex walking tasks and may contribute to the high prevalence of falls and the dual tasking difficulty in patients with PD.

P1-E-27 Functional Brain Imaging of Multisensory Integration during Computerized Dynamic Posturography in Older Adults Using Functional Near-infrared Spectroscopy (fNIRS)

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BACKGROUND and AIM: Age-related changes in static balance control have been theorized to be caused by changes in utilization of sensory feedback. Functional near-infrared spectroscopy (fNIRS) enables the estimation of brain activation during standing balance tasks. Previously, we reported activation of the temporo-parietal vestibular cortex in young adults during a balance task requiring primarily vestibular feedback control.(Karim et al., 2013) The purpose of this study was to examine what brain regions are activated in older adults during sensory integration balance tasks. METHODS: Fifteen community-ambulating healthy older adults (mean age: 73 ± 5y; 7 male) participated in this study. A Smart Equitest platform was used to provide the sensory integration test conditions. A 32-channel continuous wave fNIRS instrument was used to record hemodynamic changes bilaterally over the dorsolateral frontal cortex, temporo-parietal cortex, and occipital cortex. An A-B-A block design (baseline-test-baseline) was used to elicit changes in balance control while subjects maintained balance during four pairs of sensory integration balance test conditions: 1) Eyes Open (EO) while standing on Fixed platform (Fixed) - Sway-referenced platform (SR) - Fixed platform; 2) Eyes Open in the Dark (EOD) during Fixed - SR - Fixed; 3) Fixed platform during EO-EOD-EO; and 4) SR platform during EO-EOD- EO. Each block lasted 40 seconds (i.e. 2 min total trial time), and the four test conditions were randomly presented. The root-mean-square (RMS) of the center of pressure (COP) from the two baseline blocks was averaged and subtracted from the test condition. A repeated measures ANOVA was used to test differences among the sensory integration conditions. fNIRS data were analyzed based on a spatial-temporal version of a general linear model. Group-level analysis across the subjects was performed using a random-effects model of brain activity. RESULTS: The greatest changes in COP occurred when the platform changed from Fixed to SR, both during EO and EOD. Despite the substantial change in COP, these conditions elicited relatively small changes in fNIRS activation. The most significant change in activation occurred during the transition from EO to EOD while standing on the SR platform (Figure 1). The locus of activation was centered in the supramarginal gyrus. CONCLUSION: Older adults had large changes in activation in the supramarginal gyrus, part of the vestibular cortex, only during the condition when the sensory integration condition shifted toward a vestibular-only mode of control during constant sway-referencing. This result replicated the findings in young adults. (Karim et al., 2013) However, in contrast with young adults, the older adults did not demonstrate a large change in activation when vestibular only control was produced with constant removal of visual input. These differences may reflect age-related changes in sensory weighting.

P1-E-28 Suthalamic activity during the initiation of gait in human

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Background: Before a movement, different steps are needed, from the intention to act to the movement execution, in coordination with postural adjustments. The role of the subthalamic nucleus (STN) in these different steps is not clearly established. One hypothesis is that the STN is involved in the inhibition of undesired actions, acting as a refrain signal on the basal ganglia output structures. In Parkinson's disease the STN is overactive with increased bursting and oscillatory activities, leading, at least party, to motor deficits (rigidity, akinesia and tremor). The deep brain stimulation (DBS) of the STN, thought to result in a functional inactivation, provokes motor improvement. With time, patients developed gait and balance disorders that became resistant to dopaminergic drug treatment. The STN-DBS is no or less efficacious on these motor symptoms. An aggravation of freezing of gait and falls with STN-DBS has been reported in some patients suggesting that the STN is involved in gait and balance control. Methods : We recorded local field potentials of the STN during gait initiation in 10 patients with Parkinson's disease candidate to surgery. Biomechanical parameters of gait and EMG activity of lower limbs muscles were recorded simultaneously. Assessments were performed in both OFF (without) and ON (with) levodopa conditions. Results: During gait initiation, we mainly observed a hypersynchronisation in the alpha band and a desynchronisation in the beta band, that started during the anticipatory postural adjustment phase. During the step execution phase, the alpha activity increased with a maximum at the time of the foot-contact. In some patients, an increase in the gamma band activity was also noted during gait execution. Conclusion: These preliminary results suggest that the STN is involved in the different steps of gait initiation process in human, mainly with alpha oscillations.

P1-F-29 Physical Fitness in Older People with Mild Cognitive Impairment and Dementia

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Background and aim: Low levels of physical activity, poor physical fitness and dementia are common in older people. Maintenance of physical activity and good physical fitness is important for functional independence. Identification of levels of physical fitness as well as the association between physical fitness and cognitive function in older people with MCI or dementia are essential to establish effective prevention and rehabilitation strategies to maintain functional independency and avoid institutionalization .We addressed two aims: the physical fitness level in older persons with mild cognitive impairment (MCI) or dementia, and examined which cognitive domains were associated with physical fitness in this group. Methods: The cross-sectional study included 98 community-living older people �65 years of age with MCI or dementia. Physical fitness was assessed using the Senior Fitness Test and cognitive function was assessed with five cognitive tests: The Mini-Mental State Examination, the clock drawing test, The Trail Making Tests A and B and The 10-word-list learning test from the Consortium to establish a registry for Alzheimer's disease. Associations between physical fitness and cognitive performance were analysed in a multiple linear regression analysis with the physical fitness components as dependent variables. Results: Most of the participants scored below reported criteria for maintaining physical independence in later years. There were significant associations between reduced performance in most of the components of physical fitness and reduced cognitive function. Declines in executive function were most related to declines in physical fitness. Conclusion: Older people with MCI or dementia seem to have lower levels of physical fitness than their peers, indicating that they are less physically active, and are at increased risk of physical dependence in later years. These factors should receive more attention in people with MCI and dementia because they risk losing independence. Declines in EF are most related to a decline in physical fitness and these patients should receive special attention because they seem to have a higher risk for declines in physical fitness.

P1-F-30 Limited importance of rigidity and bradykinesia for gait and balance in patients with mild Alzheimer disease.

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BACKGROUND AND AIM: Previous studies have shown that the parkinsonian signs bradykinesia (slow execution of movements) and rigidity (increased resistance to passive movement) occur frequently in patients with Alzheimer's disease (AD) and generally progress with increasing severity of the disease. Both parkinsonian signs and gait disturbances may precede and predict incident dementia and AD. However, there is little evidence of the functional importance of parkinsonian signs on gait and balance in patients with a mild degree of AD. METHODS: Ninety-eight home-dwelling patients with a mild degree

of AD were recruited from a memory clinic. Parkinsonian signs were evaluated using the original version of the Unified Parkinson's Disease Rating Scale part III motor examination. Bradykinesia was categorized as present if a patient obtained a score of ¡Ý 2 on one or more of the eight items concerning bradykinesia, and rigidity correspondingly on at least one of five items. Gait was evaluated using comfortable gait speed, and balance was evaluated using timed performance on the one-leg standing (best performance of left and right leg, up to 60 seconds). Multiple regression analyses were performed with gait speed and one-leg standing as dependent variables. Independent variables were entered into the models in two blocks. Block 1 contained the covariates (age, sex, comorbidity, and Mini Mental Status Examination (MMSE)), and Block 2 contained rigidity or bradykinesia to evaluate the independent contributions of these signs. RESULTS: The patients' mean (SD) age was 71.7 (8.9) years, 55 (56 %) were men, 37 (37.8 %) had comorbidities. Their mean (SD) MMSE was 24.6 (3.0). Thirteen (13.3 %) had rigidity and 30 (30.6%) had bradykinesia. Mean gait speed was 1.10 (0.24) m/s and median (inter quartile range) time on one-leg standing was 15.5 (38) seconds. Bivariate associations between one-leg standing and both bradykinesia ($p<0.001$) and rigidity ($p =0.049$) were significant, and also between gait speed and bradykinesia ($p=0.001$). However, after adjusting for age, sex, comorbidity and MMSE score, neither bradykinesia nor rigidity had significant contributions to explain the variance in gait speed. Both rigidity ($p=0.039$) and bradykinesia ($p=0.023$) were significantly associated with one-leg standing, however the R2 change were as low 0.03 for both parkinsonian signs. CONCLUSIONS: In this sample of home-dwelling patients with a mild degree of AD rigidity was rare, while bradykinesia was present in one third of the sample. Evaluation of these signs did not contribute importantly to explain the variance in gait speed and one-leg standing. Thus, rigidity and bradykinesia appears to have limited relevance for the clinical evaluation of gait and balance.

P1-G-31 The relationship between movement reinvestment, balance confidence, and balance performance in healthy older adults

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BACKGROUND AND AIM: Movement reinvestment is a tendency to direct attention to the control and/or perception of movement and is assessed with the Movement Specific Reinvestment Scale (MSRS). The MSRS has a conscious motor processing (CMP) subscale which reflects an individual's tendency to consciously monitor and control his/her movements, and a movement self-consciousness (MSC) subscale which reflects an individual's concern about how his/her movements look (Masters and Maxwell 2008). Greater movement reinvestment, and more specifically CMP, has been linked to fall status in older adults (Wong et al. 2008). As a relationship between movement reinvestment, balance confidence, and balance performance in older adults has not been established, this study sought to explore these relationships. Given the well-established link between balance confidence and balance performance, this study also examined whether movement reinvestment could explain variation in balance performance over and above that of balance confidence. METHODS: Participants were 153 healthy, community-living older adults (105 women; mean (SD) age 66.6 (7.2) years). Participants completed the MSRS, the Activities-specific Balance Confidence scale, as well as 1-leg stance, timed-up-and-go (TUG), and obstacle course tests. First, bivariate correlations were conducted among all variables. Next, 3 separate hierarchical regressions were performed to predict 1-leg, TUG, and obstacle course duration. In all regressions, age, gender, fall status, and balance confidence were entered simultaneously on the first step, followed by CMP and MSC together on the second step. RESULTS: Several significant relationships between movement reinvestment, balance confidence, and balance performance were found. Higher CMP and MSC were associated with lower balance confidence. Higher MSC and lower balance confidence were associated with shorter stance and longer gait durations. CMP was unrelated to stance or gait durations. The final regression models predicting 1-leg, TUG, and obstacle course duration were significant (R2 change of .031, .044, and .034, respectively). However, only MSC was significantly positively related to TUG and obstacle course duration on the final step, after controlling for age, gender, fall status, and balance confidence. CONCLUSIONS: While CMP has been linked to fall status in older adults (Wong et al. 2008) and negative outcomes in individuals with balance problems (Masters et al. 2007), our results suggest that a greater concern for movement style is associated with poorer balance outcomes in healthy, community-living older adults. MSC, as opposed to CMP, may be more of a concern in these individuals due to negative aging stereotypes such as looking frail, unfit, or unable to perform balance tasks. It also appears that movement reinvestment, specifically MSC, provides added insight into balance assessment, over and above that of balance confidence, in older adults.

P1-G-32 Controlling perceptual interference and balance in older adults: How does cognitive function relate to balance performance at different ages?

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BACKGROUND AND AIM: In older adults, falls continue to be a serious health concern and are a strong prevention target [1, 2]. Recent literature has suggested that higher cognitive processes are important in balance and gait [3-5]. Specifically, a set of attention-related processes, termed executive functions, have been linked to postural control and falls [6-9]. Executive functions are known to decline with age [10]. However, cognitive processes that are most influential in postural control are not known, nor do we know the extent to which aging impacts these processes. Perceptual inhibition is a measure of perceptual interference or the ability to resist perceptual information that would trigger erroneous responses. Results found by Redfern et al. [5] suggested that perceptual inhibition may be an important component of the sensory integration process utilized to maintain balance and is impacted by aging. The goal of this study is to better understand how different measures of executive functioning, including perceptual inhibition, are associated with sensory integration processes during standing balance. METHODS: Inhibitory function was evaluated using the Motor and Perceptual Inhibition Test (MAPIT) [5, 11]. Additional aspects of cognitive function were measured using the computerized test battery by CNS Vital Signs, LLC. Postural sway measurements were collected using a dynamic posturography platform (Equitest, Neurocom Inc., Clackamas, OR). The protocol consisted of randomized blocks of standing while changes in the support surface or visual scene movement were provided with and without a concurrent information processing task. Visual conditions were eyes open with a fixed scene (EO) or sway-referenced visual scene (VSR). Platform conditions were fixed floor (FIX) or sway-referenced floor (SRF). The information processing task was a visual choice reaction time (CRT) task. Each trial lasted 180 seconds. Postural sway was evaluated using the RMS of the center of pressure (COP) in the anteroposterior direction. Cognitive function measures were correlated to postural sway and reaction times. RESULTS: Postural sway increased as the difficulty of the task increased. In older adults, perceptual inhibition was positively correlated with increased postural sway during FIX EO and SRF EO. Perceptual inhibition was also correlated with slower reaction time during VSR SRF in older adults. In young subjects, faster reaction times were correlated with several measures of cognitive function. CONCLUSIONS: The perceptual inhibition component of sensory integration is important in balance control in older adults. Declines in executive functioning are associated with changes in the sensory integration process, and the decline in this aspect of cognition with age may be an important component of age-related imbalance and falls.

P1-G-33 Does anxiety influence the ability to utilize sensory feedback while walking in PD?

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BACKGROUND AND AIM: Research evidence has suggested that anxiety influences gait in PD, with an identified dopa-sensitive gait response in highly anxious PD. Clinical anxiety research has suggested that anxiety might consume shared processing resources especially in threatening situations. Thus, it is possible that in threatening situations anxiety might consume more processing resources, limiting one's ability to process information such as sensory feedback especially in highly anxious PD. It has been well-established that sensory feedback is essential for gait in PD, and if PD are unable to use this feedback, gait suffers. Therefore, the current study aimed to (i) evaluate whether anxiety influences the ability to utilize sensory feedback in PD while walking in threatening situations, and (ii) examine whether dopaminergic medication influences one's ability to use sensory feedback in threatening situations. METHODS: 48 participants (24 HC; 12 Low Anxious [LA-PD], 12 Highly Anxious [HA-PD]) completed 20 walking trials in virtual reality across a plank that was (i) LOW: located on the ground (ii) HIGH: plank located above a deep pit, while provided with or without visual feedback about their lower limbs (VF;-VF). The plank varied in size from 60-100 cm. Both ON and OFF states were evaluated in PD. Gait parameters and self-reported anxiety levels were measured. RESULTS: HA-PD reported greater levels of anxiety across all trials (p<0.001) compared to HC and LA-PD, and all participants reported greater anxiety during the HIGH VF, compared to LOW VF and HIGH-VF (p=0.01). There was a significant group x condition x feedback interaction (p=0.01) for step width which showed that HA-PD were the only group that did not adapt their step width in the LOW VF, while HC and LA-PD used feedback to adapt their step width. Trending interactions in step length variability (p=0.06) and step time variability (STV) (p=0.08) hint that during the LOW condition, feedback reduced gait variability in HA-PD, whereas when walking in the HIGH condition, feedback increased gait variability in HA-PD, while it decreased gait variability in the HC and LA-PD group. A medication x group interaction was also found for self-reported anxiety within the PD groups (p=0.013). Dopaminergic medication significantly reduced anxiety levels in HA-PD to be similar to that of LA-PD. In contrast, dopaminergic medication did not significantly change anxiety levels in LA-PD. Additionally STV was influenced by medication, feedback, plank size and group (p=0.04) which revealed that only during HA-PD's ON state, was feedback able to reduce STV in the HIGH condition (especially on the 60cm plank). CONCLUSIONS: The current study suggests that in highly anxious PD, anxiety places a high demand on processing resources which may impact the ability to utilize sensory feedback while walking, and that sensory feedback processing can be improved in stressful situations with dopaminergic therapy.

P1-G-34 Dual-task cost in four domains of gait- a comparison between elderly with mild to moderate Parkinson's disease and healthy controls.

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Background and aim: The impact of cognitive function on gait in individuals with Parkinson's disease (PD) has received increasing attention in recent years. Previous studies have found that walking while simultaneously performing an added task, i.e. dual-task (DT), inflicts on the gait pattern among people with PD. However, it is still somewhat unclear how DT interferes with gait (i.e. DT cost, DTC). Following a conceptual model for gait assessments (Lord, Galna et al. 2013), Rochester et al.(Rochester, Galna et al. 2014) recently compared newly diagnosed elderly with PD with healthy controls, and found that the controls (unlike the PD group) increased their step width and step width variability during DT. Our aim was to, following the same conceptual model, investigate the dual-task cost (DTC) in elderly with mild to moderate PD, compared to age- and gender-matched controls, by presenting the results of 4 domains of gait (Pace; Variability; Rhythm; and Postural control). Methods: 101 elderly individuals with PD (44 % females) with a mean age of 72.9 years (SD: 5.5) and 47 healthy age matched controls (43% females) with a mean age of 71.2 years (SD 6.0) participated in this study. The mean disease duration and UPDRS motor score in the PD-group were 5.4 years (SD: 4.8) and 32.5 (SD: 11.7), respectively. Gait was assessed using an 8-m-long walkway system (GAITRite systems). The participants were instructed to walk at preferred speed, with and without a cognitive DT (reciting every second letter of the Swedish alphabet). Each gait condition was repeated 6 times. DTC was calculated as follows: (dual-task - single-task)/single-task*100. Two-way ANOVA was used to assess between group differences. Significance level was set to p=0.05 Results: The results of the pace domain showed that, compared to ST-gait, the PD group decreased their step velocity as well as step length significantly more than did the control group (p=0.005 and p=0.002, respectively). The postural control domain showed that the increase of step width during DT in the PD group was significantly higher than in the control group (p=0.000). However, there was no between group difference with regards to step width variability (p=0.887). We found no between group differences for the variability domain (step length: p=0.548; step time variability: p=0.332) or for the rhythm domain (step time: p=0.181). Conclusion: These results in elderly with mild to moderate PD, although preliminary, differed from those found by Rochester et al., where no differences were found for the pace domain. Moreover, whereas they found that it was the healthy controls that walked with increased step width at the postural control domain, our results (with increased step width in the PD group during DT) showed the opposite pattern. This may indicate that, when exposed to DT conditions, individuals with PD may alter their walking strategies as the disease progresses. Future studies needs to investigate this.

P1-G-35 Tai Chi training reduces dual task gait variability, a potential mediator of fall risk, in healthy older adults: cross-sectional and randomized trial studies

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BACKGROUND AND AIM: Tai Chi (TC) exercise improves balance and reduces falls in older, health-impaired adults. TC's impact on dual task (DT) gait parameters predictive of falls, especially in healthy active older adults, however, is unknown. This study aims to compare differences in usual and DT gait between long-term TC-expert practitioners and age-/gender-matched TC-naïve adults, and determine the effects of short-term TC training on gait in healthy, non-sedentary older adults. METHODS: A cross-sectional study compared gait in healthy TC-naïve and TC-expert (24.5±12 yrs experience) older adults. TC-naïve adults then completed a 6-month, two-arm, wait-list randomized clinical trial of TC training. Gait speed and stride time variability (%) was assessed during 90 sec trials of undisturbed and cognitive DT (serial-subtractions) conditions. RESULTS: During DT, gait speed decreased (p<0.003) and stride time variability increased (p<0.004) in all groups. Cross-sectional comparisons indicated that stride time

variability was lower in the TC-expert vs. TC-naïve group, significantly so during DT (2.11% vs. 2.55%; p=0.027); in contrast, gait speed during both undisturbed and DT conditions did not differ between groups. Longitudinal analyses of randomized TC-naïve adults revealed within-group changes in stride time variability during DT following 6 months of TC training (2.58% vs. 2.29%, p=0.034), but not in the control group (2.58% vs. 2.46%, p=0.445); intent-to-treat analysis of between-group changes in this outcome was not significant (p=0.271). The two groups also did not differ significantly in longitudinal changes of undisturbed or DT walking speed. CONCLUSIONS: In healthy active older adults, positive effects of short- and long-term TC were observed only under cognitively challenging DT conditions and only for stride time variability. DT stride variability offers a potentially sensitive metric for monitoring TC's impact on fall risk with healthy older adults.

P1-H-107 Therapeutic Effects of Robot-Assisted Gait Training in people with Stroke

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Therapeutic Effects of Robot-Assisted Gait Training in people with Stroke Chien-Hung Lai1,2, Chih-Wei Peng1,2, Jiunn-Horng Kang?P,2,Chih-Chao Hsu?P, 2 , Shih-Ching Chen1,2 1Department of Physical Medicine and Rehabilitation, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan 2Department of Physical Medicine and Rehabilitation, Taipei Medical University Hospital, Taipei, Taiwan Background and aim: Stroke is a leading cause of long-term disability and affects cognition, walking ability, balance, and functional activity. Robot-assisted gait training system (RGTS; Lokomat) is important issues in the advanced rehabilitation medicine. RGTS allow delivering continuous support and guidance for the legs in a physiological gait pattern, higher repetition accuracy, and prolonged training. Despite an increasing amount of available RGTS, determination of their effectiveness has remained controversial. The purpose of this study is to investigate the effects of RGTS and in individuals with stroke. Methods: In this study, we compared the efficacy of RGTS combined with the conventional rehabilitation training to only undergoing conventional rehabilitation training in individuals with stroke. Results: Participants who received RGTS combined with the conventional rehabilitation training showed significantly greater gains in Berg balance scale and motricity index (P<0.05) than those trained on the conventional rehabilitation training. Conclusions: Treatment with RGTS and traditional rehabilitation appears to be more effective than only undergoing traditional rehabilitation for enhancing returns in balance and muscle strength in individuals with stroke.

P1-H-36 Does the passability of apertures change when walking between people versus objects?

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BACKGROUND: When confronted with a small space while walking, a shoulder rotation is initiated for spaces deemed too small for straight passage in order to maintain a safety margin between the shoulders and the obstacles at the time of crossing. Rotations occur for apertures smaller than 1.3x the shoulder width (critical point) but are not required for spaces larger than this value (Warren & Whang, 1987). This is true for both doorways and spaces created by two single obstacles (Hackney et.al, 2013). Small spaces can also be created between two people, such as when walking in a busy mall or moving through a crowded party. Since research has demonstrated that individuals choose to walk closer to an empty bench compared to a stationary group of people (Knowles et. al, 1976), the purpose of the study was to determine whether individuals pass through two people in a similar manner as they do for two pole objects. Specifically, the study aimed to determine passable versus impassable spaces for passing through two people and identify whether other aperture crossing behavior (walking speed, safety margins, rotation magnitude etc.) differ for people versus poles. It is hypothesized that in the current study, individuals will rotate their shoulders for larger aperture widths (evident by a larger critical point) when the space is created by two people rather than two objects. METHODS: Nineteen participants (10 males & 9 females; mean age 24.7 +/- 4.4 years) walked at a self-selected pace along a 7m path and passed through an aperture located 5m from the starting location. The aperture was either created by two light-weight pole objects or by two people (confederates). In both conditions, the width of the aperture ranged between 1.0-1.5x each participant's shoulder width in increments of 0.1. The study was conducted as a block design (people or pole obstacles) and the aperture sizes were randomly presented within each block. Participants were instructed to pass between the obstacles but to ensure they did not collide with them. RESULTS: Analysis revealed that when walking between two confederates, individuals rotate their shoulders more frequently at larger relative aperture widths ($F(1,18)=9.61, p<0.01$), as evident by a larger critical point (1.28 for people and 1.41 for poles). Additionally, individuals initiated shoulder rotations earlier ($F(1.18)=3.39, p<0.05$), rotated their shoulders to a larger degree ($F(1.18)=27.72, p<0.01$) and left a wider clearance between their shoulders and the obstacles at the time of crossing ($F(1.18)=7.21, p<0.05$) when walking between two people compared to two poles. However, individuals passed through the confederates at a faster speed than they did the pole obstacles ($F(1,18)=4.41, p<0.05$). CONCLUSIONS: It appears that the passability of apertures changes when walking between two people versus two objects. Specifically, individuals leave a larger margin of safety when passing through people compared to objects.

P1-H-37 How do children age 7 complete a combined motor and cognitive task?

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BACKGROUND AND AIM: Dual motor tasks have been well studied in adults however there is limited knowledge regarding strategies used by children during cognitive-motor multitasking paradigms. By age 7, children are capable of adult-like postural strategies with articulated head, trunk and segmental control for most balance tasks [Assaiante et al,Neur Plasticity 2005,12(2-3):109-118] but periodically these children exhibit en bloc segmental coordination to simplify complex movements [Assaiante, Neurosci Biobehavior Rev 1998,22(4):527-532]. Interestingly, a common cognitive load assessment tool, the auditory Stroop test, has revealed adult-like responses in children aged 6 years [Guy et al,Inf Child Dev 2012,21:521-536;Jerger et al,Brain Lang 1988,35:86-104]. This finding suggests that by age 7, children can execute motor and cognitive tasks at adult levels when performed separately, however the mechanisms of their integration are largely unknown. The current work increased cognitive load and motor tasks in a stepwise approach, and hypothesized that en bloc control strategies would be used as attentional limit was reached in order to maintain balance and correctly answer the Stroop task. METHODS: Healthy children (n=12, mean age 7 years) and young adults (n=10, mean age 21 years) first performed the auditory Stroop test while seated (8 trials, no motor task) to confirm their understanding of the cognitive task. Participants then balanced a ball on a Frisbee on the non-dominant palm of the hand while reaching with the dominant hand to pick up a toy off the ground while standing (12 trials) and after walking along a 6 meter path towards the toy (12 trials). Kinematic data from the head, trunk, pelvis, feet and both elbows and wrists as well as accuracy and response latency to the cognitive cue were recorded. RESULTS: All children (CH) and adults (AD) successfully completed both motor and cognitive tasks when combined in both postures; the ball and Frisbee were not dropped. Cognitive accuracy rate for AD was similar for both postures (standing=84%; walking=80%) though CH decreased from 83% correct while standing to 67% while walking and response latency was more variable for CH than AD across postures ($p<0.01$). Angular range of motion (ROM) measures indicated that the trunk, upper arm (UA) and forearm (FA) segments were moving as articulated individual segments in AD and CH while walking (ROM for trunk≠UA≠FA; $p<0.001$). However, articulated control of the UA and FA were not evident in CH while standing (ROM for UA=FA, $p>0.05$) and the ROM for the trunk and FA were significantly different between CH than AD while standing ($p<0.05$). Gait velocity was significantly slower for CH than AD ($p<0.05$) across the entire trial (toy approach, pickup and post pickup). CONCLUSIONS Children age 7 can successfully perform a simultaneous upper body motor and cognitive task however simultaneous motor and cognitive performance is not yet at adult like levels.

P1-H-38 Verticality perception during standing and sitting

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Background: Impairment of verticality perception can cause falls or even inability to stand due to latero- and retropulsion. The internal estimate of verticality can be assessed through the subjective visual, haptic, or postural vertical (SPV). The SPV has been primarily assessed in a sitting position. However, the internal representation of body orientation might be different between sitting and standing, mainly because of the major role of somatosensory input for estimation of the SPV. Methods: We set up a paradigm using a device tool to measure SPV during stance in three dimensions (Spacecurl®) and compared data to measurement during sitting in the same subjects. Sensory input in healthy subjects (n=25) was manipulated by visual roll stimulation and Achilles tendon vibration. Results: Test-retest and inter-rater reliability of SPV measurements were good (normality values -1.7° to 2.3° in the sagittal plane and -1.6° to 1.2° in the frontal plane). Minor alterations occurred with aging: SPV shifted backward with increasing age, and the variability of verticality estimates increased. Comparing sitting and standing, results are comparable in healthy subjects for both planes (roll and pitch). In patients with retropulsion, however, assessment during standing showed larger deviations. Conclusion: Assessment of SPV in standing can be done with reliable results. It will now be used in patients with balance disorders to assess impaired perception of verticality and to monitor therapy.

P1-H-39 Impaired Interlimb Coordination after Concussion

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Background. While gait may not be obviously impaired after concussion, there is some evidence suggesting that locomotion post concussion is suboptimal. Bilateral coordination of locomotion in humans has been quantified in different ways, one of which is the phase coordination index (PCI). A recent study on split-belt treadmill suggests that concussion may affect bilateral coordination abilities, however, its impact on left-right lower extremities coordination during normal walking is unknown. Aim. To evaluate functional locomotion during normal walking in acutely concussed college athletes. Methods. Twenty-two college athletes (age 20.6±1.35; men 15, women 7) who sustained sports-related concussion 48-72 hours prior to testing and fifty age-matched students athletes with no history of concussion participated in the study. Sixteen out of the 22 athletes were followed up longitudinally at approximately days 5 and 9 after concussion. Athletes were tested at Portland State University, Lewis & Clark University, and George Fox University. Subjects were asked to walk at their regular pace for 2 minutes. Participants wore 3 Opal sensors on the posterior trunk at L5 and the ankles. The sensors record 3D accelerations and angular velocity and wirelessly stream data to a laptop. Spatio-temporal gait characteristics and PCI were derived using APDM system and software. Results. Our main finding was that the PCI was significantly higher in the concussion group when compared to controls (3.03 ± 0.85 vs 2.45 ± 0.60, p=0.003). Stride time (1.13s ± 0.08 vs 1.10s ± 0.07) and double support time (24.08% ± 4.62 vs 22.77% ± 3.91) were slightly higher in the concussion group, while gait speed (1.36±0.13m/s vs

1.40m/s ± 0.12) was slightly decreased, but differences didn't reach statistical significance. Across the three repetitions in time, the PCI showed a trend in decreasing towards normal value in the concussed group. Conclusions. Traditionally, inter-limb coordination was thought to be generated only at the level of the spinal cord via central pattern generators but there is evidence that higher centers in the brain play an important role in inter-limb coordinating. Though gait is not obviously impaired after concussion and not considered in return-to-play decision, this research provides some evidence that subtle coordination deficits may be present and can be detected with inertial sensors. The difference in mean PCI between the control and concussed groups is significant and suggests that PCI may be important to consider after a concussion. Acknowledgements. NIH R21HD080398, OCTRI KL2TR000152, UL1TR000128.

P1-H-40 KNEE FLEXION LIMITATIONS INFLUENCE LOWER LIMB INTERSEGMENTAL COORDINATION DURING OBSTACLE CLEARANCE

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BACKGROUND & AIM: The planar law of coordination has been observed to hold true throughout several paradigms including walking on an incline, stairs, and clearing obstacles [1-3]. This planar relationship between the segment elevation angles of the lower limb is thought to be a way that the CNS conserves energy by limiting the degrees of freedom during walking [4]. It was the goal of the current study to examine whether this law holds true when the range of motion (ROM) at a joint is compromised. METHODS: 7 healthy young males (mean: 22.6 years old, 1.75 m tall, 77.5 kg) were fitted on their right side with a commercially available knee brace with flexion limiting capabilities. Following unconstrained trials with the brace on, the ROM of the knee was mechanically limited to approximately 70, 50, and 30°from full extension, in a randomized order. Each participant performed 5 walking trials stepping over an 18 cm tall obstacle in their travel path for each brace condition. Kinematic data of the pelvis, right shank and thigh, and both feet were collected using an Optotrak system (NDI, Waterloo, ON). Principal component analyses were performed on the segment elevation angles of the foot, shank, and thigh for the right lower limb for each trial. Using the first 2 eigenvalues, the amount of variation limited to a single plane was calculated (planarity index, PI). Eigenvectors were used to determine the relative dihedral angle of the plane of variation to the XZ plane [1]. One-way ANOVA examining the influence of brace restriction on PI and dihedral angles were performed ($p<0.05$) and Bonferroni post-hoc corrections were used where appropriate. RESULTS: The PI ranged from 97.23 - 98.48% indicating that the segment elevation angles maintained the classically reported relationship for each condition. The only significant difference was between the 30 and 70°flexion limitation conditions in the PI, where the more restricted knee resulted in less planar movements. There was no significant difference in the dihedral angles which ranged from 44.69-46.61°. CONCLUSIONS: This study has shown that even with restricted knee range of motion accompanied by a perturbation (obstacle in the travel path), the segment elevation angles of the lower limb remained consistently planar. However, there was a difference in the magnitude of variability contained within the plane between the lowest and highest degrees of flexion limitation. Qualitatively, these results seem to be attributed to reduced foot and shank segment angles during stance phase, and increased angles during swing phase of the most restricted knee. Limiting ROM during obstacle clearance appears to reduce the planar nature of limb segmental control, however, only slightly even in the most extreme cases. REFERENCES: [1] Noble & Prentice(2008) EBR [2] Ivanenko, d'Avella, Poppele, Lacquaniti(2008) J Neurophysiol [3] Maclellan & McFadyen(2010) EBR [4] Lacquaniti, Grasso, Zago (1999) News Physiol Sci

P1-H-41 ASSOCIATION BETWEEN BALANCE AND GAIT ABNORMALITIES IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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Background and aim Patients with chronic obstructive pulmonary disease (COPD) may show gait abnormality [1] associated with severity of disease [2]. COPD impacts on diverse body systems remote from the lung as muscle and peripheral nerves. Therefore, it is not clear whether gait abnormality and balance impairment, or both, are related to severity of disease or to secondary changes in lower-limb muscles and nerves. Aims of the study were: 1. to compare spatio-temporal variables of gait in patients with COPD and in healthy subjects (HS), and 2. to search for correlations of gait variables with clinical findings and balance performance. Methods We recruited 40 patients with COPD staged from 1 to 4 according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria, and 40 age- and sex-matched HS. The following evaluations were performed in both patients and HS: Forced Expiratory Volume in 1 s (FEV1) through spirometry; proximal and distal muscle strength of the lower-limbs, quadriceps and Achilles tendon reflexes, sensation at the level of the big toe through clinical scales; dynamic balance performance through the Mini-BESTest (MBT). Body sway during quiet stance eyes open and eyes closed was assessed with a force platform. Spatio-temporal variables of gait (speed, cadence, step length and width, foot yaw angle, single and double support duration) were assessed through a 4-m sensorized walkway. Results Strength of proximal muscles of the lower limbs was significantly reduced in patients with COPD with respect to HS, whereas strength of muscles around the ankle, as well as tendon reflexes and sensation, were unaffected. Body sway during quiet stance and MBT (both balance and gait items) were abnormal in patients. Most gait variables were significantly affected in patients with COPD with respect to HS, except foot yaw angle and step width. Muscles weakness affected balance but not gait MBT items. On the other hand, the worse the balance items the

more affected the gait MBT items. This finding was confirmed through instrumental evaluation: the larger the body sway during quiet stance the slower the gait speed. Conversely, neither clinical nor instrumental variables of balance and gait were influenced by FEV1. Conclusions Weakness of proximal muscles, though moderate, is consistent with the changes in muscle structure affecting patients with COPD [1]. Gait abnormality proved to be associated with dynamic balance performance, a finding already shown in the case of diseases of the central [3] and peripheral nervous system [4]. The lack of relationship between COPD staging and balance or gait variables points to the insufficiency of spirometry for predicting abnormalities of balance and gait in these patients. References [1] Roig et al. J Cardiopulm Rehabil Prev 2011;31:120-4. [2] Beauchamp et al. Respir Med 2009;103:1885-91. [3] Morton and Bastian. J Neurophysiol 2003;89:1844-56. [4] Nardone et al. Clin Neurophysiol 2014;125:327-35.

P1-H-42 Attentional demands during treadmill walking: dynamic gait stability and associated neural correlates

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BACKGROUND AND AIM: Stability control during gait requires attention, which may be compromised as the cognitive demand increases. The biomechanical and neural components which reflect this increased attention to maintain gait stability remain unclear, eg. how do temporal distance gait parameters adapt and different brain areas activate in the task of holding a cup of hot liquid in the hand while walking and not spilling or falling. The primary aim of our study was to characterize gait pattern changes and to study associated cortical activities as the attentional demands increase during treadmill locomotion. METHODS: Eleven healthy young adults and one stroke participant were recruited. The CMill, a 3m long treadmill instrumented with force plates was used for this study. Near infrared spectroscopy measurement was performed using the NIRScout system with a custom-built cap covering the frontal cortex. The experimental protocol included repeated block trials consisting of four alternating blocks of standing (20s) and walking (25s) at a preset speed determined to be comfortable during the baseline habituation process. There were a total of five trials, each of which consisted of four randomized conditions including the cup being either empty or filled with water, jelly or hot liquids (coffee/tea). Participants held the cup in the dominant (healthy controls) or unaffected (stroke) hand. Throughout the trial, the participants were asked to look ahead into a target and adjust their arm posture in such a way that they could see both the surface of the cup and the target simultaneously. Primary outcome measures included step length, step width, center of pressure and gait variability measured by percentage coefficient of variation in stride duration (%CV). The cortical hemodynamic response was quantified by analyzing concentration changes of oxygenated hemoglobin (oxyHb). RESULTS: Walking with a cup filled with hot liquid was associated with a decrease in step width as well as %CV and a general increase in stride length in healthy participants but not the stroke individual. The decrease in step width suggests that all subjects adapted to the back and forth sloshing frequency of the fluid by adjusting their gait so as to suppress the resonant sloshing frequency and thereby preventing any spillage. Changes in gait parameters were also associated with corresponding changes in OxyHb concentrations in the frontal cortex. CONCLUSIONS: Decreased step width indicates that gait adaptation during the task of holding a filled cup requires frontal plane control of the trunk. Absence of gait modifications in the stroke participant may be related to the inability to coordinate dynamic changes in the frontal and sagittal plane of postures. Extension of this paradigm to older adults as well as additional stroke participants will provide insight into how attentional demands affect gait and reveal associated cortical changes in these populations.

P1-H-43 Does postural configuration affect saccadic reaction time during reaching?

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DOES POSTURAL CONFIGURATION AFFECT SACCADIC REACTION TIME DURING REACHING? BACKGROUND AND AIM: Smooth movements necessary throughout life can be attributed to the ability of the CNS to interpret sensory inputs and respond with complementary motor action commands. Goal-directed tasks such as reaching require a coordinated whole body strategy which needs to a) identify (direct gaze toward) the goal and b) successfully produce a voluntary motion to reach the goal whilst ensuring balance is maintained. From a neuro-mechanical perspective, various postures may have a further effect on saccadic reaction time as the requirements of balance may impact on the speed of neural processing. Thus, our primary aim was to determine whether postural configuration and the corresponding increases to postural demand affect the timing of saccades involved in orienting to, and reaching for a target. METHODS: 11 healthy participants (age: 24.3±2.2) produced goal-directed, whole body reaching movements (REACH) or simple saccades (LOOK) to horizontally arranged targets located 20° and 40° from a central target. Four separate postural configurations; seated (SIT), standing (STAND), stance with feet together (NARROW) and stance upon a narrow platform (BEAM) were presented in randomised blocks of 50 trials. Whole body kinematics were collected at 200Hz and synchronised with electrooculography (EOG-1000Hz). EOG was calibrated relative to head position for eye-in-head position. Gaze shift onset was determined using a 15°/s velocity threshold and confirmed with visual inspection. Left and right-side targets were then pooled. RESULTS: Preliminary results (n=4) reported here suggest that for all conditions, mean latencies are in line with gaze shifts during simple saccade or reaching tasks. Small gaze shifts saw slight changes to visual processing time between REACH and LOOK regardless of condition (Figure 1A) while, variations between the two became greater at the more eccentric target (Figure 1B). Mean latency was greatest for the SIT condition (322.02ms±83.53ms) while reaching during stance produced the smallest latency (STAND: 276.67ms±60.68ms). Despite the small sample size, a significant main effect for target eccentricity was found (20°: 283ms vs. 40°: 305ms, p=0.006) and, complemented with the small error, the trends highlighted may prove to be significant with a full complement of data. CONCLUSIONS: Increases to postural demands evoked changes in eye latencies within each postural configuration. However, the STAND condition consistently produced smaller latencies than the more stable SIT which contradicts previous isolated findings (Scotto Di Cesare, 2013). Considering the kinematic characteristics of reaching (e.g. movement time) have previously been shown to be unchanged with posture, further insight is necessary into segmental coordination and feedforward postural muscle activity to determine how saccadic reaction time may influence movement initiation.

P1-H-44 Changes of smoothness at the center of mass and foot by walking speeds

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BACKGROUND AND AIM: Based on the minimum jerk theory (or maximum smoothness theory), the most spontaneous or skillful motion occurs at the end-point of the movement with maximum smoothness [1]. The smoothness can be quantified by using the jerk, which is defined as the rate of change of acceleration with respect to time. In walking study, the theory has been applied to the end of the limbs (i.e. foot and hand movement). In one of the examples, it has been reported that the foot movement of runners while walking were smoother than those of normal subjects [2]. In general, it has been known that the walking is very efficient movement in human. The energy expenditure may be very similar to the movement at center of mass (COM). In other words, the smooth control of the COM must be one of the most important factors in terms of energy consumption and gait feedback mechanism. Thus it was assumed that it could be found the important characteristics of the smoothness at the body COM as well as the end trajectory (i.e. foot). Therefore, the purpose of this study was to compare the smoothness at the foot and the body COM while over-ground walking with five different speeds. METHODS: Ten male subjects without any disorder on lower extremities participated in this experiment (age: 25.1±1.6 years, height: 176.7±5.0 cm, weight: 71.8±9.7 kg). They were walked on 30 meters in length corridor with five different walking speeds: slowest (SSW), slow (SW), preferred walking speed (PWS), fast (FW) and fastest (FFW) speed walking. To acquire walking speed, stride length, and body acceleration at the lumbar (L4~5) and top of the right foot, Mobility Lab. system (APDM, Inc. OR, USA) was used. The lumbar location was used as the COM in this experiment. To quantify the smoothness of foot and COM movement, the normalized jerk (NJ) was used. RESULTS: Table 1 showed the actual walking speeds and the ratio for the PWS (%PWS). Fig. 1 showed the normalized jerk at the foot and the COM. As the walking speed increases, the smoothness at the foot was shown as increasing pattern (i.e.: decreasing NJ). In contrast, the smoothness at the COM showed the quadratic pattern with minimum NJ value (i.e.: the smoothest) at the FW speed. CONCLUSIONS: In general, the relationship between the energy expenditure and speeds can be represented using a quadratic equation, which has the minimum point at the 'optimal walking speed' [3]. The results showed that the tendency of the smoothness at the COM while walking is very similar to that of the energy expenditure. To clarify the relationship between smoothness and energy expenditure, further study is necessary to perform the measurement of energy consumption and motion, simultaneously. REFERENCES: [1] Hogan, N. (1984). Journal of Neuroscience 4(11): 2745-2754. [2] A. Hreljac (2000). Gait & Posture 11(3): 199-206. [3] Saibene, F. and A. E. Minetti (2003). European Journal of Applied Physiology 88: 297-316.

P1-H-45 Timing of turn to sit Timed Up and Go Subtasks in Parkinson's Disease

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INTRODUCTION-Motor impairments are common in Parkinson's disease (PD) and can affect the timing of movement. We recently evaluated the timing of the turn to sit subtask of the Timed Up and Go (TUG) in community dwelling older adults without PD (n=1159, 80±8 yrs). 75% of the elderly employed a distinct mobility strategy (DMS), in which first turning is completed and only then sitting begins. The other subjects employed an overlapping mobility strategy (OMS), in which part of the turning and sitting take place concurrently. Longer separation (D-interval[s]) between tasks in DMS and longer overlap (O-interval[s]) in OMS were related to worse mobility, cognition and parkinsonian scores. Here we aimed to better understand the factors that contribute to the duration and choice of strategy by comparing our previous results in older adults to those in healthy young adults and in patients with PD. METHODS-29 healthy young adults (28.10±4.22 yrs, 51.7% female) and 92 patients with PD (63.90±9.17 yrs, 22% female, UPDRS motor sum "off": 39.9±13.2) performed the TUG while wearing a body-fixed sensor on the lower back. Patients with PD performed the trial on and off medications. The type of strategy, O-intervals and D-intervals were quantified. We compared the clinical characteristics of the OMS and DMS PD groups with and without medications. Group comparisons were performed using Chi-square, Student's t-test or Mann-Whitney test, as appropriate. RESULTS-Similar to older adults, most of the young adults (66%) employed the DMS strategy (young versus old p=0.113). In contrast, only 37% of the PD group (both on and off) employed the DMS strategy (p<0.0001 compared to elderly). The young adults exhibited a significantly shorter D-interval compared to the elderly (p=0.0002) and tendency for a shorter O-interval (p=0.147). In the PD OMS group, a higher O-interval was associated with a higher posture score (on) (p=0.044), and a tendency for higher rigidity score (p=0.055, 0.075 on and off, respectively). In patients who employed the same strategy both on and off (DMS: n=18, OMS: n=49), no significant difference was found between the on and off D-intervals or O-intervals (p>0.75). Patients who switched from OMS at off to DMS at on (n=13) showed significantly smaller D-interval and O-intervals at on and off respectively (p<0.005), compared to other patients. CONCLUSIONS-Patients with PD are more likely to overlap between their turning and sitting movements compared to healthy young and older adults. This may reflect a loss of control that is not mediated by dopamine. However, aging per se does not appear to influence this choice. Longer O-intervals and D-intervals seem to be affected by age, but not to anti-parkinsonian medications. People who employ a shorter (i.e. better) O-interval while off also employ shorter (i.e. better) D-interval at on when they switch strategies. A body-worn sensor can provide sensitive metrics about the timing of mobility subtasks in PD.

P1-H-46 THE NEURAL ORIGIN OF SWITCHES IN COORDINATION OF ARM AND LEG MOVEMENTS DURING WALKING

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Background and aim Humans walk bipedally, with arms that swing when they are not involved in voluntary tasks. As humans increase walking speed, there is a concurrent transition in the frequency ratio between arm and leg movements from 2:1 to 1:1 and in the phase relationship between the movements of the two arms from in-phase to out-of-phase. The coordination between arms and legs appear to conform to strict rules, which appear "hard-wired" in the CNS as a remnant of privileged connections used in locomotion. This hints at neural networks being responsible for arm swing. Wagenaar et al. (2000) proposed that changes in frequency-coupling and phase relations discriminate patterns of coordination within the human walking mode. Whether this transition is a mere by-product of the mechanical constraints of walking using multiple segments, or if it is coded in the nervous system is, as of yet, an open question. Methods Subjects walked on a treadmill at different controlled speeds (1 km/h to 4 km/h in steps of 0.5 km/h). They were not instructed to swing in any particular way. Additional trials were recorded as 'ramp speed condition', in which velocity was gradually increased and then decreased within the range 1-4 km/h in steps of 0.5 km/h (each velocity had to be maintained for 10 strides). Two sets of 'ramp speed conditions' were recorded: one with natural arm swing and another one in which arms were crossed. We recorded: bilateral kinematic of limb and arm movement; 32 bilateral limb, trunk and arm muscles; and whole-head EEG. Results Amplitude of arm movements and EMG activity increased with increasing belt velocity. Dominant frequencies of arm movements coincided in the lower walking speed range with the step frequencies, and in the higher walking speed range with the stride frequencies. Although these changes in frequency coupling were observed in all the subjects, differences between subjects emerged in the transition phase. Some subjects showed a change from step-to-stride synchronization symmetrically in both arms, while others showed asymmetry between arms. The 'crossed arm' condition did not completely abolish activity of arm and shoulder muscles. Nonnegative matrix factorization (NNMF) was used to determine the general design of the motor output in the human walking mode. Preliminary analyses revealed changes in the muscle synergies as a function of the walking mode and similar muscle synergies for the normal arm swing and the crossed arm condition. Conclusion Common temporal activation patterns, in the two arm conditions, represent an effective motor control strategy. The persistent muscle activity that we found to some extent even when the arm was immobilized implies that lower and upper limb muscle activations are coupled during human walking. This seems to support the concept that coordinated movements of legs and arms are generated by coupled segmental networks of the spinal cord, which are influenced by higher CNS centers.

P1-H-47 Effects of speed of walking on the accuracy of foot placement control

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Background:Time constraints are known to deleteriously affect a person's ability to adjust footfall location, such as when trying to avoid obstacles, in both healthy and clinical populations [1]. Speed-accuracy trade-offs in stepping movements are well known [e.g. 2], however, these have been examined only in discrete individual steps from standing rather than walking. Aim: To measure effect of gait speed on the accuracy of foot-placement control. Method:Ten healthy young participants (mean±SD age 27 ±5 yrs; 5 male) stepped to targets at three speeds (self-selected (SSWS), fast (SSWS%2B20%) and slow (SSWS-20%)) on a force instrumented treadmill (C-Mill). Targets were projected onto the treadmill at participants' step length and width at each walking speed. Target sizes were: large (60cm deep x40cm wide; no accuracy constraint) or small (length and width of the individual's shoe, accuracy constrained). Targets were presented in semi-randomised order at a ratio of 3:1 (large to small targets) for left and right legs. Small targets were presented at locations 10% shorter or longer than normal step length (counterbalanced) to ensure participants actively controlled foot placement to the target. Two blocks of 64 steps (16 small) were performed at each walking speed in random order. Targets were visible two steps in advance. Error in footfall location was measured as distance in anterioposterior (AP) and mediolateral (ML) directions from centre of pressure (COP) to the centre of the target during mid-stance. Results: AP errors were greater at fast compared to slow speed ($F(2,18)=12.56$; $p<0.001$). An interaction of speed and step length indicated AP-error was smaller ($F(1,9)=12.97$; $p=0.006$) when stepping to short targets slowly than making short or long steps at either fast or SSWS. Variability in AP error was greater ($F(2,18)=5.64$; $p=0.013$) at fast compared to slow speed. Overall ML error was much smaller than AP-error (9.7 ± 18mm; -48 ± 22mm). Variability in ML error was higher at fast compared to slow and SSWS ($F(2,18)=7.76$; $p=0.004$), see Figure 1. Discussion: Walking slowly reduces AP error when stepping to shortened accuracy-constrained steps. Overall, walking quickly increased stepping AP error compared to walking slowly, with the greatest error lengthening steps at fast speed. ML-error was small relative to AP error and was not affected by speed or the direction of target shift. Error in ML footfall placement may be tightly controlled to maintain balance. Further research is needed to explore the effects of age and stroke related disability on control of footfall location under varying speed and

accuracy constraints. Motor control of these types of target walking paradigms may have practical implications for gait rehabilitation techniques that use modifications of stepping accuracy and/or speed to stimulate recovery. References: 1.Van Swigchem R. et al. Phys Ther. 2014;94(5):654-63. 2. Uemura K et al. Hum Move Sci. 2013;32(6):1393-403.

P1-H-48 Reactive stepping ability in healthy adults as a control comparison for stroke survivors.

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BACKGROUND AND AIM:Stroke survivors have difficulty adjusting foot-placement to step over obstacles or step medially and impairments are worse under time pressure [1-2]. Unlike older adults, young adults are able to make medial adjustments in response to stepping cues as late as mid-swing. The extent to which online step length adjustments can be made in healthy young and older adults and stroke survivors is not known. AIM: To compare the control of reactive and planned anterior-posterior (AP) and mediolateral (ML) stepping adjustments in healthy young and older adults to stroke survivors. Presented here is data from young adults.METHODS:Healthy young adults (n=10, 5 males, mean±SD age 27.3±5.1yrs) stepped to targets projected on a force-instrumented treadmill (CMill) while walking at comfortable speed. Targets were either visible two steps ahead (planned) or at late stance of the aiming foot (reactive). Targets (8cm deep x 40cm wide) were placed to elicit lengthening or shortening of steps (±25% of baseline step lengths) and narrowing (20cm deep x 15cm wide on the midline of the treadmill). Three targets of each step condition were presented in random order, interspersed by targets coinciding with usual step lengths and widths (totalling 60 steps). Target dimensions coincide with the variability in step parameters previously reported in stroke survivors [3] such that targets should only be missed if error in footplacement exceeds usual variability. Error in footplacement was measured as distance (in ML direction for narrow steps and AP direction for short/long steps) from centre of pressure to the centre of the target during midstance.RESULTS:ML errors in narrow steps were not different in either the reactive or planned conditions (mean ± SD: 0.001 ± 0.060m; -.0.019 ± 0.044m respectively). A significant interaction effect between timing (reactive and planned) and length of step adjustment (short vs long) indicates significantly (p=.004 $F(3,27) = 14.50$) larger AP errors in long steps in both reactive and pre-planned conditions than for short steps. Short steps were undershot in the reactive condition and overshot in the planned condition (Figure 1).CONCLUSIONS:Significantly larger errors in long steps indicates greater difficulty lengthening than shortening steps. Short step adjustments were undershot in the reactive condition. Ongoing data collection and analysis will examine how older adults and stroke survivors perform on this task and the relevance of target stepping as a measurement paradigm for gait adaptability in patient groups. The paradigm is sensitive enough to detect small but significant differences in the stepping performance of young healthy adults. Therefore we are well placed to identify the anticipated much larger differences in stroke patients. This data analysis is currently underway and will also be presented at the meeting.

P1-H-49 ANGULAR BALANCE CONTROL AS A GAIT REHABILITATION TARGET POST STROKE

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BACKGROUND AND AIM: Humans with post-stroke hemiparesis often have difficulty walking. Walking within a body-weight support harness has been shown to produce rapid improvements in walking kinematics, however, extended training in this environment has failed to produce expected long-term gains. Those observations are inconsistent with currently published perspectives of how stroke disrupts walking. We postulate a novel mechanism that accounts for those observations and other post-stroke walking behaviors. Central to this thesis is a specific mis-coordination of leg muscles that disrupts the ability to retain upright posture. We hypothesize that the body-weight support harness provides angular motion constraint that offsets the postural disruption allowing natural kinematics to emerge. METHODS: This study tests that hypothesis by observing the behavior of individuals affected by stroke while they walk in a custom harness that provides angular motion constraint but no body-weight support. Eight individuals with post-stroke hemiparesis gave informed consent to walk on a treadmill while in a safety harness that was adjusted to exert no force on the participant. The participants performed two walking tasks: 1) unsupported walking at their preferred speed and 2) with the angular constraint harness walking at the same speed. Each task was performed for two to three minutes. We quantified stepping kinematics by measuring the anterior-posterior position of each foot. Mounted above the treadmill, our custom harness system constrained horizontal translation of the torso, as well as pitch and roll rotation, but did not apply any vertical support. The system consisted of eight horizontal elastic cords, four attached to a hip belt and four attached to a shoulder harness. The cords were separated by 90° from each other and oriented 45° off the frontal and sagittal planes. The distal ends of the ~1.5m cords were attached to rigid anchors. The system allowed normal body sway associated with normal walking while securely preventing the participant from tipping beyond ~10°, with a non-linear increase in force with body tilt. RESULTS: This study demonstrated the feasibility of implementing a harness system that does not support body weight but does stabilize torso motion in the horizontal translational, pitch, and roll degrees-of-freedom. Five of the participants responded to the harness with a significant reduction in temporal and spatial stepping kinematic deviations. Two showed no change and one a slight increase in gait deviations. CONCLUSIONS: The results of this study support our hypothesis that improved walking kinematics can be achieved while in a balance-stabilizing harness in the absence of weight support. This finding contributes additional evidence for our postulated gait disruption mechanism and suggests that future therapy should be directed at correcting the underlying mechanism rather than addressing kinematic deviations.

P1-I-51 Cognitive and sensorimotor interference while walking : a study in adolescent girls

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Background and aim: Better understanding adolescence may have a clinical significance for many developmental pathologies due to the fact that sensorimotor development is not linear and that adolescence may be a specific phase in the development of postural control. Indeed, the body undergoes many physical changes during adolescence that necessitate an updating of internal models of action. There is clear evidence that both children and adults stabilize head in space to ensure the adequate execution of various daily activities, especially walking. The present study investigated whether this skill is affected by the large and sudden body-related changes that occur during adolescence. Methods: Twenty adolescent girls (mean= 14.8±1.1 years) walked overground or on a narrow support. In addition to varying balance constraints, changes in visual (eyes open or closed) and cognitive (naming backward the months of the year) requirements were also applied. The dual-task conditions serve to complexify walking in order to better explore the balance strategies repertoire. Kinematics of foot, pelvis, trunk, shoulder and head were measured with a motion capture system in order to calculate locomotor parameters as well as angular dispersions and segmental stabilizations. Results: A first result is a decreased speed and stride length when walking becomes more demanding, whatever the sensorimotor or cognitive constraints. Moreover, the segmental stabilization strategies remain unchanged under single- and dual-task overground walking, involving a systematic stabilization of pelvis and shoulder in space while the head stabilization strategy is transitory lost. In contrast, the head stabilization in space strategy is re-selected under increased balance constraint of the narrow support, with a stronger stabilization under dual-task conditions. Conclusion: Our findings demonstrate a nonlinear development of the head control during locomotion, with a turning point at the time of adolescence. Dual-tasking appears as a revelant tool to investigate the selection of specific balance strategies during critical developmental periods.

P1-I-52 The effect of age and coordination on gait propulsion strategy in primary school aged children

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BACKGROUND AND AIM: Children with Developmental Coordination Disorder (DCD) aged nine to 13 years have a different running propulsion strategy compared with typically developing (TD) children of the same age. Propulsion strategy (PS) describes the proportional use of ankle push-off power relative to hip pull through power during late stance/early swing in gait. It has been hypothesised that the

reduced running PS in children with DCD reflects an immaturity of motor skill development evidenced by suboptimal ankle power generation at push-off. However, the normal development of PS in TD children younger than nine years has yet to be established. This study aimed to investigate this gait immaturity hypothesis by comparing the PS of i) six to nine year old TD with nine to 13 year old TD children, and then ii) six to nine year old TD children with nine to 13 year old children with DCD. METHODS: 15 TD children aged six to nine years (TD younger), 17 TD children aged nine to 13 years (TD older), and 12 children with DCD aged nine to 13 years (DCD older) participated in the study. Peak ankle power generation at push-off (A2) and peak hip power generation at early swing (H3) were calculated using inverse dynamics for normal walking, fast walking, jogging and sprinting from three-dimensional motion analysis and force plate data. PS was calculated as peak A2/(peak A2 %2B peak H3). RESULTS: Younger and older TD children used the same PS when running (TD younger 0.73 (95% CI 0.69 - 0.77); TD older 0.74 (95% CI 0.71 - 0.77)). However, children with DCD demonstrated a reduced PS compared with both younger and older TD groups (0.635 (95% CI 0.6 - 0.67)) through using relatively more hip power generation at early swing. In walking differences were less clear. Post hoc analysis revealed that at slower walking speeds the three groups were relatively similar in terms of PS, however, at faster walking speeds the older TD children maintained a higher PS than both the older children with DCD and the younger TD children. CONCLUSION: The findings of the study reveal that propulsion in running matures as early as six years of age, as six to nine year old and nine to 13 year old TD children demonstrated the same running strategy. This is surprising as it has been suggested that running skill matures in later childhood. The gait immaturity hypothesis is not supported as the children with DCD adopted a different, rather than immature, running PS. Six to nine year old TD children have a different, more ankle based PS compared with nine to 13 year old children with DCD. The ankle based strategy focussing on push-off is efficient because it utilises recycled elastic energy. When this strategy is not optimised, then propulsion needs to be supplemented by additional hip flexor pull through of the swinging limb. Fast walking may require greater skill than running, as younger children and children with DCD were less effective at maintaining ankle power as walking speed increase

P1-J-53 Change in standing postural control and physical functions with 6-months physical exercise in children with mild developmental disorders

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[Background and aim] Children with mild developmental disorders may show reduced muscle tension, decreased agility of limbs and concomitant reduced hypersensitivity of foot soles, which may delay development of physical functions. We assessed the effect of exercise on upright postural balance ability in children with mild developmental disorders. [Methods] Subjects comprised 11 children with mild developmental disorders (mean age 5.0, range 4∸6 yrs). Informed written consent was obtained from their parents. Postural balance was measured by Gravicorder GS-31P stabilometer (Anima Co.) during two trials of 30-s under condition of static upright posture with eyes open. The data sampling frequency was 20 Hz. Measurements were made before and after 6-months of one hour weekly exercise performed as group activity including, balance and rhythm exercises, free play, and mother and child play. Pre- and post-measurements were analyzed using Wilcoxon test, SPSS ver21. Differences with P<.05 were considered significant. [Results] With eyes open, trajectory length(LNG) was 182.8(128.3)cm[mean(SD)], 128(68.7)cm; LNG/time 6.9(5.1)cm/sec , 4.3(2.3)cm/sec; anteroposterior LNG 119.6(78.1)cm , 82.4(37.8)cm; anteroposterior LNG/time, 4.6(3.4)cm/sec , 2.7(1.3)cm/sec; ENV.AREA 39.3(41.2)cm2 , 21.2(23.6)cm2; before and after 6 months respectively(p<.05). [Conclusion] Research on physical development of children with mild developmental disorders is insufficient. It known that such development in children with mild developmental disorders is slower than in normal healthy children. After six-months of one hour per week group physical activity, instability decreased anteroposteriorly,, and radially which is an index of the general center of gravity, suggesting improvement in standing balance and physical strength. Physical activity including balance and rhythm exercises in weekly filioparental group activity from an early age may help offset delay of physical development in children with mild developmental disorders.

P1-K-54 The Immediate and Long term effects of Hart walker in an adult with cerebral palsy

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BACKGROUND AND AIM: Deformity prevention and contracture care is essential in adult patients with cerebral palsy (CP) . We intervened with Hart Walker (HW) in an adult with CP and reviewed the immediate and long term effects in the range of motion of the lower limb, distance and kinematic parameters in gait. METHODS: Case: A 30 year old male with cerebral palsy (spastic quadriplegia , dominate side: left, GMFCS level: IV). Indoor movements were by crawling and outdoors were by a wheel chair with assistance. He attended a social welfare labor facility. We intervened with the HW from July 2005 . Daily life patterns were fixed, pre to post intervention of the HW. This case was specifically selected due to the absence of existing influence from other intervening factors such as medical treatments. Methods: The hip joint range of motion (ROM) was measured five times(11/05,10/06,09/07,03/09,10/11). Three dimensional (3-D) analysis was performed by VICON 370 system (Oxford metrics) four times(10/06,09/07,03/09,10/11) . Markers were placed on 12 parts of the patient's body and 3 on the HW instrument itself. Average gait speed, cadence, stride length, trunk tilt angle, trunk lateral tilt angle, hip/knee flex and extension angles were extracted from the 3-D

measurement data. All the three measurements were adopted. This study was approved by the Research Ethics Committee of Showa University. Written informed consent was obtained from the Subject. RESULTS: The immediate effects was detected in the extension of knee/hip extension angles, P-angle, ankle extension angle (relief of muscle tone). As a long term effect, the knee extension angle expanded but no other significant changes were seen in other ranges. Gait speed between first and second time points improved from 9.1 to 29.9m/min and the cadence values from 49.6 to 139.6 steps/min. The hip flexion angle decreased and extension angle increased. The left side movement range decreased and the right increased. Gait improved for the first 2years, but then deteriorated , because of mal-fitting of HW. The gait improved after the readjustment of HW. CONCLUSIONS: The lower limb muscle tone relieved immediately, suggesting muscle tone containment effects of the HW. The long term effect of ROM was seen in the knee joint. This effect may be due to the suspension mechanism of HW and repetitive desirable movements, presumably due to the restriction of degree of freedom with HW. In adult CP patients, the Hamstring is considered to become target of orthopedic interventions, but gait with the HW might maintain gait function through muscle length preservation.

P1-K-55 Differential influence of postural remediation insoles on the postural Maddox rod test

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Introduction: In podiatry, there are two different types of insoles: flat (F) or thermomoulded (T) [1]. They are used in different foot concepts: mechanical, proprioceptive and postural remediation. Regarding the concept of postural remediation, several clinical trials are used to validate the podiatric treatment: the posturodynamic clinical test, Postural Maddox rod test [2]. In clinical practice, we can see a change after the treatment of the podal system remediation. Aim: We are interested in the effects induced by the postural remediation treatment according to the F and T insoles on Postural Maddox rod test. Methods: The study used 30 subjects. The treatment of postural remediation determined by clinical examination for each subject was transcribed on both types of insoles (F and T). To evaluate Postural Maddox rod test, we used our qualitative clinical procedure: the positions of the thumbs. If the streak did pass through the middle of the fixation light (orthophoria), thumbs were horizontal (report 0). If the streak did not pass through the middle of the fixation light (vertical heterophoria), then hyperphoria caused thumbs to be down (+1) and hypophoria caused thumbs to be up (-1). Postural Maddox rod was carried out in 3 situations: control (C); flat postural remediation insole (FM) and thermomoulded postural remediation insoles (TM) immediately and after 4/6 weeks. Results: The results reveal a decrease in postural Maddox scores regardless of the type of insole (FM or TM). They decrease the vertical phorias. The reduction is more important for TM than FM. Setting up to 4/6 weeks: the postural remediation treatment is increasing the number of subjects with orthophoria especially with TM (postural remediation on thermomoulded insoles). Discussion: PM and TM are used in postural remediation treatments on subjects with postural disorders and instability or balance problem where vertical phoria is noticed [2]. Those specific postural stimulations modified the afferent information and induced better posture control. This postural improvement reduced vertical phoria. The difference between the two types of insoles relates to the amount of afferent sensory information they recruit, while correcting the podal system [1]. TM recruits more quantity than FM. This additional quantity of afferent cue provides a variation on the Maddox Postural causing a substantial improvement. Conclusion: The treatment of postural remediation can be achieved with both FM and TM. With the same stimulation, the result of the balance sheet is transcribed variably on both types of insoles. Maddox Postural is amended by PM and TM, however TM provides the best results on orthophoria.

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P1-K-56 The effects of vibrotactile cuing on recovery performance from treadmill-induced trip in healthy young adults

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BACKGROUND AND AIM: Multiple studies show that fall recovery training on an instrumented treadmill which incorporates mechanical obstacles improves recovery performance in healthy young and older adults. Currently used perturbation-delivery technologies are impractical in clinical training regimens due to system complexity and the need to incorporate mechanical obstacles. This study devised an experimental system to evaluate the effects of vibrotactile intervention as predictive cuing on recovery performance after a treadmill-induced trip perturbation. METHODS: The developed system induced a trip using a gait phase detection algorithm during a walk on a split-belt treadmill and provided predictive intervention via vibrotactile cuing before the trip. The proof-of-concept tested healthy young adults (24.7±3.2 yrs; 4 females, 6 males). Each participant wore a safety harness and 24 reflective passive markers, and 3 vibrating actuators were placed on the skin over the left lateral head of triceps brachii, left external oblique, and left fibularis longus muscles. The participants walked at self-selected speeds on the split-belt treadmill. Eight trials consisting of 1 trial without vibrotactile cuing followed by 6 trials with vibrotactile cuing (2 lead time X 3 cuing locations), and by 1 trial without vibrotactile cuing were performed. Vibrotactile cuing was provided to one of three body locations, and either 250 or 500 ms prior to the time of the trip perturbation (lead time). The lead time and body locations for vibrotactile cuing were randomized during trials with vibrotactile cuing. In each trial, a trip perturbation was provided to the participant's non-dominant foot by stopping the corresponding belt at the start of the loading phase occurring at approximately 10% of the gait cycle. The stopped belt returned to the previous speed when the participant's dominant foot's first heel strike occurred. No information about

the timing of the trip perturbation, lead time, and body location was provided. RESULTS: When vibrotactile cuing was available, all participants significantly improved recovery performance from the trip by reducing response step time, maximum response step force, recovery time, maximum whole body center of mass (COM) position, maximum whole body COM velocity, maximum trunk flexion angle, and maximum trunk flexion velocity. The beneficial effects of vibrotactile cuing were independent of the lead time and body location conditions. CONCLUSIONS: The results suggest that vibrotactile cuing as predictive information can improve recovery from a trip perturbation in healthy adults. Non-significant effects of either lead time or body location for the application of vibrotactile cuing on recovery performance indicate that cuing can be effectively applied to any body segment immediately prior to a trip perturbation. The proposed system has applications for the clinical training of high-risk individuals.

P1-K-57 Influence of Insole Types, with or without Anterior Bar Stimulation, on Postural Control.

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Title: Influence of Insole Types, with or without Anterior Bar Stimulation, on Postural Control. Sophie Loureau1, Marc Janin2,3 1 Podiatrist, 42 rue du Prieuré Saint Thomas, 28230 Epernon, France. 2 PhD, Podiatrist, 7 rue de Treguel, 86000 Poitiers, France. 3 Applied Podiatry College, 7 rue de Treguel, 86000 Poitiers, France. Corresponding author: Sophie Loureau mail: sophie.loureau@wanadoo.fr Presentation format: poster Introduction: In clinical podiatry, we dispose of two types of insoles, flat (F) or thermomoulded (T) [1]. We can associate these, or not, with plantar stimulation such as a pressure relief insole: anterior bar (BA) [2]. Stimulation with F and T activates various plantar afferent cues, which produce different plantar sensory feedback from the podal system [1]. A BA element induces specific plantar mechanoreceptor stimulation. As a result, motor response depends on this stimulation [2]. We are interested in the effects produced by these stimuli, combined or not, through pressure distribution and ground forces reaction (GFR) on a medio-lateral plan (left/right). Methods: We recorded the medial repartition of the Center Of Pressure (COP, left/right distribution, %) and the position of GFR (mm), under each foot of 10 subjects, using a baro-stabilo-podometrie platform (Fusyo3, Medicapteurs, France, 40 Hz, 30 s, subject shod). We compared these results for 4 sensory variation conditions: flat without BA (F), flat with BA (FBA), thermoulded without BA (T), and thermoulded with BA (TBA), with the condition control (C). Results: All sensory variations change COP and GFR. The results obtained with flat insoles (F) are more surprising because no increase of plantar sensory information, neither specific stimulation (BA) differentiates it from C. The variation of plantar sensory information induced by thermomoulded (T; TBA) leads to the most significant modification by enlarging the recruitment induced by thermomoulded (medial arch contact). A dissociation of medial position between COP and GFR appears for FBA and T: COP moves on the right hand side, while GFR remains on the left one (see figure). Conclusions: All stimulations induce a change in the sensorimotor feedback resulting in an adjustment of the subject's posture. This variation would cause dissociation of the biomechanical referents regardless of stimulation (FBA and T). So that would suggest that this reaction is dependent on the quality/quantity of the podal system afferent. BA stimulation induces a different effect depending on the insoles F or T on which it is positioned. Bibliography: 1. Christovão et al. 2013. Effect of Different Insoles on Postural Balance: A Systematic Review. J Phys Ther Sci. 25;10:1353-1356. 2. Janin, Toussaint. 2005. Change in center of pressure with stimulations via anterior orthotic devices. Gait & Posture, 21;1.S79 .

P1-K-58 The Effects of Attractive vs. Repulsive Instructional Cuing on Balance Performance

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BACKGROUND AND AIM: Torso-based vibrotactile feedback has been shown to improve postural performance during quiet and perturbed stance. Vibrotactile displays typically include an array of tactors distributed around the torso accompanied by instructions to "move away from the vibration" (i.e., repulsive cuing strategy), serve as "alarm" signals to indicate body movement, and require volitional postural responses. However, volitional postural responses to alarm signals may be incongruous with the kinesthetic messages from tactile receptors stimulated. Recent studies have shown that in the absence of instructions, subjects make small (~1°) non-volitional responses in the direction of vibration when vibrations are applied to the skin over the internal oblique (IO) and erector spinae (ES) muscle locations. An attractive cuing strategy (i.e., "move toward the vibration") leveraging this "natural" tendency may facilitate postural adjustments. The purpose of this study was to characterize the effects of cuing strategy on postural performance. METHODS: Six healthy older adults participated in a pilot study including two non-consecutive days of computerized dynamic posturography testing. Four tactors were placed on the torso over the right and left IO (front) and right and left ES (back) locations, and were activated in pairs when the torso inclination, measured by an IMU, exceeded a 1° threshold in either the front or back directions. A randomized, controlled crossover design was used and participants performed 24 repetitions of SOT 5 on each test day. Performance metrics included root mean square sway, percentage time within a 1° zone, and maximum and average peak-to-peak torso inclination angles. Cuing strategy preferences were collected using a questionnaire. RESULTS: Although not statistically significant, repulsive cues produced slightly better performance across all metrics. However, the slopes of the linear least squares fits to the averaged results on a per metric basis were steeper for all performance metrics (i.e., participants' performance improved at a faster rate) when attractive cues were used. Regardless of cue type, participants improved at a faster rate across trials on the first compared to the second testing day. Four out of six participants indicated that they preferred using repulsive cues. CONCLUSIONS: Performance improved with both cuing strategies; however, participants performed slightly better when using repulsive cues regardless of whether they completed repulsive cuing trials on the first or second day of testing. The results suggest that when a sensory signal is attributed an "alarm" significance, the corresponding messages are interpreted according to the cognitive assignation and not as the natural feedback. The findings support the use of a repulsive cuing strategy for short-term balance applications. However, performance may be as good if not better using attractive cues after an extended training period.

P1-K-59 Influence of vibrating lower-leg tendon for gait in patients with diabetic neuropathy

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Background and aim: Walking is one of basic motion of human daily life. The basic gait motion uses various senses such as visual, vestibular and somatic sensation to know posture and the surrounding with human body. We focused on deep sensibility which acts on sense of position and sense of movement in the sensors group. The motion illusion phenomenon induced by vibration stimulation with deep part mechanoreceptors such as muscle spindle and tendon spindle, and this phenomenon influences adjustment of the joint angle. The purpose of this study is to investigate the effect of tendon vibration in lower-leg during a walk. The influences of the gait motion are different in the plantar tactile sensibility of subjects with diabetic neuropathy. 10 elderly people males with diabetic neuropathy of different symptoms (age: 64.0±27.0 year, weight: 64.35±24.15 [kg]) were recruited in this study to investigate that the relation between plantar tactile sensitivity and tendon vibration stimulus for gait motion. Methods: The step time is measured by the 3-axis accelerometer attached on the lumbar spine part three (L3). And the vibration devise attached on tendon of the tibialis anterior muscle. The vibration max amplitude of this device is about 2.4[mm] with a sine wave. This vibration frequency is about 100 [Hz]. In this study, the step time calculate from heel contact to next heel contact. The subjects walk self-select velocity with/without tendon vibration on 10 [m] walkway in 10 times each condition. The tactiles sensitivity of the subjects were measured by using SWM (Semmes-Weinstein Monofilament). Results: The tendon vibration walking compared with self-select walking by using two-sample t-test. The subjects are divided into four different sensitivity groups by using SWM data (groups: Normal, Diminished light touch, Diminished protective sensation, Loss of protective sensation). The statistical results show no significant difference on the tendon of the tibialis anterior muscle in all subjects. However, the step time is significantly reduced ($p<0.01$) by particular group of "Loss of protective sensation". Conclusions: We focused on deep sensibility and aimed to induce motion illusion phenomenon at ankle joint by vibration stimulus. The step length is significantly reduced by some particular group with tendon vibration walking compared with self-select walking. The subjects with decreased plantar tactile sensibility and ankle joint function during a walk are particularly sensitive to vibration stimulus. The tendon spindle is engaged in deep sensibility, and is excited by vibration stimulus on the tibialis anterior muscle tendon. The experimental results suggest that the small vibration stimulus can be induced by displacement of human motion.

P1-K-60 Balancing a book on the head may improve postural control

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Recently technical devices have been developed and used in rehabilitation of patients suffering from postural problems of various etiologies. The technology is based upon creating external feedback postural cues enhancing postural control. In theory balancing a book on the head would also yield extrinsic gravitational cues as well as intrinsic, proprioceptive enhancement to the postural control system. We tested 12 healthy volunteers (7 male, 5 female), aged 20-45 years, with and without balancing a book on the head, standing on a force platform while being subjected to vibratory simulation to the calf-muscles of the leg. The test conditions were randomized in order to account for simple order effects; with eyes open or closed and balancing a book on the head or not. Balancing a book stabilized postural sway when the eyes were open, predominantly by reducing the anteroposterior swaypath and by decreasing the slow compensatory postural adjustments <0.1Hz ($p<0.01$). The fact that balancing a book on the head stabilizes postural sway could constitute a new and tantalizingly easy method of postural rehabilitation, the effect possibly attributed to external sensory information or that the balancing act diverted attention from maintaining postural control (i.e. balancing a book constitutes a cognitive task). Because of the simplicity and the low cost involved enables the intervention to be available everywhere, which ought to be attractive from a postural rehabilitation perspective, however the effect on patients with postural problems remains to be tested.

P1-L-61 Pre- and unplanned walking turns in Parkinson´s disease - effects of anti-parkinson medication

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BACKGROUND AND AIM: Although anti-parkinson medication improves linear walking in individuals with Parkinson's disease (PD), it is not clear whether it improves turning. Therefore, the aim of this study was to investigate spatial step regulation and turning performance during preplanned and unplanned walking turns in PD, compared to healthy controls. Our hypothesis was that medication would enhance spatial stepping and thereby improve turning performance. METHOD: Nineteen individuals with PD (7 females; mean age: 71 years; range: 69-72) and 19 healthy controls (7 females; mean age: 72 years; range 65-87) participated in this study. The PD group had a Hoehn & Yahr score of 2 to 3, average disease duration of 5 years (range 1-17) and were all independent ambulators. None of the participants suffered from dyskinesia, dizziness or any other conditions affecting gait. Three-dimensional position of retro-reflective markers positioned on the trunk and feet segments was recorded. Participants walked at normal pace, through a 9-meter T-shape walking alley where the turning position was delineated by 2 poles. They performed one of 3 tasks: walking straight, or performing a right or left 135° turn. In the preplanned condition, the walking direction was provided with a visual signal prior to walking initiation. In the unplanned condition the same visual signal occurred during steady state walking (0.6m prior to the intersection point). Participants were tested after overnight withdrawal of medication (OFF) and approximately one hour after taking their usual dose of medication (ON). Outcomes were turning strategy (step and spin turns), velocity and spatial gait parameters (averaged for the first 3 turning steps and normalized to straight walking). As a proxy for the efficiency of turning, we used the maximum re-rotation of the pelvis segment (after 3 turning steps). Data for right and left turns were averaged for all outcomes. Within-effects (PD-OFF vs PD-ON) and between group-differences (PD-ON vs Controls) were analyzed with ANOVA ($P<0.05$). RESULTS: Step and spin turns were performed as frequently during pre- (OFF: 48%/50%, ON: 50%/50%) and unplanned turns (OFF: 47%/53%, ON: 53%/47%), $P>0.67$. As illustrated in figure 1, medication improved step width increment during pre- (OFF: 1.74, ON: 2.04, $P=0.05$) and unplanned turns (OFF: 2.13, ON: 2.58, $P=0.02$), whereas step length ($P>0.08$), velocity ($P>0.75$) and the level of re-orientation ($P>0.11$) were unchanged. For both turning conditions, while comparing PD-ON with controls, the PD-group turned with a narrower step width ($P<0.04$, see Figure 1) and showed less efficient pelvis re-orientation ($P<0.01$). CONCLUSIONS: Turning impairments in PD are only partially improved by anti-Parkinson medication. In line with previous findings, we showed that step width regulation, although somewhat improved by medication, is a key feature and a potential source for instability and falls in PD.

P1-L-62 Balance deficits that are selectively dopa-responsive in Parkinson's disease

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BACKGROUND AND AIM: Previous research has suggested that balance impairments may be linked to anxiety in PD, yet when directly investigated by having participants stand on a low platform compared to a high platform, PD made similar postural adjustments as healthy individuals. It is important to note that this previous research excluded PD suffering from anxiety. PD were only tested 'ON' dopaminergic treatment, although dopaminergic treatment has been shown to reduce symptoms of anxiety in PD. Thus, our study aimed to carefully evaluate the influence of dopaminergic medication and anxiety on balance while standing in LOW and HIGH virtual environments, in groups of high and low anxious PD groups. METHODS: 24 individuals with idiopathic PD and 24 healthy older adults were examined. PD participants were divided into high and low trait anxious groups, and tested both ON and OFF

dopaminergic medication. Balance was examined during quiet stance on a force platform where participants completed 5 trials each, in two different virtual reality conditions (total 10 trials, 30 seconds each). In the LOW condition, participants stood on a narrow plank located on the ground, while in the HIGH condition the plank appeared to be high above a deep pit. Average postural deviations in all planes of movement were recorded, in addition to measures in the anterior-posterior and medial-lateral planes to provide both averages and variability scores. Further, self-assessment manikins were used at the end of each trial to record the perceived anxiety of participants. RESULTS: All groups reported significantly greater levels of anxiety when standing in the HIGH condition compared to the LOW (p=0.001), with high anxious PD reporting greater levels of anxiety overall (p=0.018). A condition by group interaction for overall postural stability demonstrated that highly anxious PD had the poorest balance during the HIGH condition (p=0.014), which was driven by greater postural sway in the anterior-posterior plane (p=0.011). All groups demonstrated increased postural sway in the medial-lateral plane during the HIGH condition (p=0.006). Similarly, high anxious PD also had greater postural variability (p=.031), driven by high variability in the anterior-posterior plane (p=0.033). It was found that dopamine significantly reduced self-reported anxiety (p=0.049), and only improved balance in the HIGH condition for low anxious PD (p=0.056). In the medial-lateral planes, balance was improved with medication across all PD individuals in the HIGH condition (p=0.019). CONCLUSION: This study provides evidence that anxiety influences balance control in PD, especially those who are highly anxious. It appears dopaminergic treatment does modulate anxiety's influence on balance or participants ability to adapt when standing in anxious environments, especially in those PD patients who are highly anxious. Further research is needed regarding the clinical implications for fall prevention in PD.

P1-M-63 Implicit Cues and Explicit Motivations Modify Occupational Handling Strategies and Postures

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BACKGROUND AND AIM: Handling is a fundamental motor skill that can be performed through alternative movement combinations depending on the individual, their physical and cognitive states, and the surrounding environment. Manipulations to elements of this context may have opportunity to change behaviours, specifically potentially injurious occupational ergonomics. In addition, eye movements and fixations have been shown to have a direct relationship with the spatial and dimensional aspects of object handling, and targeted visual cues might modify task performance and reduce injury risk. In this pair of experiments, our goal was to study the differences in handling and postures of individuals given various cognitive states and visual cues. We hypothesize that motivation and visual cueing will have a direct impact on handling techniques, and eye tracking will be used to confirm a relationship between visual attraction and ergonomic behaviours. METHODS: In experiment 1,

31 participants (16F) were equipped with a pair of Mobile Eye - XG eye tracking glasses (ASL). Subjects stood in front of a suitcase that was adjusted to be 53% of their height, and were read one of the three scripts (positive, negative or neutral) which would hypothetically motivate them to handle the suitcase in different techniques. Participants' handling techniques and postures were recorded alongside the eye tracking data. In experiment 2, 57 participants (37F) performed a manual materials handling task of pulling a suitcase horizontally. They were asked to place the suitcase at their perceived safe vertical affordance, and then to complete 5 isometric pulling trails. Directional cues (UP, DOWN) were placed on the suitcase in some of the trials. Participants' were recorded to analyse postures in frame of shoulder abduction and lateral trunk flexion. RESULTS: Two main handling postures were observed in experiment 1. For the positive group, preference was given to single hand handling (90% of trials) while the negative and the neutral groups preferred handling with both hands (73% & 63% of trials). An 'Attraction Index' that identifies the strength of eye fixations (number, duration, proximity) was calculated (Figure 1). The front handle had the highest index (4.0) for the positive group, while the left handle (1.9) and the front handle (1.4) had the highest indices for negative and the neutral groups respectively. In experiment 2, cueing did modify maximum shoulder flexion ($f(2,54)=3.595$, $p=0.034$) and maximum lateral trunk flexion ($f(2,54)=4.309$, $p=0.018$) postures. The DOWN directed cue led to significantly greater shoulder and trunk postural deflections. CONCLUSIONS: When carrying out an occupational task, the goal is to perform the task most efficiently, while not compromising on the safety factor. Appropriate motivation and environmental cues may encourage safer ergonomics, and decrease handling - related injuries.

P1-N-64 Gait, muscle strength, and body balance in healthy older adults: differences between younger old and oldest old

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BACKGROUND AND AIM: Older people need to maintain physical function to perform activities of daily living independently. Aspects related to physical function such as gait, muscle strength or body balance typically deteriorated with age, especially in the last years of life. Differences between young adults and olderadults in aspects related to physical function have been widelystudied. However, given that older people comprise a wide range of age, it is necessary to examine differences within the older population.Therefore, the aim of the present study was to compare gait, muscle strength and body balance between the younger old (YO) and the oldest old (OO). METHODS: 55 participants were divided by age in two groups: YO (n=27, 61-71.8yrs) and OO (n=28, 72.3-87yrs). Maximal isometric muscle strength, maximal gait speed and static body balance were assessed. Muscle strength was tested in upper and lower extremities with dynamometers (handgrip and knee extensors at 60 and 90 knee flexion degrees), gait speed was tested in an 8-metters walkway platform and balance was assessed with

a force platform (Dinascan IBV, model 600M) under three conditions: eyes open (EO), eyes closed (EC), and dual task (DT). The balance variables were computed in the anterior-posterior (AP) and medial-lateral (ML) directions. Strength and balance data were normalized by body mass and base of support, respectively. T-test were used for strength and gait variables and two (age groups) by three (balance conditions) ANOVAs were used for balance variables. RESULTS: YO participants presented faster maximal gait speed than OO participants (YO 1.75±0.23 m/s, OO 1.59±0.25 m/s, $p=0.012$). There were no differences in any strength variables between age groups. Regarding to balance, in the three conditions, two variables, peak velocity and trajectory, were statistically different between YO and OO, and only in the AP direction (all $p<0.05$). The OO participants presented higher, that is worse, peak velocity (22%) and trajectory (32%) in AP direction than the YO participants. There were no differences between groups in ML balance variables. CONCLUSIONS: Gait speed and muscle strength values felt within the usual values among non-frail older people. Although OO were walking slower than YO, both age groups presented levels of gait speed considered as physically functional among older adults. OO maintained a relatively high level of strength despite aging. In our study AP balance seemed decisive to discriminate between YO and OO. In contrast, ML balance has been reported as a discriminating factor between fallers and non-fallers older adults, as well as when comparing young adults with older adults. Interestingly, AP balance was also described as a key factor when comparing new-walkers with experienced-walkers in toddlerhood. We suggest exercise interventions with special emphasis on AP balance when participants are in the oldest range of age.

P1-N-65 Validation of a new sport specific trunk function and balance assessment for para-kayak athletes

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Background and Aim The kayak stroke is complex with alternating 3D upper body movements. The complex interplay between forces in different directions places marked demands on sitting balance control and postural stability. In particular, para-kayak athletes (i.e. athletes with physical impairment) may be limited in their sport performance by impaired trunk muscle function; however, there are no established clinical methods for examining motor function in the trunk muscles of these individuals. Therefore, the aim of the study was to a) develop and implement a test to determine the trunk function in para-athletes, b) assess if the results from a manual muscle test correlate with the results from a trunk function and balance assessment scale, c) and correlate the trunk function and balance assessment scale results with sport specific trunk values obtained from a kayak ergometer test. Methods 64 international or national level para-athletes (19 F, 46 M) from 12 different countries volunteered for the study. Thirty para-athletes and 10 international elite able-bodied kayakers (4 F, 6 M) conducted the kayak ergometer test. The athletes' abdominal muscles were assessed with a manual muscle exam during six different trunk muscle tasks (flexion/extension, rotation left/right and side flexion left/right) and scored on a scale from 0-5. Next, they were then asked to complete various static, dynamic, and perturbation-type (i.e. push and resistance) trunk balance tasks while sitting unsupported on a firm or unstable surface. Functional task performance was graded on a 3 point scale. Lastly, the test on the kayak ergometer was performed at sub-maximal intensity. Fifty-four reflective markers were used to construct a 14 segment 3D kinematic whole-body model (12-camera optoelectronic system). Max/Min values of trunk flexion/extension, rotation, side flexion and total Range of Movement (RoM) were calculated. Piezoelectric force transducers were connected with the rope from the ergometer flywheel to continuously measure force during the stroke cycles. Power output was defined as a product of paddle forces and velocity of the markers attached on the force transducers. Results Scores on the manual muscle test were predictive of functional trunk balance control in para-kayak athletes ($r=0.82$, $p<0.001$). During kayaking, sitting in a position of forward trunk flexion and having a greater RoM in trunk rotation correlated significantly with greater power output (F $r=0.74$, M $r=0.88$). There was a positive correlation between the results from the trunk function and balance assessment and the sport specific trunk values obtained from the kayak ergometer ($r=0.69$, $p<0.001$). Conclusions The results from this study suggest that the manual muscle test and trunk functional and balance assessment are valid methods to assess sport specific trunk function in para-kayak athletes and can be used in defining if the athletes had no, partial or full trunk function (Fig 1).

P1-N-66 Sagittal Knee Kinematics During Flamenco Dancing - preliminary studies

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BACKGROUND AND AIM Flamenco is a very demanding Spanish dance technique. 'ZAPATEADO' is a repetitive percussive footwork performed in a traditional high-heeled shoes. To provide a proper adaptation to the demands during stepping the knee flexion must be maintained to absorb the forces. This position also enables to separate the lower limbs from the trunk, allowing the foot to strike quickly. Because of a high incidence of knee injuries among flamenco dancers, the purpose of the research was to examine the knee joint position during 'zapateado'. METHODS 12 women (27.82±8.04 years, 60.22±7.19 kg, 167±8.23 cm) participated in the study approved by Research Ethics Committee of the San Antonio Catholic University (Spain). They have been attending Flamenco course for at least 2 years 4 hours per week. The dancers' task was to perform ZAP-3 Test. The test, widely used by flamenco dancers, consists of six footwork performed with the forefoot, heel and toes, alternatively with both feet5. They repeated the sequence of steps during 15 seconds at maximum speed taking care of high technical quality. The subjects wore their specific flamenco high-heeled shoes (6 cm). The knee joint

parameters were derived from the video registration in the sagittal plane (120 Hz). To identify the knee angle we used the following anatomical landmarks: greater trochanter of the femur, head of the tibia, lateral malleolus. Kinovea 0.8.22 software was used for the kinematic analysis. The variables of interest were: step frequency and sagittal knee kinematics of the right (supportive) leg when the left was performing steps. RESULTS Analysis of the results showed that during Zap-3 Test an average number of steps was 127.09±18.08, accomplished at a frequency of 8.47±1.21 steps per second. As to the angular displacement of the knee during step test was 144.71±8.20º. CONCLUSIONS The degree of knee flexion in flamenco dancing is a very important aspect. The ballet is encoded from its origins whereas flamenco is not. Therefore it is necessary to study its biomechanical characteristics to establish optimal and healthy patterns. To our knowledge there are no previous research considering this issue. Proper knee flexion is a result of an ergonomic adaptation during fast footwork phases of dancing which is accompanied by a gentle posterior pelvic tilt. The sagittal knee joint resistance to dynamic changes is provided by the proper coactivation of the quadriceps and hamstring muscles. Extended position of the knee may produce less impact absorption through the musculotendinous system increasing the force transmitted to the passive structures of the knee and, consequently, more impacts rise to the spine. However, excessive knee flexion may cause injury to the patellar level. Our study is the first approach to identify the proper knee angle while performing stepping percussive movements of the feet, but more investigations are needed.

P1-N-67 Long-term Tai Chi Training May Improve Dual-task Standing and Cognition in Older Adults

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BACKGROUND AND AIM: Numerous activities of daily living require individuals to "dual-task," or stand while concurrently performing an unrelated cognitive task. Such dual-tasking increases postural sway and this "cost" tend to increase with advancing age. Tai Chi (TC)--a "mind-body" exercise combining slow movements with heightened body awareness and focused attention--reduces fall risk and improves cognitive functioning in older adults, and may therefore reduce dual-task costs over time. The aim of this study was to 1) determine the cross-sectional effects of long-term TC training on standing dual-task cost in older adults, and 2) determine the relationship between standing dual-task cost and cognitive function in older adults. METHODS: Twenty-six TC expert older adults (age 63±8years, TC experience 24±11years) and 60 non-TC expert older adults (age 64±8years) were studied. Postural sway speed and range in the anterior-posterior (AP) and medial-lateral (ML) direction were recorded during quiet standing and while performing a dual-task condition. Dual-task cost was calculated as the percent change in postural sway outcomes from single- to dual-task condition. Cognition was assessed using a battery consisting of verbal memory (digit span test), visual attention and task switching (Trail Making Test), and semantic (animals, supermarket) and phonemic (FAS test) verbal fluency. RESULTS: One-tailed t-test demonstrated that the TC expert group had lower dual-task cost to postural control in COP sway speed (p=0.04), range (AP=0.04, ML: p=0.03) and area ellipse (p=0.03) compared to the non-TC group. The TC expert group had a higher digit span total (p=0.003), lower time on the Trail Making Test A (p=0.001) and higher category naming (p=0.01) and FAS total (p=0.03), as compared to the non-TC group. Linear regression revealed that across groups, those with lower dual-task cost in sway speed (AP: p=0.04, ML: p=0.03-0.04) and area ellipse (p=0.02-0.05), performed better on the FAS test. Those with lower dual-task cost in range ML was associated with higher performance on both the category (p=0.03) and FAS test (p=0.01-0.04). No other associations were found. CONCLUSIONS: Older adults with long-term TC training have lower dual-task cost and better cognitive function compared to older adults without TC training. Moreover, our results suggest that dual-task cost is partially dependent on cognitive function in older adults.

P1-N-68 Effect of a walking exercise on crouch gait in children with cerebral palsy: a kinematic analysis

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BACKGROUND AND AIM: Crouch gait, characterized by excessive flexion of the hip, knee and ankle during stance phase, is commonly reported in children with diplegic cerebral palsy (CP). Such a gait increases energy expenditure and muscle force requirements. Hence, even over a short distance, crouch gait, especially when combined with muscle weakness, may increase the risk of falling. The aim of this preliminary study was to assess the impact of a short walking exercise on gait kinematics in children with CP with a crouch gait. METHODS: Seven children and adolescents (mean age [SD]: 13 [4] years) with spastic diplegic CP who were able to walk independently for at least 6 minutes and who had knee flexion greater than 15° during the stance phase of gait participated in the study. Muscle strength was measured at knee flexors/extensors, and hip flexors/extensors and abductors using a handheld dynamometer. First, kinematic, kinetic and muscle activity data were collected during a 10-meter walk. The mean of 6 trials was used for analysis. Then, participants were asked to walk during 6 minutes at a comfortable pace, around a path of 23.2 meters long. During the exercise, standardized encouragements were provided and gait kinematics and muscle activity were recorded every two laps. The outcome measures were muscle strength, and range of motion, maximal and minimal sagittal plane hip, knee and ankle joint angles during stance and at initial contact. The position, velocity, and acceleration of the global center of mass (COM) were also analyzed. These outcomes were compared

before and after the walking exercise, i.e. during the 10-m walk and during the last lap of the walking exercise. RESULTS: Muscle strength analysis revealed lower limb muscle weakness for all participants compared to reference data. There was no significant difference between walking speed before and after the walking exercise. Significant differences were observed during stance concerning the range of motion and maximal ankle joint angles ($p \leq 0.01$), and the minimal ($p \leq 0.05$) and average ($p \leq 0.01$) positions of COM. The ankle dorsiflexion and range of motion increased during stance phase, and the position of COM decreased. Moreover, the ankle angle at initial contact ($p=0.06$) tended to increase, and knee maximal angle ($p=0.06$), and maximal COM position ($p=0.06$) tended to decrease. No significant difference was noted at the hip or pelvis. CONCLUSION: Individuals with CP who walk with crouch gait tend to be more crouched at the end of a 6-minute walking exercise at comfortable pace. Consequently, kinematic differences were observed after 6 minutes of walking at comfortable pace, which can be considered as a daily life exercise. These results could be helpful to guide rehabilitation by identifying factors contributing to gait modification during daily locomotion. Future studies may use electromyographic analyses to evaluate whether muscle fatigue is related to these kinematic modifications.

P1-N-69 Effectiveness of an exercise program for hip fracture patients - the EVA-HIP randomized controlled trial

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BACKGROUND AND AIM: Hip fractures represent a severe threat to autonomy and wellbeing in old age. Almost half of elderly women will sustain a hip fracture and few regain prefracture function. Function after hip fracture does not stabilize until one year following the fracture, while ordinary rehabilitation is ended within few months. At present there is insufficient evidence to make recommendations concerning timing and content of interventions to maximize gait recovery and regain prefracture activity levels. Most exercise studies on extended rehabilitation are efficacy-driven studies with selected patients and there is a lack of effectiveness studies to provide results that are generalizable. This study aimed to evaluate the effectiveness of an extended exercise program provided at a time when ordinary rehabilitation is usually ended. METHOD: This was a randomized controlled trial, comparing an exercise intervention to treatment as usual, starting four months following fracture. All hip fracture patients >70 years undergoing surgery at St.Olav University Hospital between 2011 and 2013 were screened for eligibility. Inclusion criteria were community dwelling and able to walk prior to the fracture. Inclusion and retrospective assessment on prefracture function was performed during the hospital stay. Baseline assessment and randomization were performed four months after surgery with follow-up assessment 12 weeks and 8 months after randomization. The intervention group received 20 supervised home-exercise sessions by a physiotherapist, consisting of five individually adjusted and progressive exercises focusing on weight bearing exercise to improve gait control. Prefracture function included basic and instrumental activities of daily living (p-ADL and I-ADL) and cognition. Baseline and follow-up assessment included spatial and temporal gait characteristics (GAITRite®), activity monitoring of free-living physical behavior (activPAL?) and p- and I-ADL. RESULTS: 223 patients were included during the hospital stay (89% of eligible patients), mean age 83.5 ±6.2 years, 72% women. Prefracture function (mean, SD) was: Barthel index (0-20): 18.5 (2.1), Nottingham E-ADL (0-66): 42.1 (16.7), Clinical Dementia Rating Scale (0-18): 1.7 (3.2). At four months 183/223 (82%) performed the baseline assessment of whom 142 participants were randomized and 112/142 (79%) completed the twelve months follow-up. The results on gait characteristics and activity will be analyzed and reported in time of the conference. CONCLUSION: This study will add new insight about effectiveness of extended exercise programs on gait control and activity level and includes a more representative group of community-dwelling hip fracture patients than has been reported earlier. As prefracture data are available in 89% of eligible patients the study will provide additional information about patients who refuse further participation or drop out from other reasons during the follow-up period.

P1-O-70 Sleep quality is associated with dual-task walking among community dwelling older adults:

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Background: Sleep problems are common in older adults, with half of community dwelling older adults reporting chronic sleep difficulties. Sleep complaints are associated with an increased risk of mortality and morbidity such as poor physical performance and greater functional limitation. Dual-task (DT) interference during walking is widely recognized as a functional mobility concern among older adults, and is an important public health problem due to its association with an increased risk for falls. The effects of sleep quality on DT performance are yet to be determined. Aim: To determine the associations between objective sleep measures and DT performance while walking. Method: Thirty-six (21 women) community dwelling older adults (Mean age-71.3, SD 5.8; Montreal Cognitive assessment mean=24 SD-2.7) participated. Sleep was measured based on seven days of wrist actigraphy monitoring, to include sleep and wake minutes and percentages, sleep efficiency and number of wake episodes. Gait was assessed during a one minute walk as a single-task (ST) and with verbal fluency as a DT. One minute verbal fluency was conducted while sitting as a single-task. Dual-task cost (DTC) was computed using the formula [(ST-DT)/(ST)]*100 for both the motor and cognitive tasks, so that higher scores reflect higher DTC (i.e., lower functional ability). In addition, cognitive and motor performance tests were administered. Bivariate correlations were performed using SPSS. Findings: Cognitive DTC was negatively correlated with sleep minutes ($r=-0.427$), sleep percentage ($r=-0.62$) and sleep efficiency ($r=-0.63$, all $p<0.001$); and positively correlated with wake minutes ($r=0.62$, $p<0.001$) and number of wake episodes (r=0.45, p<0.05). Wake episodes was positively correlates with Trail Making Test-Part B (r=0.41, P<0.05). Conclusions: Poor sleep is associated with lower ability to divide attention efficiently between two tasks. Experimental and longitudinal studies are needed to assess the directionality of these associations, to reveal underlying mechanisms and to assess the efficacy of potential interventions.

P1-O-71 Toe clearance profiles distinguish fallers with incident Parkinson's disease when classified by fall type rather than fall frequency.

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BACKGROUND AND AIM: Falls are common in people with Parkinson's disease (PD) and can occur during even in the early stages of the disease[1,2] with 35-90% of people with PD experiencing one fall and 18-65% regarded as recurrent fallers[3]. Many factors predisposing people with PD to falls have been proposed[4] but inadequate foot clearance has been less addressed and may distinguish PD non-fallers from different types of PD faller. METHODS: Participants (tested <4 month post diagnosis of idiopathic PD) walked around a 25m circuit at a comfortable pace for two minutes. Bilateral trajectories of the calcaneus and dorsal aspect of the hallux were measured using VICON (100Hz) and trajectory signals were extracted from filtered data (Figure 1). Prospective falls were collected using falls diaries for 12-months post assessment. Fallers were grouped using two classification systems: falls frequency (single/recurrent) and pre-fall event (ambulatory: fell during simple locomotor tasks such as walking/stair climbing or transitional: fell during a postural transition)[2] and compared with non-fallers. A Kruskal Wallis test evaluated group differences in trajectories using both classifications. Post hoc tests identified differences post corrective procedures. RESULTS: Data were collected from groups classified by falls frequency: 48 non-fallers (Median age[range]66.7[43.1]y), 8 single (70.8[20.2y) and 13 recurrent (71.8[32.8]y) fallers; and fall event: 10 ambulatory (69.3[32.8]y) and 11 transitional (73.2[23.5]y) fallers. The groups did not differ in age, education, cognition, disease severity or freezing of gait[5]. When classified by pre fall event , transitional fallers walked with lower minimum toe clearance in mid swing (T2, p=.013) compared with non-fallers and similar differences existed between transitional and ambulatory fallers with the addition of a reduced toe gradient (p=.009) observed for transitional fallers. No significant differences existed between non- and ambulatory fallers or when comparing the variability and asymmetry of foot trajectories. When classified by fall frequency only peak heel clearance distinguished fallers (H1, p=.017) where single fallers walked with the lowest clearance. CONCLUSIONS: Foot trajectory profiles distinguished non-fallers from the type of faller in the early stages of PD in the absence of other clinical outcomes. Trajectories during more complex ambulatory tasks such as obstacle crossing or stair climbing may distinguish between non-fallers and ambulatory fallers when locomotor demands are higher and falls risk is amplified. Classification by fall event in combination with profiling of foot trajectories may help identify the underlying mechanism of falls and aid clinicians tailor falls

interventions more effectively. REFERENCES: [1] Kerr (2010) Neurology [2] Mactier (2015) Parkinsonism & Relat Disord [3] Allen (2013) Parkinson's Disease [4] Wood (2002) JNNP [5] Nieuwboer (2009) Gait & Posture

P1-O-72 The effect of treadmill training with and without virtual reality on postural control and gait in elderly fallers

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BACKGROUND AND AIM: Gait and balance impairments, tripping over obstacles and attentional decline are associated with the occurrence of falls in the elderly. Treadmill training (TT) with virtual reality (VR) may offer a complete and challenging approach to tackle fall problems in the elderly. Up to now, the susceptibility to training effects of gait and postural control deficits is not clear. Therefore, we investigated the differential effects of treadmill training with and without extra challenges offered via VR on gait and balance parameters. METHODS: Twenty six elderly fallers were randomly assigned to an intervention (TT+VR) or control group (TT). Participants received 18 training sessions over a period of six weeks. Motor components of the training, including walking speed and duration, increased over the course of the training for both the TT and the TT+VR group. In addition, in the TT+VR group patients were trained in obstacle crossing, navigation, responding to distractors, and environmental changes. Assessments on gait and balance took place one week before and after the training program using the GaitRite system and OPAL sensors. Additionally, parameters of postural sway were measured by force plates to assess static balance during standing with eyes open and eyes closed on i) a stable surface, ii) an unstable surface and iii) with (20s) and without (20s) Achilles tendon vibration. Limits of stability (LoS) were derived from differences between maximal center of pressure displacement in anterior-posterior and medio-lateral direction during a maximal leaning task. Center of pressure displacements were calculated for the various conditions and expressed as a ratio of their respective LoS. RESULTS: As this trial is ongoing, we analyzed the blinded pre-post results of this study. Results showed no differences in postural sway or LoS measures pre and post-training across all quiet standing conditions. However, Mini-BESTest scores improved significantly after training ($p=0.036$). We also found a significant improvement in gait, regarding speed and step length respectively during i) normal walking ($p<0.00001$, $p<0.0001$), ii) dual-task walking ($p=0.002$, $p=0.001$) and iii) obstacle crossing ($p=0.006$, $p=0.014$). For fast walking, a trend towards increased gait speed ($p=0.074$) and a significant improvement in step length ($p=0.012$) were found. CONCLUSIONS: A six-week TT with or without VR improved gait and balance in elderly fallers. However, so far results predominantly showed a positive effect on dynamic postural control (Mini-BEST), but not on static balance for stability limits or sensory orientation as measured by force plates. Further work is needed to understand whether adding VR

balance challenges to regular TT training offers a more robust intervention, addressing different aspects of postural control.

P1-O-73 Reduced power Progressive Addition Lenses provide good stair ambulation safety in older people whilst providing adequate spot-reading ability

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Background & aim. A randomised controlled trial has suggested that providing long-term multifocal spectacle wearers with single-vision distance (SV) spectacles for use outside the home reduces falls risk [1]. However, such an intervention requires patients to continually switch between using two pairs of glasses, and adherence to this intervention was found to be poor [1]. The present study determined whether reduced addition power progressive-addition lenses (PALs) could improve gait safety on stairs, while providing sufficient ability to see near objects for short periods of time. If this were the case, they may be a better alternative than SV spectacles for outdoor use. Methods. Healthy elderly long-term PAL wearers completed stair ascent and descent trials (over a 3-step staircase) wearing reduced and full power PALs and bifocals, their own habitual PALs, and SV spectacles. Main outcome variables were foot placement and clearance parameters. To determine whether spectacle type had a deleterious effect on stair negotiation, we also assessed foot scuffs, M-L trunk sway (ascent), and landing control (descent). Near visual acuity, critical print size and reading speed were measured using Bailey-Lovie near charts and MNRead charts at 40cm. Results. The reduced addition PALs (red-PALs) caused the least changes in stair negotiation compared to the habitual and/or SV spectacle conditions, with foot placement and clearance values when using them being much the same as those when using SV lenses and/or habitual PALs, and with the number of trials and/or participants in which a foot scuff occurred being lower than that returned for the SV condition. In contrast, the full addition bifocal caused the greatest changes in stair negotiation compared to the habitual, SV and/or red-PALs conditions, with increased duration, longer foot placement distance before the stairs, decreased horizontal heel clearance (descent), and increased vertical toe clearance and clearance variability (ascent). Near word acuity and MNRead critical print size were better with the red-PALs than with the SV lenses ($p<0.0001$). Red-PALs provided reading ability at a level of 0.24 ± 0.13 logMAR, which is satisfactory for most near vision tasks undertaken short term. Conclusions. These findings suggest that elderly individuals are more likely to adhere to use of red-PALs outside the home as they provide sufficient near vision for 'spot reading' tasks such as reading price tags and food labels. The lack of difference in gait kinematics between the red-PALs and distance SV spectacle conditions suggest that use of red-PALs for everyday locomotion should not blur or distort vision when viewing steps, stairs, kerbs, and thus that their use should improve every day gait safety. A randomised control trial is required to determine whether trips and falls incidences are reduced as a

result of using red-PALs for everyday locomotion rather than full-powered PALs. REFS. [1] Haran et al 2010: BM

P1-O-74 Exploratory study on a sensor-based fall risk assessment tool

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BACKGROUND AND AIM: Tools for assessing the risk of falling are central for fall prevention. Some of the currently available tools depend subjectively on the examiner, and those that have been externally validated have been judged not to be accurate enough. Wearable inertial sensors have been proposed to increase the accuracy in predicting future falls while guaranteeing the objectivity of the assessment. Most of the previous studies were based on falls assessed retrospectively, and based on small sample sizes. With this study we aim at looking for new sensor-based markers for fall risk and exploring the possibility of a fall risk assessment tool. METHODS: Two hundred fifty-seven subjects aged 65 or more and enrolled in the FARSEEING-InCHIANTI study (FU4) [1] performed four motor functional tests while wearing a smartphone: Timed Up and Go (TUG), Romberg, 5-time repeated chair standings (5RCS), 400 m walk path (400m). A six month follow-up survey (monthly telephone interview) was conducted to assess the occurrence of any falls. Ninety reliable features were computed from the signals recorded by the inertial sensors embedded in the smartphone. Missing values on these features were imputed after probabilistic principal component analysis (R function pcaMethods::pca). Lasso logistic regression, and linear and quadratic discriminant analysis were applied in order to predict the occurrence of any falls during the follow-up. For the linear and quadratic discriminant analysis, a wrapper feature selection was applied. Five-fold cross validation was used for model assessment. RESULTS: Twenty-five subjects fell at least once during the 6-month follow-up. The features that were more recurrently selected by the trained models were: duration of Sit-to-Walk (TUG), root mean square (RMS) of the acceleration during chair-rising (vertical and anteroposterior components, 5RCS), total time for 5RCS, coefficient of variation of the cadence during straight course (400m). The areas under the receiver operating characteristic curves (AUC) for the trained models range between 0.55 and 0.59, with standard deviations between 0.12 and 0.16. CONCLUSIONS: The present study is one of the firsts on fall prediction using information on falls collected prospectively and on a relatively large sample of older adults. We have identified new possible inertial sensor-based markers of risk of falling. In future studies we will study how to integrate sensor-based information with clinical and behavioral information in order to improve the discriminative ability of the presented models. The AUC may possibly result higher if the follow-up is extended to one year [2]. Acknowledgments The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement FARSEEING

n° 288940 and by Sovvenzione Globale Spinner 2013. References [1]www.inchiantistudy.net. [2]Palumbo et al. Methods Inf Med 2015

P1-O-75 Similar Virtual Reality Games Elicit Different Challenges for Balance Training

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Background: Age-related decreases in postural control and muscle strength have been identified as major risk factors for falls and can be improved with training. Virtual Reality (VR) balance training may have advantages over regular exercise training. However, the available studies on the effect of VR balance training have yielded conflicting results. Explanations for this inconsistency might be that commercially available games have not been optimized to improve balance in older adults and that movements made during the game depend on the controllers used to play the games. Therefore, the aim of this study was to assess the balance challenge and level of difficulty of two similar skiing games played on different gaming systems. Methods: Eight young participants performed three trials of two skiing games: Kinect Sports Season 2 and Wii Fit on the Wii Balance board, where the Wii balance board is a simple force plate and the Kinect sensor an infrared depth sensing camera that creates a 3D image of the body. The functional limits of stability were determined in a task in which they are asked to move a dot on the screen, representing their COM, as far as possible in 8 different directions. 3D marker data were obtained with 6 opto-electronic cameras at a sample frequency of 100Hz. Body center of mass was calculated based on a 45 markers, 15 segments model. The influence of the games and trials on the maximal COM displacement in each of the 8 directions was tested with a repeated measures MANOVA. Results: Subjects showed significantly bigger maximal COM displacements in right (0.071m, $p<0.05$), left (0.066m, $p<0.05$), and anterior-left direction (0.028m, $p<0.05$) and reached closer to their limits of stability during the Kinect Sports Season 2 game compared to the Wii Fit game (figure 1). Furthermore, from the first to the third trial, in both games, significant reductions in maximal reach were found in anterior-right (0.014m, $p<0.05$), left (0.028m, $p<0.05$) and anterior-left direction (0.026, $p<0.05$), indicating a learning effect. Conclusions: These data show that VR-games that look similar at first sight elicit different movements, bringing the subjects more or less close to the limits of stability and can thus be more or less suitable as a balance training tool. The different movement patterns observed during a similar skiing task indicate that apart from the task, the movement sensors used in the game (COP versus full body tracking) as well as their gain settings have an important impact on the movements performed. Also results indicate that subjects quickly become more efficient, which might limit the effectiveness of the game as a balance training tool. The results show the importance of documenting the actual movement performance elicited by VR- interventions, to develop effective balance games.

P1-O-76 Psychometric properties of the Spring Scale Test - a clinical instrument to assess balance in the elderly

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Background and aim: The Spring Scale Test (SST) is a low-cost clinical tool that was developed to quantify balance reactions in standing and to assess the risk of falls in active aging adults (http://www.rippsmethod.com/about.html). A spring scale is attached to the waist of a standing subject, and the force needed to provoke a reaction in different directions of perturbations can be measured. Our goal was to assess the inter-rater reliability and the convergent validity of the SST in comparison to the Mini Balance Evaluation Systems Test (Mini-BEST) and the Activities-specific Balance Confidence Scale (ABC Scale) in a healthy, community-dwelling sample of individuals aged 75-85 years. Methods: 20 community-dwelling older adults were recruited from a senior residence. Participants completed a preliminary health questionnaire and a modified falls/imbalance questionnaire. They then performed the SST, followed by the Mini-BEST, the ABC Scale questionnaire, and finished with a second SST rated by a different member of the research team. Each evaluator was blinded to the results of the other evaluators. Results: The mean age of the population was 81.2 years (mean 3.4; range 75.2 to 86.9 years). In this population, 65% had not fallen in the past year, 25% had fallen once, and 10% had fallen twice. The inter-rater reliability is generally good, based on the results of the Cronbach's alpha coefficient of concordance: anterior initial loading ($\alpha = 0.846$); anterior final loading ($\alpha = 0.862$); anterior threshold ($\alpha = 0.815$); posterior initial loading ($\alpha = 0.903$); posterior final loading ($\alpha = 0.864$); and posterior threshold ($\alpha = 0.643$). Moderate but significant correlations were found only between the Mini-BEST total score and the SST anterior threshold ($r = 0.645$, $p < 0.01$), and anterior final unloading ($r = 0.721$, $p < 0.05$). Similar correlations existed between the Reactive Postural Control sub-score of the Mini-BEST and the SST anterior threshold ($r = 0.628$, $p < 0.01$), as well as the anterior final unloading ($r = 0.757$, $p < 0.05$). The correlations between the Mini-BEST and posterior testing of the SST were not significant. There were also no significant correlations between SST events and the ABC scores. Conclusion: Results from the anterior threshold and unloading testing components suggest that the SST is a reliable and valid tool to assess reactive postural control in healthy, community-dwelling individuals aged 75-85 years. The SST can be clinically useful to assess balance functions in the elderly, but there are limitations to the measurement device and some adaptations to the testing protocol are needed.

P1-O-77 Accelerometer based free-living data: does macro gait behaviour differ between fallers and non-fallers with and without Parkinson's disease?

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BACKGROUND AND AIM: Gait impairment and falls are frequent among older adults and people with Parkinson's disease (PD), and may lead to loss of functional independence and poor quality of life. Current approaches for evaluating falls risk are based on self-report or testing at a given time point and therefore may be suboptimal. Continuous monitoring of gait is emerging as a powerful tool to assess motor impairment and falls risk in real life using accelerometer-based technology, potentially providing an accurate and objective measure of risk [1]. Macro level gait behaviours (e.g., volume, pattern, and variability of walking bouts) are sensitive to PD pathology [2], however, there are conflicting reports about their association with falls risk. The aim of this study was to explore the association between physical activity (PA) and falls history by analysing whether macro level gait behaviour differs between fallers and non-fallers with and without PD using 7 day accelerometer-based free-living data. METHODS: 227 fallers (F: 106 elderly, 121 PD; age: 76±6 yrs, and 72±6 yrs, respectively) enrolled in the V-TIME study [3], who fell twice or more in the 6 months prior to assessment, together with 65 participants without a history of falls (NF: 50 elderly, 15 PD, age: 65±9 yrs, 70±7 yrs, respectively) enrolled into ICICLE-GAIT [2] were tested. Data were recorded continuously for 7 days with a tri-axial accelerometer (Axivity AX3, UK, 100Hz, ±8g) placed on the low back (L5). Macro level outcomes (MLO) representing the volume (% walking time, number of steps, mean bout length), pattern (alpha (α)), and variability (S2) of free-living activity were extracted in MATLAB® (R2012a) [2]. General linear modelling examined the effect of fall history (F vs NF) and pathology (PD vs elderly) on MLO, controlling for age, sex and BMI. RESULTS: Although the % walking time and number of steps was not related to fall history, F tended to walk in shorter bouts (p=.004) and had a less variable walking pattern (lower S2, p=.019) compared to NF. PD spent less time walking (p=.002), took fewer steps (p=.002), and accumulated proportionally more steps in shorter bouts (higher α) compared to the elderly (p=.006), regardless of falls history. There were no interactions between pathology and falls history for any of the outcomes. CONCLUSIONS: Our results showed that there is an association between falls history and PA. Volume-based MLO, pattern and variability of the walking bouts derived from free-living accelerometer-based data are independently associated with a history of falls and PD. These results support the use of a single accelerometer-based sensor to assess falls risk in free living settings, however, future work is needed to confirm if MLO can predict falls, potentially guiding clinical decision making. REFERENCES: [1] Lord S et al., Mov Disord, 2013; 28(11):1534-43 [2] Lord S et al., J Neurol, 2013; 260(12):2964-72 [3] Mirelman A et al., BMC Neurol, 2013;13:15

P1-O-78 Functional Reach performance and fall prediction in a cohort of 1102 elderly - the TREND study

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Objective: To investigate the predictive value of the Functional Reach test on future falls during a 2-year -observation period in a large cohort of healthy community-dwelling elderly. Background: Falls are associated with increased mortality and morbidity, as well as with functional impairment and reduced quality of life. The value of the functional reach (FR) test to predict future falls has been proposed by small studies in elderly, however, to the best of our knowledge, has never been confirmed in a large cohort study. Methods: Approximately 1100 non-demented individuals between the age of 50 and 83 years were assessed in the frame of the TREND study (www.trend-studie.de) with the Functional Reach Test. FR distance was determined by asking all participants to reach with their right arm forward as far as possible. Two years later, falls history over the last 24 months was assessed. Individuals who reported more than one fall within two years were classified as Fallers (N=65), whereas individuals with no fall were categorized as Non-Fallers (N=753). Based on literature, a FR distance <25cm was defined as being associated with increased fall risk. The relative risk of falling was calculated with a 2-by-2-table. Results: In our cohort, 65 study participants reported ≥2 falls during the observation period of 24 months, with a mean falls frequency of 3.4 (2.4). 753 participants reported no fall. A FR distance <25cm predicted Fallers with a relative risk (RR) of 1.84 (confidence interval 1.12-3.02) Conclusion: This study shows that a FR <25cm is associated with an almost 2-fold increased risk for repetitive falling in the course of the following 2 years in a non-demented older adults. This finding underlines the usefulness of the FR as a tool for fall risk assessment. The FR may have a particular value in balance assessment batteries that do not only focus on single balance systems, but try to cover the whole range of balance deficits potentially occuring in older adults.

P1-O-79 Falls in the real world are related to obstacle crossing behaviors in a lab setting for young adults

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BACKGROUND AND AIM: It is well known that falls result in substantive injuries for all age groups. Thirty to fifty percent of falls are the result of a trip (Berg et al., 1997; Blasi at el., 1988). Experiments of adaptive locomotion indicate that a closer foot placement (Chou and Draganish, 1998; Patla and Greig, 2006) and inadequate foot elevation (Heijnen et al., 2012) are factors that lead to obstacle contact. However, it is unknown how obstacle crossing characteristics - measured in the lab under specific conditions - translate to fall-risk in everyday activities. Identifying fallers based on their gait characteristics will help in the development of fall prevention programs. It was hypothesized that fallers, compared to non-fallers, would have a closer foot placement and a lower foot clearance during adaptive locomotion. METHODS: Thirty-four young adults (20.1±1.0 yrs) participated in two components: a gait assessment in the lab and a daily online survey. For the lab component, subjects walked on an 8 m walkway for 150 trials. An obstacle was placed in the middle of the walkway (obstacle height was 25% of leg length). Standard variables during obstacle crossing were measured. For the survey component of this study, subjects reported number of slips, trips and falls on a daily basis with an online survey for 12 weeks. Subjects were categorized as fallers and non-fallers based on the survey results. Data collection is ongoing; a longer duration of fall assessment and more subjects will be reported at the conference. RESULTS: Twenty falls were observed in nine subjects (26%); the most common causes of the falls were slips followed by trips. Fallers (N=9), compared to non-fallers (N=25), had a lower trail foot clearance over 150 trials (12.9 vs 18.7 cm; p=0.014). Fallers also placed the foot closer to the obstacle for both the lead (87.2 vs 102.2 cm; p=0.007) and trail foot (23.3 vs 28.4 cm; p=0.047). Trail foot clearance during the initial three trials of the experiment was also lower for fallers (14.2 vs 18.6 cm; p=0.019). The significant finding based on the first three trials suggests that it is not necessary to collect 150 trials to assess fall-risk, three trials are adequate. If this is also true for older adults, it will substantially reduce data collection duration. The protocol relied on a single obstacle that is unlikely to be encountered during every day activity. However, this specific adaptive locomotion task was able to distinguish those with a higher fall risk in the real world. As falls of all causes (e.g. trip or slip) were included, these findings indicate that obstacle crossing behavior can be used to assess general balance. CONCLUSION: This study provides direct evidence that obstacle crossing behavior, a specific task assessed in the lab, can be generalized to falls in the real world for young adults, even when all the falls did not result from tripping.

P1-O-80 Can a five week visual training task improve balance in older adults?

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Background: Over an individual's lifespan, many factors may affect the balance control of an individual due to changes within one or more sensory systems (i.e. vision, balance, sense of movement). Research has revealed that once individuals reach the age of 60, their risk of falls increase drastically. The purpose of this study was to determine if an improvement in balance control (i.e. stability) of older adults is attainable using a visual training paradigm across a five week period. Methods: Two groups of participants were assessed at two time points, baseline and post-intervention. The first set of assessments focused on balance: 1) sway margin task--individuals stood with a narrow base of support and leaned as far as they could in the AP and ML directions while keeping feet flat on the force plate; 2) quiet standing with narrow BOS for 45s--eyes open or closed and either directly on a force plate or on a compliant surface; and 3) a TUG task that assessed mobility skills of the individual. The control group (n=8,$\bar{x}$ age=71.6; 3 males, 5 females) was recruited from a self-defense class designed for older adults, participating in two classes a week for five weeks. The treatment group (n=9,$\bar{x}$ age=71.3; 2 males, 7 females) were community-dwelling individuals with moderately to low physical activity involvement, participating in the visual training paradigm for two 45 minute sessions per week for five weeks. The training sessions incorporated the use of six fitLights arranged in an arc formation, each placed at 30, 45, 60 degrees relative to the individual--approximately 50cm away from each participant. Participants were instructed to tap the fitLight with their right foot if illuminated red and left foot if blue. The sessions consisted of four blocked conditions, progressing from right only, left only, ipsilateral (i.e., left foot, lights on left side and vice versa), and contralateral foot taps. Each block started off with a practice trial and then four full trials where each fitLight illuminated six times at a random sequence. Results: All participants demonstrated an increase in sway margin ($p<.05$), with a change of $\bar{x}t=0.013$cm and $\bar{x}c=0.013$cm in the AP; $\bar{x}t=0.015$cm and $\bar{x}c=0.005$cm in the ML direction after the five weeks. Additionally, the treatment group had a significant decrease in RMS of COP displacement ($p<.05$) in the AP ($\bar{x}t=0.205$cm/s, $\bar{x}c=-0.148$cm/s) and ML ($\bar{x}t=0.153$cm/s, $\bar{x}c=0.068$cm/s) compared to the control group. Conclusion: This study suggests that an improvement in balance control is possible in older adults over a five week period of training. The increase in sway margin indicates a greater area over which the individuals have confidence in sufficiently controlling balance. The decrease in COP displacement suggests an increase in the participants' capacity to localize and maintain a stable reference point, which inherently demonstrates improved postural control.

P1-O-81 Impaired modulation of reactive balance responses post stroke: Response to varying magnitudes of unpredictable perturbations.

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BACKGROUND AND AIM: Successful recovery from sudden loss of balance necessitates the ability to scale the reactive balance responses to the degree of balance loss depending on the central set and prior exposures. While under healthy conditions this ability is preserved, whether or not cerebral lesions such as a stroke affects scaling of reactive balance responses remains to be determined. We aimed to examine the effect of hemiparetic stroke on the postural stability and compensatory stepping response to increasing magnitude (velocity & acceleration) of unpredictable slip-like support surface perturbations in stance. We hypothesized that with greater postural instability at higher perturbation magnitudes, stroke survivors compared to healthy controls would be unsuccessful at recovering balance. They would thus demonstrate lower postural stability at touchdown resulting from an inefficient compensatory step and reduced ability to control posterior trunk excursion. METHODS: Ten chronic stroke survivors and 10 healthy age-matched controls after a familiarization trial were exposed to three levels of forward perturbations (accelerations 7.5, 12, and 16.75 m/s2 for levels I, II and III respectively) in a random order. Stability at liftoff (LO) and touchdown (TD) was measured as the shortest distance of the instantaneous center of mass state (position and velocity relative to base of support) from a theoretical threshold for backward loss of balance. Compensatory step length and trunk angle at TD were also recorded. RESULTS: With increasing perturbation magnitude, both the groups reduced stability at LO (main effect of magnitude, $p < 0.05$). Further, at higher perturbation magnitudes (level II and III) stroke survivors were more unstable than the controls (group x magnitude interaction, p<0.05). At TD, while the controls improved stability at higher perturbation magnitudes, the stroke survivors showed a reduction in stability at higher perturbation magnitudes (magnitude x group interaction, p<0.05, Fig. 1A). Although in both the groups, the degree of loss of balance at LO directly related to the perturbation magnitude, the controls successfully recovered balance by increasing stability at TD however; such a relationship was not preserved in stroke survivors. This could be explained by shorter a compensatory step length (Fig. 1B) and greater trunk extension at TD observed at higher perturbation intensities in the stroke survivors compared to the controls (group x magnitude interaction for both variables, p < 0.05) resulting in a COM position closer to the edge of the BOS. CONCLUSIONS: The findings reflect the challenges post stroke in the reactive control of stability suggesting inability of the central nervous system to make online modification of the compensatory step and trunk movement based on the perturbation magnitude. Such absence of the reactive balance response scaling could be the potential factor increasing the risk of falls in these people.

P1-O-82 A Quantitative Evaluation of the Stay Well At Home Multifactorial Fall Risk Reduction Program

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BACKGROUND AND AIM: Falls among older adults is a significant public health concern and effective interventions are needed to address this issue. Multifactorial fall risk reduction programs have been shown to be effective in reducing fall rates and/or fall risk in high risk older adults but long-term adherence to engaging in fall risk reducing behaviors remains a challenge. The adoption of theory-based approaches aimed at changing attitudes, perceptions, and risk-taking behaviors have been recommended to address this issue (Brawley & Culos-Reed, 2000). The Health Action Planning Approach (Schwarzer, 1992) guided the development of Stay Well At Home (SWAH), a multifactorial fall risk reduction program delivered by trained facilitators in the home and via phone. METHODS: Older adults identified at moderate-to-high risk for falls received an in-home program and follow-up phone coaching over a 4-month period. Trained facilitators guided recipients through a progressive home exercise program and interactive discussions addressing important fall-related topics, goal-setting, overcoming barriers to taking action, and building social support. Changes in balance, gait, and lower body strength (Short Physical Performance Battery; SPPB), as well as balance-related self-confidence (Balance Efficacy Scale; BES) and fall-related attitudes and behaviors (Fall attitudes, and Behavior Scale for Older Persons; FaB scale) were evaluated immediately following completion of the in-home phase of the program and again at the completion of the 4-month intervention. RESULTS: Preliminary results for 18 participants tested at the completion of the in-home visit phase of the program yielded the following outcomes: Balance-related self-confidence increased significantly (p = .016) with the greatest change evident for the sub-scale of balance tasks performed without support (p=.023). A significant change in the total score for the FaB scale was also observed (p=.007) at the conclusion of the in-home visits with fall-related attitudes and behaviors showing significant improvement. Improvements in balance and gait were also evident post in-home visits but did not achieve statistical significance. Overall SPPB scores improved by 7% with the greatest improvement observed for the strength sub-scale (12%). CONCLUSIONS: These preliminary findings support the qualitative findings emerging from semi-structured interviews conducted with some of the same recipients at the conclusion of the in-home visits. Improvements in balance, gait, and strength will likely require a greater dose of structured exercise in this higher risk group of older adults. One additional concern is that the SPPB may lack the sensitivity needed to show a change in physical performance in this group of older adults. Follow-up measurements of balance, gait, and strength scheduled after program completion may address the dose and/or measurement sensitivity issues.

P1-O-83 Daily-life gait quality as outcome measure to evaluate interventions: How many subjects are required to detect relevant changes?

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Background and aim Up to date, most fall prevention studies have focused on fall incidence as outcome measure. Recording fall incidence is laborious, prone to error and requires long follow-up periods. Recent technological developments allow for assessment of daily-life gait quality as a measure of fall risk and as outcome for such interventions. In the current study, we investigated how many subjects would be required to detect changes in gait quality among older adults. Methods Two weeks of trunk accelerometry were obtained in 163 older adults aged 65 and over. The median interval between measurements was 14 (iqr 28) days. Gait quality was estimated with a range of parameters reflecting e.g. gait stability and variability. Repeated measures ANOVAs were employed to extract the overall mean and variance components reflecting within-subject, between-subjects, and between-measurement variation. Custom sample size calculations with correction for repeated measures were performed considering a required power of 0.8 and a between-measurement correlation of 0.6. The numbers of subjects required to detect an intervention effect of 10% of the mean value were estimated for all gait quality measures. Results There was no difference in means of any of the gait quality measures between measurements and their correlation was high (r = 0.77 to 0.97). Gait variability generally required the largest number of subjects, ranging from 13 to 35 with highest numbers for ML direction. Gait smoothness showed large directional effects and required 24 and 19 subjects for VT and ML direction respectively, while AP direction required only 4. Gait intensity (as measured by RMS and range) required 12 to 22 subjects, walking speed and stride frequency required 4 to 9 subjects. Gait symmetry and gait complexity required 4 to 7 subjects. Conclusion Detection of intervention effects using daily-life gait variability measures as outcome requires a substantial number of subjects, while fewer subjects are required when employing gait complexity as outcome. The results of this study help to determine the number of required subjects for the design of intervention studies.

P1-O-84 The impact of falls on functional recovery after discharge from in-patient stroke rehabilitation

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BACKGROUND AND AIM: Stroke survivors generally improve in sensory, cognitive, and motor function over a course of in-patient rehabilitation. Upon returning to the community, individuals with stroke continue to recover and work towards regaining independence in activities of daily living. However, between 37-73% of individuals with stroke experience a fall in the first 6 months after discharge from hospital [1-3]. Falls can have significant physical and psychosocial consequences, including injury, fear and anxiety, and reduced mobility and activity [4], which may threaten the goal of regaining function after discharge. This study aimed to explore the effect of falls on long-term recovery after discharge from in-patient stroke rehabilitation. METHODS: We conducted a prospective cohort study of patients who were discharged home from in-patient stroke rehabilitation (n=65; time post-stroke=44 days, IQR=28). Participants were recruited at discharge and completed a 6-month falls monitoring period using postcards with follow-up assessment at the end of the 6 months. Analysis of covariance was used to identify differences between fallers and non-fallers at the 6-month follow-up on balance confidence (Activities-Specific Balance Confidence (ABC) scale), balance function (Berg Balance Scale (BBS)), motor recovery of the leg and foot (Chedoke-McMaster Stroke assessment (CMSA)) and cognition (Montreal Cognitive Assessment (MoCA)). RESULTS: 40% of participants (26/65) had at least one fall; a total of 53 falls were reported during the study period (9 participants fell more than once). Controlling for discharge scores, fallers and non-fallers did not differ on the ABC (fallers: 75.4%, non-fallers: 81.5%; p=0.059), MoCA (fallers: 24/30 points, non-fallers: 25/30 points; p=0.14) or CMSA leg scores (fallers: 5 points, non-fallers: 6 points; p=0.052) when assessed 6 months post-discharge. BBS scores (fallers: 49 points, non-fallers: 55 points; p=0.0008) and CMSA foot scores (fallers: 5 points, non-fallers: 6 points; p=0.0006) were significantly lower for fallers than non-fallers. CONCLUSIONS: Physical performance was compromised in fallers when compared to non-fallers 6 months post-discharge from in-patient rehabilitation. These differences may be mediated by reduced activity following a fall, resulting in either deconditioning or less capacity for ongoing motor recovery. Stroke survivors may benefit from supported discharge including falls prevention strategies and education for continued functional recovery. REFERENCES: [1] Forster & Young, BMJ, 1995; 311(6997): 83-6. [2] Mackintosh et al., Arch Phys Med Rehabil, 2006; 87(12): 1583-9. [3] Mackintosh et al., Clin Rehabil, 2005; 19(4): 441-51. [4] Batchelor et al., Int J Stroke, 2012; 7(6): 482-90.

P1-O-85 Large Trials on Falls Prevention in Parkinsons Disease: Outcomes of Hospital, Outpatient and Home Based Physiotherapy

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BACKGROUND AND AIM: A series of 3 large RCTs were conducted with more than 350 participants to evaluate methods to reduce falls and improve walking in Parkinson's disease (PD). There are more than 6 million people worldwide with PD and more than 60% fall. The aim was to evaluate therapy outcomes for outpatient clinics, hospitals and the home. METHODS: In the outpatient clinic trial 210 people with PD were randomised to one of three physiotherapy groups (i) cognitive motor strategies (ii) progressive resistance strength training (iii) a life-skills control group. Patients had 8 weeks of physiotherapy once per week and a home program. The falls rate was recorded over a 12 month period after therapy. Walking speed and health related quality of life were also tested (Morris et al, 2015). In the hospital trial 28 patients were measured and were either randomly allocated to a movement strategy group or an exercise therapy group; they received two weeks of intensive rehabilitation for up to 16 sessions (Morris et al, 2009). The home based trial had 143 participants who received 6 weeks of home based therapy that was either combined strength training and strategies or a life-skills control group (refer to protocol in Morris et al. 2012). RESULTS: For the outpatient clinic trial there were 1547 falls (Morris et al 2015). These comprised 193 falls for people who received strength training, 441 for those who received cognitive movement strategy training and 913 for controls (Morris et al, 2015). For the strength training group the incidence rate ratio compared to controls was 0.151, 95% CI 0.071-0.322, $P < .001$ (Morris et al, 2015). For the movement strategy group there were around 62% fewer falls than controls (IRR = 0.385, 95% CI 0.184-0.808, $P = .012$) (Morris et al, 2015). Disability improved only in the strategy and strengthening groups. For the inpatient hospital trial participants who were trained in cognitive movement strategies showed improvements in walking, balance, disability and quality of life over the course of rehabilitation whereas only quality of life improved in the exercise group (Morris et al, 2009). For both groups there was subsequent deterioration in the 3 month follow up period (Morris et al, 2009). Preliminary analyses have been conducted for the home based trial, with indications of comparable falls and gait outcomes for a 6 week program of strength training coupled with cognitive strategies compared to a life-skills control group, with more than 2000 falls reported over the 12 month follow up period. CONCLUSIONS: The dosage, content and delivery location of physiotherapy are critical elements to match to individual needs when structuring rehabilitation programs to reduce falls and improve mobility. It is recommended that when designing falls prevention and mobility programs for people with PD at least 8 weeks of therapy be delivered with adequate time dedicated to each element of therapy in order to achieve a training effect.

P1-P-86 The Effect of Lead-limb and Seat-height on Transition From Sitting to Upright in Healthy Individuals

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BACKGROUND AND AIM: Sit-to-walk (STW) is a common transitional motor task, however it is rarely incorporated into motor rehabilitation as sit-to-stand represents the pre-gait clinical milestone, followed by progression to sit-to-stand-and-walk (STSW). Evaluation of demand-based rehabilitation is often rudimentary, due in part to the absence of pre-morbid data and is predicated on achievement of functional task milestones. Comparison of key task indicators with normative data might facilitate more sensitive monitoring of progression than task-attainment alone. Rising from seats higher than knee-height (KH) is more achievable for impaired patients, but whether this significantly affects task dynamics is unclear. Furthermore, a single normative data set independent of lead-limb would simplify patient assessment. This study tested whether lead-limb and rising from 100 and 120%KH affects the kinetics and kinematics of STSW and STW in young healthy individuals. METHODS: Ten (5M) young (29±7.7 (SD) years) healthy volunteers performed STSW and STW tasks. Subjects rose from an instrumented height-adjustable stool with feet shoulder width apart on independent force plates (Kistler; 2100Hz) with optical motion capture (Qualysis; 60Hz). Five trials of each task were completed at 100 and 120%KH whilst leading with the dominant (DOM) and non-dominant (NonDOM) legs. For each trial movement onset (T1), maximum centre of mass (COM) horizontal velocity (T2), seat-off (T3), peak net vertical ground reaction force (vGRF; T4), maximum COM vertical velocity (T5), and upright stance (T6) were determined. Subsequently mean time from T1 to each other event, COM velocities at T2 and T5, vGRFs at T4, and centre of pressure (COP) to COM horizontal distances at T3, T4, T5, T6 (as a measure of stability) were obtained. The effect of seat height (100, 120%KH), lead-limb (DOM, NonDOM) and interaction were determined within tasks by a 2-way ANOVA with statistical significance assumed at $p \leq 0.05$. RESULTS: Lead-limb had no effect in either STSW or STW tasks, with no significant interaction effect with seat height. In contrast, at 100%KH higher peak vGRFs were generated for STSW [$F(1,39)=6.062$; $p=0.019$] and STW [$F(1,39)=8.567$; $p=0.006$]. Peak vertical COM velocities were also higher at 100%KH in STSW [$F(1,39)=15.537$; $p<0.001$] and STW [$F(1,39)=27.052$; $p<0.001$]. However, peak horizontal COM velocities, COP-COM distances, and all times did not differ between seat heights. CONCLUSION: Lead-limb had no effect upon STSW or STW parameters in young healthy individuals, suggesting that normative data independent of lead-limb can be utilised to monitor motor rehabilitation. While 120%KH reduced peak vGRFs and COM velocities in STW and STSW, all other variables were invariant. Therefore, 120%KH is an appropriate seat height for functional assessment of the transition from sitting to upright in patients.

P1-P-87 Balance function in patients who had undergone allogeneic hematopoietic stem cell transplantation

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BACKGROUND AND AIM: Patients who have undergone allogeneic hematopoietic stem cell transplantation (allo-HSCT) often experience falls. A previous study reported that the incidence of falling among allo-HSCT patients during hospitalisation is 50%. No reports have demonstrated balance function after transplantation. Therefore, the purpose of this study was to investigate the balance function of allo-HSCT patients by conducting a postural sway test. METHODS: Thirty patients (18 men and 12 women) who underwent allo-HSCT between February 2013 and September 2014 at the Hyogo College of Medicine Hospital were included in this study. The patients were evaluated for up to 3 weeks before and 7 weeks after the transplantation. They were evaluated for their performance in the functional reach test (FRT), timed up-and-go (TUG) test, and postural sway test. Postural sway was recorded at the centre of pressure (CoP) displacement by using a force platform equipped with a data processor, with eyes-open and closed conditions, respectively. RESULTS: TUG test score was significantly increased after allo-HSCT compared with before allo-HSCT in all the patients ($P < 0.01$). In addition, the length of CoP displacement was significantly increased after allo-HSCT with the eyes open and closed ($P < 0.01$). Furthermore, the root mean square (RMS) area of CoP with the eyes closed was significantly increased after allo-HSCT than before allo-HSCT ($P < 0.01$). While, the FRT score and RMS area of the CoP with the eyes open were not significantly different between before and after allo-HSCT in all the patients. CONCLUSIONS: The allo-HSCT patients in this study had worsen dynamic and static movements of the CoP after transplantation. Rehabilitation staff, nurses, and physicians should recognize the decreased balance function of patients who have undergone allo-HSCT.

P1-P-88 The virtual physiotherapist system utilizing IMU sensors.

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Background: The proposal of the developing system named Virtual Physiotherapist (VPh) supporting rehabilitation in home environment or in a medical facility according to a specified training plan is presented. Its key feature is related to the fact that rehabilitation does not require direct supervision of the human physiotherapist. Motion data of a patient's training are stored in VPh memory and available

offline to be analyzed and assessed by a medical expert who supervises the rehabilitation process. VPh consists of the acquisition module and software which supplies specified functionality. They are configurable in respect to the type of training. The crucial property of the developing system is related to an online feedback activated in case of remarkable differences between exemplary motion and one performed by a patient. Thus, motion data of a training have to be captured and a method which estimates differences between two motions has to be proposed. The acquisition technique based one IMU sensors is going to be applied. It gives possibility to create any configuration of the sensors in respect to specified kinematical chain of a human body and performed exercises. What is more, it has no strict limitations related to acquisition place. Methods: To compare motions and to determine the most remarkable differences Dynamic Time Warping (DTW) transform with rotation distance metrics based on Euler angles and unit quaternion coding is chosen. DTW synchronizes motion sequences by matching their time instants with dynamic, monotonic transform of a time domain. As the result dissimilarity of compared motions is calculated. It reflects a total score assessing quality of training performed. To identify incorrect movements, the warping path, representing DTW synchronization is analyzed. Its segments corresponding to noticeably dissimilar time instants indicate the movements. What is more, DTW is calculated separately in respect to motion sequences of subsequent body parts which allows to assess them. DTW applied to multidimensional time series with rotational data of a complete set of joints evaluates coordination of movements. Results and conclusions: The preliminary experiments were carried out. The motion recordings were captured in Human Motion Laboratory of PJAIT (http://hml.pjwstk.edu.pl). They are related to selected rehabilitation exercises. At the current stage the proposed method is evaluated by a comparison of analyses of a training provided by a medical expert and VRh system. The obtained results seems to be satisfactory. The VRh determines similar improperly performed movements as a human expert. However the crucial is a proper choice of threshold dissimilarity values for calculated DTW costs. They are different for applied rotation distance functions and body parts. Acknowledgement: The work is supported by The Polish National Centre for Research and Development, the project is named "Virtual physiotherapist".

P1-Q-89 Estimation of Smartphone Orientation Worn on the Thigh during Physical Activity

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BACKGROUND AND AIM: The ubiquity of smartphones has led to the investigation of their use as an ambulatory monitor for those that suffer from a chronic disease whose symptoms can be indirectly assessed through physical activity (PA). The state-of-the-art in activity classification from ambulatory monitors has focused on machine learning algorithms that extract features from a magnetic and inertial

measurement unit (MIMU) to estimate PA. The accuracy of attitude and heading reference system (AHRS) algorithms that describe the orientation of the MIMU need to be assessed during different PAs if they are to be used by algorithms designed to detect falls or estimate PA. A complementary filter-based AHRS algorithm (CAHRS) that uses a MIMU to estimate device orientation was validated by comparison to a gold standard reference from a motion capture system (Vicon). The tuning parameters, which weight the sensitivity of CAHRS to the accelerometer and magnetometer sensors, are optimized to minimize the root mean square error (RMSE) in the estimated Euler angles describing the orientation of the device, and determine if the accuracy of the estimates and optimum tuning parameters are affected by the PA performed. METHODS: Data were recorded from the smartphone's MIMU whilst reflective markers on a non-ferrous rectangular plate attached to the device enabled its orientation to be measured. The device was placed on the upper thigh to simulate a pants pocket position whilst four PAs were performed. The performance of CAHRS during each PA was assessed by calculating the RMSE for the Euler angles (roll, pitch, yaw) = (Φ°,θ°,ϕ°).The optimum tuning parameters for CAHRS (μa, μm) during each PA were identified. RESULTS: The RMSE varied with the activity performed. Whilst walking in a figure of 8: Φ=2.48°, θ=4.12°, ϕ=5.87° (μa=0.0046, μm=0.0001). During ascent and descent of a step ladder: Φ=4.56°, θ=15.31°, ϕ=9.15° (μa=0.0049, μm=0.0004). When transitioning between standing and lying, Φ=3.57°, θ=6.38°, ϕ=6.29° (μa=0.0036, μm=0.0001).Whilst stepping up and down on a box: Φ=2.63°, θ=2.36°, ϕ=11.28° (μa=0.0022, μm=0). CONCLUSIONS: Accuracy of AHRS used to estimate the orientation of body worn MIMUs need to be validated under conditions involving translation and rotation. The tuning parameters that produced the lowest RMSE varied between physical activities which suggests that the optimum values are dependent on the nature of the body movement, and possibly the location of the MIMU. Although not fixed to the body during general use the movements that the smartphone experiences indirectly describe the orientation and translational motion of the thigh which aid in estimating PA.

P1-Q-90 Impulse-momentum analysis shows that walking on a split-belt treadmill was energetically optimal after adaptation

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1) Background and aim Asymmetric walking, especially walking on a split-belt treadmill, has been applied to the study of walking disabilities such as hemiparesis. These studies have reported that the large asymmetry observed in kinematic features at the early stage of split-belt walking gradually changes to being more symmetric as the walking continues due to a process of adaptation. We hypothesized that an energetic perspective may provide important insights into this locomotor adaptation. Human walking is known to be energetically optimal by impulse-momentum analyses such as a gravitational impulse model. In this study, we examined whether asymmetric walking adaptation on

a split-belt treadmill could be explained in terms of energetics using impulse-momentum analysis. 2) Methods To examine whether the energetics of gait adaptation occurred in an optimal manner in split-belt walking, we analyzed the impulse-momentum of step-to-step transitions for split-belt walking using the impulse model. The impulse model consists of a point mass and two massless rigid legs. To represent the asymmetric features of split-belt walking, especially the leg angle, we introduced the leg length change into the impulse model for each step-to-step transition. In addition, the momentum difference relative to two belts was introduced to represent the difference of speed between two belts. Model parameters were leg angle and the amplitude of the gravitational impulse which were set from the angle of impulses and the duration of double support phase respectively, based on experimental data. Optimal push-off which minimized work done throughout a stride could be obtained from the work-energy relationship for each belt. To validate the model, we obtained the kinetic and kinematic data from a split-belt walking experiment on nine subjects who signed the informed consent form approved by IRB of Georgia Tech. They walked in baseline periods with tied belts (0.5 and 1.5 m/s), the adaptation period with split-belt (0.5:1.5 m/s) and the post-adaptation period with tied belt again (0.5 m/s). Impulses and work were calculated by integrating forces and power, which were obtained as product of force and velocity of the center of mass relative to each belt. 3) Results In early adaptation, subjects could not generate optimal push-off impulse so that the push-off impulse could not compensate the collision loss, and this result showed that gait during the early adaptation was not energetically optimal. Gait during the late adaptation, however, was energetically optimal so that optimal push-off was generated to compensate collision loss fully as consistent with the model prediction. 4) Conclusions The results imply that adaptation during split-belt treadmill walking occurred to optimize energetics and it could be explained in terms of energetics by an impulse-moment analysis.

P1-R-100 Presence of multiple obstacles affects gait safety in healthy elderly and people with Parkinson's disease

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BACKGROUND: Tripping over obstacles is one of the main reasons for falls in people with Parkinson´s Disease (PD) [1]. People with PD have altered locomotion patterns during obstacle crossing, such as larger step width and lower velocity, compared to healthy controls [2-3]. However, studies have only examined stepping over a single obstacle. The presence of a second obstacle can impair the avoidance strategy for the first obstacle in people with PD [4-5]. The aim of this study was to analyze the influence of a second obstacle during walking in people with PD. METHOD: Twenty people with mild-moderate PD and 19 healthy elderly (CG) participated in this study. Subjects were clinically and cognitively evaluated. The participants were then required to walk at a self-selected speed on a pathway in three conditions (three trials per condition): no obstacle, single obstacle (single) and a pair of obstacles (pair). The second obstacle was positioned 1.10m from the first in the pair. The obstacles were made of foam (15cm high). Step length, duration, width and velocity were analyzed for the obstacle-crossing steps (includes both obstacles in pair condition), and compared to values from no obstacle condition. Toe clearance (vertical distance from foot to obstacle) was also measured. Optoelectronic motion analysis (Optotrack®) and a carpet with pressure sensors (GAITrite®) were used for acquisition of gait parameters. MANOVA with repeated measures was performed to compare experimental conditions. Bonferroni post hoc tests were used to localize the differences between experimental conditions ($p<0.05$). RESULTS: Participants increased step length during crossing for both the single obstacle and second obstacle (pair), in relation to no obstacle. Furthermore, the participants had longer step lengths for the single obstacle than for either obstacle in the pair condition. Velocity was slower in all obstacle conditions, in relation to no obstacle ($p<0.001$). In addition, velocity was slower for the first obstacle (pair) than for the single obstacle ($p<0.005$). Participants also had a higher leading limb toe clearance for the second obstacle compared to the first in the pair condition ($p<0.001$). Finally, trailing limb distance in the first obstacle (pair) was reduced compared to both single ($p<0.001$) and second obstacle (pair) ($p<0.001$). There were no differences observed between CG and PD. CONCLUSIONS: The presence of a second obstacle can impair the crossing of the first. The second obstacle may be a distraction from the first, which may indicate that elderly people change their focus of attention and planning of future actions before they finalize the overtaking of the first obstacle [5]. This altered strategy may contribute to an increased likelihood of trips and falls. REFERENCES: [1]Stolze et al. (2004) J Neurol; [2]Vitório et al. (2010) Gait Posture; [3]Galna et al. (2010) Hum Mov Sci; [4]Krell; Patla (2002) Gait Posture; [5]Chapman; Hollands (2007) Gait Posture

P1-R-101 The Impact of Segmental Trunk Support on Posture and Reaching in Children with Cerebral Palsy: A Kinematic and Electromyographic Study

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BACKGROUND AND AIM: One of the most challenging clinical features in cerebral palsy (CP) is postural dysfunction, which is more evident in children classified as III-V according to the Gross Motor Function Classification System. Upper limb functions are also significantly impaired and this can be accentuated by lack of postural control. Despite this fact, there is limited literature on posture and reaching control in children with moderate to severe CP. The few existent studies have always looked at seated reaching behavior while providing either full or no support of the trunk, failing to address the contributions of specific segments of trunk control on reaching. This study aimed to test the effects of external support at different levels of the trunk on seated postural and reaching control in children with moderate/severe CP. METHODS: A sample of 17 children, GMFCS III-IV (2-15 years), was clustered into three subgroups according to their intrinsic trunk control, measured by the Segmental Assessment of Trunk Control. The mild group had control of the entire trunk; the moderate group had control of the thoracic and cervical regions; and the severe group only had control of the cervical region. During the seated reaching task, participants reached for an object placed at midline, with external support at axillae, mid-rib and pelvic levels. Kinematic and electromyographic data of posture and arm were collected. RESULTS: Changes in kinematic and muscle activation patterns for reaching and posture were observed depending on the support level and group. The mild group displayed more efficient timing mechanisms compared to other groups and did not show differences in posture or reaching control across levels of support. Participants in the moderate group displayed significant improvements in postural stability and associated reaching control with axillae or mid-rib support. With a higher support, the moderate group displayed earlier muscle onset and lower arm/trunk muscle amplitudes, compared to pelvic support. Lastly, the severe group showed improvements in postural configuration and stability only when the support was at the highest level (axillae support). Muscle amplitudes and timing mechanisms were variable across support levels for severe participants. CONCLUSIONS: Based on these results, providing an external trunk support at the level above which trunk stability is compromised improves posture and arm control as well as muscle activity in upright sitting position. These benefits are more prominent in children with CP who have postural limitations at the thoracic-lumbar regions of the trunk. A multi-segmented model of the trunk in sitting control should be considered in both postural assessment and treatment of children with CP. Furthermore, this approach opens new frontiers in rehabilitation and could be included within evidence-based training protocols of upper extremity in the most involved children with CP.

P1-R-102 Resistance Training versus Balance Training to improve postural control in patients with Parkinson?s Disease

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BACKROUND AND AIM: Reduced muscle strength is an independent risk factor for falls and related to postural instability in patients with Parkinson's Disease (PD). The effect of resistance training (RT) to improve postural control still remains unclear. The aim of this study was to compare RT with balance training (BT) to improve postural control in patients with PD. METHODS: 40 patients with idiopathic PD were randomly assigned into two training groups. Participants received either RT or BT twice a week for 7 weeks. RT was performed with the aim to improve muscle strength of the lower limbs. The subjects own weight, cuff weights and elasticated bands were used as resistance. Squats, knee extensions, toe/calf raises, hip abductions and other exercises were performed. BT involved stance- and gait tasks which require feedforward and feedback postural control. Training progression during the intervention period was reached by reducing or manipulating sensory information, necessary to obtain balance.

Visual information for example was disturbed by closing the eyes or looking up to the ceiling. Proprioceptive feedback was manipulated by standing on different unstable surfaces instead of normal overground. The following assessments were performed at baseline, 8- and 12-weeks follow-up: primary outcome: Fullerton Advanced Balance (FAB) scale; secondary outcomes: center of mass analysis during surface perturbations, Timed-up-and-go-test (TUG), Unified Parkinson's Disease Rating Scale, Clinical Global Impression - Improvement (CGI-I), gait analysis, maximal isometric leg strength testing, Parkinson's Disease Questionnaire, Back Depression Inventory. Clinical tests were videotaped and analysed by a second rater, blind to group allocation and assessment time. RESULTS: No significant interaction was found between the two training types in any outcome parameter. Patients from the RT-group, but not from the BT-group significantly improved on the FAB scale (+2.4 points) and in the TUG (-1.7 sec) ($p<0.05$). Within the RT-group, improvements of the FAB scale were significantly correlated with improvements of rate of force development and stride time variability. CONCLUSIONS: Postural control of patients with PD was improved by RT. RT might be more effective than BT to improve balance performance. Our results show that the ability to generate force quickly seems to play an important role in postural control mechanisms. The relationship between improvements of balance and rate of force development needs to be studied in further, larger trials.

P1-R-103 Test-retest reliability of dual task performance measures in patients with Parkinson's disease

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BACKGROUND AND AIM: Dual task (DT) performance is frequently used to explore remaining brain capacity resources, both in elderly and in people with a neurological disorder. In people with Parkinson's disease (PD), test-retest reliability of DT measures is largely unknown. Aim of this study was to assess the reliability of gait and cognitive measures during DT performance in this population. METHODS: Sixty-two participants with PD (H&Y II-III) were included in the analysis, as part of the Belgian subsample recruited for the DUALITY study. Data from the first two baseline measurements were analyzed to assess test-retest reliability over a period of six weeks. Gait velocity, as primary outcome measure, was tested with the GaitRite walkway system under single (ST) and dual task conditions (backwards Digit Span task [DIGIT]; auditory Stroop task [STROOP]; Mobile Phone task [MPT]). Cognitive measures (reaction time and errors) were assessed for each of the tasks in ST and DT condition. T-tests were used to look at systematic differences between test 1 and test 2. ICC values were calculated as a measure of reliability. In case of abnormal distributions, Wilcoxon signed-rank tests and Spearman correlation measures were used. RESULTS: No significant differences for gait velocity were found between test 1 and test 2 during ST performance ($t=0.627$, $p=0.533$) and during DT performance (DIGIT: $t=-1.712$, p=0.092; STROOP: t=-0.571, p=0.570; MPT: t=-1.421, p=0.160). ICC values were high during all tasks (ST: ICC=0.907 [0.845-0.944]; DIGIT: ICC=0.904 [0.841-0.942]; STROOP: ICC=0.910 [0.851-0.946]; MPT: ICC=0.859 [0.767-0.915]). When looking at DT interference measures, expressed as a % of ST performance, however, we saw a significantly better performance in test 2 for DT gait velocity DIGIT (t=2.562, p=0.013) and MPT (t=2.308, p=0.024). ICC values for DT interference showed fair to good reliability (DIGIT: ICC=0.683 [0.473-0.818]; STROOP: ICC=0.611 [0.357-0.765]; MPT: ICC=0.706 [0.509-0.824]). Cognitive measures did not differ significantly when comparing test 1 to test 2, except for fewer errors made in test 2 when performing DIGIT in DT condition (Wilcoxon=325, p=0.002). Reliability for reaction time values was moderate to high (DIGIT: ICC = 0.693 to 0.747 [ST reaction time: rs=0.533]; STROOP: ICC = 0.830 to 0.823). Reliability of error rates between test 1 and test 2, was substantial for DIGIT (rs = 0.619 to 0.733), but fair to moderate for STROOP and MPT (rs = 0.205 to 0.458). CONCLUSIONS: Absolute measures of DT gait velocity showed good reliability over a period of six weeks (ICC > 0.80). Furthermore, cognitive DT performance as measured by reaction time proved to be reliable in test-retest situation. Interference measures and error rates however had a lower reliability. These findings are important for choosing outcome measures of DT performance in future clinical studies aimed at improving DT capacity in PD.

P1-R-104 STN-DBS reduces freezing of gait in Parkinson's disease in the VANTAGE prospective, multi-center trial

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BACKGROUND AND AIM: In general, DBS has been demonstrated to be effective for PD symptom relief; however, improvement of FOG remains under debate. Whereas some studies support the idea that FOG is alleviated after STN-DBS, STN-DBS has also been associated with worsening of gait and balance and, in some patients, STN-DBS even induces FOG. The VANTAGE study assesses motor improvement in moderate-to-severe Parkinson's disease (PD) following bilateral subthalamic nucleus deep brain stimulation (STN-DBS) using a new, implantable, rechargeable, multiple-source, 8-contact, constant-current DBS System (Boston Scientific,Vercise?). Here we report on the effects of STN-DBS on freezing of gait (FOG) in this cohort of PD patients. METHODS: VANTAGE is a monitored, prospective, multi-center, non-randomized, open-label interventional trial, sponsored by Boston Scientific. FOG was characterized with UPDRS-II item 14, the freezing of gait questionnaire (FOGQ) and a walking test known to provoke FOG before and after surgery. Data collection included FOGQ at Baseline and 26 weeks post-

implantation, and the walking test at Baseline, 12, 26, and 52 weeks post-implantation. The walking test was videotaped and rated remotely by an independent rater (CS), blinded to the subject's implantation status. Other clinical scores were collected according to the study protocol of the main study. RESULTS: Forty total patients were implanted. Of these, thirty-eight patients were analyzed with FOGQ data according to protocol. The FOGQ showed significant improvement at 26 week follow up compared to baseline. This finding corresponds to overall improvement of gait as derived from UPDRS-III item 29 and UPDRS II item 14. Looking at FOG in particular (FOGQ item 3) 12 freezers remained freezers, 15 freezers turned to non freezers, 10 non-freezers remained non-freezers, and one non-freezer turned to a freezer at 26 week follow up compared to baseline. The walking test was performed by 29 of the 38 patients at baseline during medication off. 13 of these patients showed FOG-episodes off medication at baseline and improved after L-Dopa intake (12 patients without FOG and one patient from 9 episodes to three episodes during medication on). ON-FOG was not observed in this cohort. Postoperatively, total walking time, number of FOG episodes as well as total time spent frozen were reduced at week 12, 26 and 52 compared to baseline during medication off. CONCLUSIONS: Data from both, FOGQ and the walking test, support the idea that STN-DBS reduces FOG occurrence and severity at 26 weeks postoperatively with constant effects at week 52. The follow up data of the VANTAGE study will help to understand if the improvement on FOG persists in the long term.

P1-R-91 Pronounced Lateral Postural Instability in Persons with Progressive Supranuclear Palsy: A Comparison with Parkinson's Disease

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BACKGROUND AND AIM: Progressive supranuclear palsy (PSP) is an atypical parkinsonism associated with severe postural instability with frequent falls, appearing early in the course of the disease. Postural instability is also a common clinical feature of Parkinson's disease (PD) leading to confusion among neurologists and patients alike. These familiar presentations often lead to misdiagnosis and ineffective therapeutic strategies. The aim of this study was to examine two important aspects of postural sway variability (i.e., magnitude and structure) in persons with PSP and PD to understand disease-specific differences in postural control between the two symptomatically-resembled neurological disorders. METHODS: Ten persons with PSP (66±8 years, 164.9±11.4 cm, and 77.4±14.9 kg) and ten age and gender-matched persons with PD (64±7 years, 169.8±12.7 cm, and 78.4±15.3 kg) participated. After obtaining an informed consent, participants were instructed to stand quietly on a force platform with their eyes open for 30 seconds. Time-series ground reaction forces were collected to compute individuals' center of pressure (COP) motion in the anteroposterior (AP) and mediolateral (ML) directions. Structure and magnitude of postural sway variability in both directions were examined by approximate entropy (ApEn) and 95% confidence ellipse (A95), respectively. An independent t-test was performed for each dependent variable to compare between the two groups. A level of significance was set at p=.05. RESULTS: No significant difference was observed for A95 between PSP (6.58±6.43cm²) and PD (2.73±1.56cm²) groups (p=.08). Conversely, the PSP group exhibited significantly lower ApEn value (0.25±.04) in the ML direction when compared to the PD group (0.37±.04; p=.03). Yet, this group difference was absent in the AP direction (PSP: 0.31±.06, PD: 0.40±.06; p=.31). CONCLUSIONS: In summary, our study identified significant alteration in structure of postural sway variability in PSP, with absence of difference in magnitude when compared to the PD group. Given that low ApEn values represent a predictable time-series signal, which is generally thought to correspond to loss of efficiency and to adaptive capability, we find that persons with PSP exhibited less adaptability in the ML direction, which could help discriminate them from PD. Our findings also suggest that clinicians and therapists should emphasize improvement of lateral postural control to alleviate postural instability and to reduce number of falls in persons with PSP.

P1-R-92 Gaze behaviour in freezers may relieve processing demands

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Background and Aim Freezing of gait (FOG) in Parkinson's disease (PD) is a severe movement symptom that manifests as an unintended halting of gait. FOG is commonly provoked when freezers perform a dual-task that loads attentional resources, or process sensory demanding conditions, such as narrow spaces or without vision of limbs. It is unknown how visual cues, which guide improved gait in freezers, may compensate for either the attentional or sensory deficits in freezers. Since the environment that freezers visually navigate through can load attentional and sensory resources, this study examined gaze behaviour in conditions where sensory (removing lower-limb vision) and attentional (dual task) demands were manipulated. Methods Freezers (n=11) and non-freezers (n=17) walked (7.92m) towards and through a narrowed doorway with a device (25cm x 30cm) attached at the waste that removed vision of the lower-limbs (lower-limbs occluded=LLO) in three conditions: 1) Baseline (LLO), 2) Visual Cues (LLO+VC) and 3) Visual Cues and Dual-Task (digit-monitoring task, LLO+VC+DT). Gaze stabilized (1.00 deviation) on a location in the environment for a duration of 99ms was defined as a fixation. Percentage of total fixation duration (PTFD) was analyzed on three areas of interest (AOI): 1) PATHWAY, 2) DOORWAY, and 3) THROUGH. Results A significant Group, Condition, and AOI interaction of PTFD was found (F(4,96)=2.49, p=0.048). At baseline, freezers demonstrated a significantly lower PTFD towards the DOORWAY than non-freezers (p=0.0059). In the LLO+VC condition, both freezers and non-freezers significantly increased the PTFD towards the PATHWAY compared to baseline; however, freezers demonstrated a significantly lower PTFD towards the PATHWAY than non-freezers (p=0.04), opting to look more through the doorway. Lastly, in the LLO+VC+DT condition, both groups significantly increased

PTFD towards the PATHWAY compared to baseline (i.e. similar PTFD towards the PATHWAY in both freezers and non-freezers). Conclusion Since freezers demonstrated a shorter PTFD on the doorway at baseline, they may be utilizing a behavioural strategy to avoid gaze of the doorway, thereby minimizing the sensory demand on processing resources. When visual cues were present, freezers looked to the relevant threat more than non-freezers. Visual cues during the approach may decrease the overall demands of the task, allowing freezers more time to plan for the doorway. In the LLO+VC+DT condition, greater demand (from the dual task) on processing resources resulted in freezers adopting the strategy of non-freezers. Thus, visual cues may reduce task demands (by guiding preplanned movement) when the freezer's processing demands are high.

P1-R-93 Transcranial direct current stimulation to enhance dual-task gait training in Parkinson's disease: a pilot, randomized, double-blind, sham-controlled trial

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Background and aim: Transcranial direct current stimulation (tDCS) has been shown to improve gait, balance, motor function and bradykinesia when applied to the primary motor cortex of individuals with Parkinson's Disease (PD) (Kaski et al 2014; Benninger et al 2010; Fregni et al 2006). It has been shown to boost the effect of physical gait training in PD, resulting in greater improvements in gait velocity when tDCS and physical training are combined than when either therapy is applied alone (Kaski et al 2014). The aim of this preliminary study was to investigate whether the addition of anodal tDCS over the motor cortex (M1) would improve gait performance and motor function beyond that of dual task gait training applied alone in individuals with PD. Methods: A pilot, randomized, double-blind, sham-controlled trial with 12 week follow-up was undertaken. Sixteen participants diagnosed with idiopathic PD were randomized into a dual task gait training group with active tDCS and a dual task gait training group with sham tDCS. Training was applied in nine, 20 minute sessions performed over 3 weeks. The primary outcome was gait speed when walking over an 8m GAITRite mat and undertaking one of three concurrent cognitive tasks (word lists, counting, conversation). Secondary measures included step length and cadence over 8m, the Timed Up and Go (TUG) test under single and dual task conditions, bradykinesia and motor speed. Two-way ANOVAs were performed to determine differences between groups and across timepoints. Results: Overall, there was a significant improvement in gait speed ($p < 0.035$), step length ($p < 0.045$) and cadence ($p<0.22$) under all dual task conditions from pre to post with training with this effect maintained at follow-up. There was no difference in improvement between the active and sham tDCS groups. There was no change in TUG walking performance over time or between groups, but the active tDCS group improved in their concurrent cognitive task correct response rate post training, whereas the sham group did not. There was an improvement in bradykinesia after training in both groups, but no change in motor speed between groups or over time. Conclusions: Three weeks of dual task gait training improved gait performance during concurrent numerical and language tasks, and bradykinesia, immediately following training and at 12 weeks follow-up. The only parameter that was enhanced by anodal tDCS was the number of correct responses provided while performing the TUG and reproducing word lists or counting. Anodal tDCS applied to M1 may not be an effective adjunct to dual task gait training in PD. References: Benninger DH et al. J Neurol Neurosurg Psychiatry 2010;81(10):1105-1111. Fregni F et al 2006. Mov Disord 2006;21:1693-702. Kaski D et al. Clin Rehabil. 2014 Nov;28(11):1115-24.

P1-R-94 Self-assessment of gait symmetry in individuals with unilateral stroke: A pilot study

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BACKGROUND AND AIM: In motor learning, skill acquisition can depend on the learner's ability to identify and correct movement errors. Following a stroke, many individuals walk with an asymmetrical gait pattern. A limitation in the capacity to perceive the timing characteristics of one's own walking may interfere with one's ability to correct gait abnormalities post-stroke. The purpose of this pilot study was to assess the feasibility and accuracy of patient self-assessment of stance-time symmetry in ambulatory individuals with history of stroke. METHODS: A total of 13 adults (mean age 59.8[SD 15.9] years) with history of stroke (median onset 27.9 months [IQR 21.5]) participated in this study. Participants performed repeated walks along a GAITRite mat to determine presence, side and degree of stance-time asymmetry. They were then asked to describe their own gait pattern in terms of stance-time, using a 3 novel gait self-assessment tools: 1) a questionnaire regarding the relative time spent on each limb during gait; 2) a visual tool, in which they adjusted two vertical bars to reflect the relative time in stance on each limb during gait, and 3) an audio-based tool, where participants compared their walking pattern to a series of audio-clips representing different degrees of stance-time symmetry by the sound of footsteps. The feasibility of each of the tools was evaluated based on time and need for additional assistance to complete. Accuracy of self-assessment of presence and direction of asymmetry for those with stance-time asymmetry ratio (Stance-AR) were calculated using Cohen's Kappa(κ). Agreement between self-estimated and measured Stance-AR was assessed using intraclass-correlation coefficients (ICC). RESULTS: Participants walked at a mean comfortable gait velocity of 0.82 (SD 0.24) m/s, with a Stance-AR of 1.06 (SD 0.06). Seven of the 13 participants had Stance-AR values >1.05 indicating asymmetrical gait. Of the three self-assessment tools, the written questionnaire was completed in the least amount of time and with the fewest additional instructions. Each participant was consistent in their self-assessment across the three self-assessment tools, however, there was poor agreement between self-assessed and measured Stance-AR. On average, participants were unable to accurately identify whether they walked in a symmetrical or asymmetrical manner (κ=0.049). For participants who

were truly asymmetrical (n=7), only 4 were able to correctly identify the direction of the asymmetry (κ= 0.101). Agreement between self-assessed and measured Stance-AR values were poor (ICC=-0.009; 95% CI -2.5, 0.71). CONCLUSIONS: Based on the results of this pilot study, individuals with stroke may be unable to accurately assess the temporal characteristics of their own gait. This may have implications for their ability to self-assess and correct their gait independently or in response to therapist feedback.

P1-R-95 FREEZING OF GAIT OR AXIAL RIGIDITY? UNDERSTANDING THE COORDINATIVE NATURE OF EN BLOC TURNING IN PD

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Background - Individuals with Parkinson's disease (PD) present en-bloc movement while walking and turning. En-bloc movement is characterized by reduced separation between axial segments (head, shoulders, pelvis) during body rotations, which is exemplified in individuals with severe gait deficits, such as freezing of gait (FOG), when compared to other patients without FOG (but similar axial rigidity). Other locomotor problems, such as slowness, have also been strongly associated with increased axial rigidity (neck stiffness), which may lead to difficulties coordinating and separating axial segments. Thus it may be important to evaluate how the severity of axial rigidity may be related to en-bloc coordination deficits, and whether this might be similar to patients with FOG. Aim - The aim of this study is to understand the specific influence of FOG and axial rigidity on the relationship between segments during turning in PD. Methods - We recruited PD patients with increased axial rigidity without FOG symptoms (PD-RIG; n=11); patients with FOG with low rigidity scores (PD-FOG; n=11) and PD patients without FOG and with low rigidity scores (PD-CONTROL; n=13). Groups were matched by age and disease severity. Kinematic analysis of turning behaviours was performed using five synchronized Optotrak® cameras. Participants were instructed to walk and turn around 180° when they reached a marker placed on the floor at 3m away from the starting point. Participants performed five turns to each side (10 randomized trials in total). Angular displacement of the head, shoulders and pelvis in the transverse plane were calculated in order to estimate the continuous relative phase (CRP) and its variability; and maximum separation between axial segments (Head-Thorax, Head-Pelvis, and Thorax-Pelvis). Body velocity during turning was estimated calculating the peak velocity of the pelvis during turning. Additionally individuals who froze were compared to those who did not freeze during the task, and to PD-RIG in order to further investigate the influence of FOG pathology on axial control in PD. Results - Maximum separation between segments was significantly greater in the PD-CONTROL compared to PD-RIG (p=0.007), whereas PD-FOG fell in the middle of this spectrum. All groups turned with similar turning velocities and similar in-phase coordination, however only PD-FOG revealed a significantly lower CRP variability compared to PD-CONTROL (p=0.04). Conclusion - While all patients with PD appear to turn with in-phase coordination between body segments, unlike non FOG, PD-FOG reveal the least variability in

coordination between segments, as well as a reduced separation between segments, suggestive of a greater en-bloc turning impairment in PD-FOG. These results may be suggestive of a lack of proprioceptive feedback contributing to en-bloc impairment.

P1-R-96 Sensor-based gait parameters correlate to clinical scores and dual task performance in Parkinson?s disease

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Background and aim Impaired gait and postural stability are major motor symptoms in Parkinson's disease (PD), substantially increase risk of falls, and reduce quality of life. The UPDRS (Unified-Parkinson-Disease-Rating-Scale) part III is routinely used to assess motor impairment in PD. The UPDRS categorizes gait and balance by single items "gait" (GA) and "postural stability" (PS). However, this rating is subjective and thus leading to a high interrater variability. The aim of this study was to complement and compare clinical ratings with objective, quantitative, and rater independent measures of gait and postural control using inertial sensor-based gait analysis (eGaIT - embedded gait analysis using intelligent technology) [1]. Methods The UPDRS-III was rated by neurologists specialized in movement disorders from 191 PD patients (Hoehn&Yahr stage I-III, age 63.7±10.6). All patients and 101 age-matched controls were submitted to quantitative gait analysis. Spatiotemporal gait parameters were analyzed based on inertial sensor technology [2] laterally attached to the heel while patients performed a standardized 10 meter walk. A subpopulation of PD patients (n=40) performed this test under a dual task challenge (counting backwards in steps of three while walking). Results Spatiotemporal gait parameter such as stride length, gait speed, and foot clearance inversely correlated to UPDRS part III items (GA, PS). Additionally, stride and stance time, as well as swing time variability significantly increased with motor impairment. The dual task challenge further decreased gait speed and cadence, and increased stance time. In addition, variability of stride and stance time increased under dual task condition. Nevertheless, the aggravation of gait parameters by dual task (ratio dual/single task) was similar for patients with high or low levels of GA and PS. Conclusions Quantitative gait parameters recorded by inertial sensors correspond to the clinical assessment of gait and postural impairment in PD patients. Interfering with cognition using a dual task sensor-based gait parameters further worsened. Nevertheless, the impact of this additional challenge on gait alterations was independent from the clinical rating of GA or PS. Thus, dual task dependent gait parameters are complementary measures to the UPDRS part III. Sensor-based gait analysis supports clinical workup and provides objective information for monitoring in PD. References [1] Klucken J, Barth J, Kugler P, Schlachetzki J, Henze T, Marxreiter F et al. (2013). Unbiased and mobile gait analysis detects motor impairment in Parkinson's

disease. PlosOne 8(2), e56956 [2] Rampp A, Barth J, Schülein S, Gaßmann KG, Klucken J, Eskofier B (2014). Inertial sensor based stride parameter calculation from gait sequences in geriatric patients. IEEE Transactions on Biomedical Engineering. DOI 10.1109/TBME.2014.2368211

P1-R-97 PreAtaxia: Changes in the control of posture and gait in pre-clinical degenerative cerebellar ataxia

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Background: It is well-known from many neurodegenerative movement disorders that subtle movement changes occur often years before clinical manifestation. Effectiveness of future interventions and their evaluation will largely depend on (i) detecting these diseases as early as possible, and (ii) a more detailed understanding of the earliest dysfunctional motor control mechanisms and compensation strategies within the preclinical stage. Here, we aimed to establish measures that allow the identification and understanding of ataxia-specific dysfunctions at the earliest stage of degenerative ataxia. We hypothesized that an increasing complexity of balance and gait tasks might reveal dysfunctions in pre-clinical stages of the disease. Methods: We assessed (i) stance (Romberg test) in different complexities including closed eyes and on an elastic mat and (ii) walking on hard and soft ground. Ataxia-specific changes including spatial and temporal variability1 as well as body sway were assessed by quantitative movement analysis. Assessments were performed in three groups: 1.) Group EARLY: N=21 patients with early stage degenerative ataxia [SARA2 score: 3-7 points]; 2.) Group PRE: N=11 subjects with premanifest ataxia [SARA <3 points, 8 of 11 mutation carriers for spinocerebellar ataxia (SCA) types 1,2,3 or 6]; 3.) Group CON: N=25 age-matched healthy controls. For SCA mutation carriers in the PRE group, movement parameters were related to the genetically estimated clinical disease onset3. Results: A difference in body sway was observed in all Romberg conditions between the groups EARLY and CON ($p<0.001$) as well as between EARLY and PRE ($p<0.02$). Differences between PRE and CON have been identified in classical Romberg, with closed eyes, and on the mat with closed eyes ($p<0.002$). Body sway was correlated with estimated disease onset, indicating a continuous development of changes in pre-clinical phase. In gait, we found no single measure differentiating groups PRE and CON. This might due to differences in gait strategies which conceal subtle changes in the PRE group. However, using multi-variate features analysis, we identified feature sets that capture these strategies and enable a significant differentiation between PRE and CON subjects ($p=0.02$). Model outputs for SCA subjects were correlated ($p=0.03$) with their estimated disease onsets. Discussion: We identified features in stance and gait, which differentiate controls not only from early ataxia subjects, but also from pre-clinical gene carriers. These features show a correlation to the time of estimated disease onset, thus describing a continuum of change already within the pre-clinical phase. These findings will establish the basis for therapeutic trials aiming to delay disease onset and progression in

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P1-R-98 An Stimulation Algorithm to Treat Gait Impairment for Individuals with Parkinson?s Disease Following Deep Brain Stimulation (DBS) of the Subthalamic nucleus (STN).

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Background: A sub-group of individuals with Parkinon's Disease (PD) have a delayed onset of worsening of gait at different time-points after a successful deep brain stimulation (DBS) procedure. Delayed worsening of gait is multi-factorial and can be the consequence of: disease progression, side effects of stimulation, inadequate stimulation settings or an inadequate medication regime. The clinician is required to determine the underlying cause of gait impairment in order to treat this phenomenon. Thus, we have established an algorithm to test different stimulation and medication conditions and select the best option to gain optimal gait status. Objective: To establish an algorithm which can identify the cause of delayed worsening of gait and provide prescriptive elements to optimize gait quality, reduce freezing of gait and falls for patients with PD, who have experienced delayed onset of worsening of gait after DBS of STN. Methods: A prospective cohort study, including ten consecutive individuals. Inclusion criteria: chronic stimulation of at least one year with delayed onset of worsening of gait, no evidence of misplacement. Exclusion: Any orthopaedic or systemic disease affecting mobility/gait and capability to undergo follow-up visits and no significant side effects during surgery. Patients were evaluated at baseline, one and six months after enrolment with the Unified Parkindson's Disease Rating Scale (UPDRS) and the gait and falls questionnaire. Gait analysis (GA) with the GAITRite system was also conducted. A baseline gait assessment was conducted followed by four consequential stimulation/medication adjustments. GA was also conducted after each condition (waiting 10 min for stimulation and 40 min for medication). The most effective condition for each patient was then selected based on GA results. The four conditions were: C1 - an increase by 0.5 volts on the right and left hemisphere; C2 -80 Hz stimulation with voltage increased in order to maintain the total energy delivered constant; C3 - reduction in amplitude by 0.5V in the STN contralateral to the best side (best side based on gait analysis) in order to improve gait asymmetry; and C4 - baseline parameters with an extra dose of levodopa. Patients' settings were altered to the optimal condition and then followed 1 and 6 months later for gait analysis and the GFQ. Results: All patients successfully completed the study; C2 was selected for 6 patients, C3 for 3 and C4 for 1 case only. Modulation of stimulation enhanced gait quality by improving velocity by approx. 20cm/s, increasing the stability ratio by approx. 0.33 and improving the step length by approx. 25 cm. The improvements are stable over the follow-up period, however there was a slight decrease in the quality of gait that did not decline back to the baseline. Conclusions: Given the multifactorial etiology of gait worsening after a successful DBS procedure, we have proved that a systematic parameters/medication adjustment incl

P1-R-99 Acute effects of a novel treadmill device on gait and postural control in patients with Parkinson's disease

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Background and Aim: Gait disturbances and postural instability are typical motor symptoms in Parkinson's disease (PD). Treadmill training has been shown to be effective in improving gait performance in PD patients (Mehrholz et al., 2010). Further, highly challenging balance exercises have been suggested to counteract postural instability (Allen et al., 2011). A combination of gait and balance exercises may be particularly beneficial for improving gait and reducing risk of falling. Thus a novel treadmill device (Zebris medical GmbH) was developed, with the purpose of applying additional postural challenges during walking. For this, pneumatic actuators below the treadmill constantly induce small three-dimensional tilting movements. The aim of this ongoing study is to examine the feasibility of this novel training device and to investigate spontaneous adaptations to a single training session. Methods: Twenty-seven PD patients (age 63.6 ± 9.7 years; H&Y I-III, UPDRS 18 ± 8.4) were randomly assigned to a) treadmill training with tilting movements (TT; n = 13) or b) conventional treadmill training without tilts (CT; n = 14). After a 5-minute familiarization period on the treadmill, participants performed a single session of 15 minutes treadmill walking (three 5-minute blocks). Balance and gait were assessed prior to (T0), immediately after (T1) treadmill walking and after a 10-minute retention phase (T2). Gait outcomes included over-ground walking speed (10 meter), and spatiotemporal gait parameters (stride length, step width, double limb support) assessed on the treadmill (FDM-T pressure plate, Zebris medical GmbH). Balance was measured by center of pressure sway velocity (vCOP) and sway area (aCOP) in quiet standing (eyes open, 3trials, 30seconds). A repeated measures analysis of variance with post hoc analysis was used to analyze differences over time and between groups. Results: All participants successfully completed the single training session with no adverse events reported. Balance outcomes: vCOP decreased in both groups from T0 to T2, with a significant difference from T1 to T2 (-1.11 ± 1.62 mm/sec, p = 0.001). aCOP did not change significantly over time. Gait outcomes: The TT group showed a trend towards increased over-ground walking speed at T2 compared to T0 (TT 0.15 ± 0.39 km/h, p = 0.20; CT -0.09 ± 0.41 km/h, p = 0.41). No changes were observed in the spatiotemporal gait parameters. Conclusions: The novel treadmill training with additional postural challenges was well accepted by the participants. Thus, this intervention appears to be feasible in PD patients with early disease stages. Our preliminary data suggest that acute adaptations to this training are similar to conventional treadmill training. References: Allen NE, Sherrington C, Paul SS, Canning CG (2011). Movement Disorders, 26 (9), 1605-1615. Mehrholz J, Friis R, Kugler J, Twork S, Storch A, Pohl M (2010). The Cochrane Database of Systematic Reviews, (Issue 1): CD007830.

P1-S-105 Younger total knee replacement patients demonstrate symmetrical heel strike transients and knee joint moments during level walking

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Background: After joint replacement surgery there is a predictable pattern of deterioration in other joints of the lower extremities [1]. Abnormal gait patterns, such as asymmetry between limbs, are adopted by osteoarthritic patients [1] and after total knee replacement (TKR) often persist [2]. Asymmetry can create excessive levels of impact forces at the unaffected joints which may precede the development and affect the progression of osteoarthritis for these joints [1]. The use of TKR has increased substantially during the past two decades, particularly among younger patients [3]. Although the number of younger TKR patients (<55 years old) is rapidly growing, very little is yet known regarding their functional outcome post-TKR and if they differ from the typical, older TKR patient (>65 years old). Aim: The purpose of this study was to investigate the effect of age on the heel strike transient and knee joint moments of both the surgical and non-surgical knees among younger and older TKR patients six months following unilateral knee replacement. Methods: The three-dimensional analysis of ten walking trials was collected from a convenience sample of 59 participants, including 29 primary knee replacement patients six months after surgery, consisting of four groups: 1) Younger patient (YP: age: 54.3 ± 7.9 years), 2) Younger control (YC: age: 55.2 ± 4.0 years), 3) Older patient (OP: age: 76.9 ± 4.7 years), and 4) Older control (OC: age: 77.7 ± 4.1 years). Results: The OP group demonstrated significant asymmetry between their surgical and non-surgical limbs for the heel strike transient (0.49 ± 0.1 vs. 0.67 ± 0.2 %BW, $p < 0.03$, respectively) and peak knee adduction moment (2.32 ± 0.2 vs. 2.92 ± 0.2 %BW*H, $p = 0.01$, respectively); the YP group (0.52 ± 0.2 vs. 0.56 ± 0.2 %BW; 2.36 ± 0.2 vs. 2.34 ± 0.2 %BW*H, respectively) did not demonstrate these asymmetrical patterns nor did the OC (0.55 ± 0.1 vs. 0.53 ± 0.1 %BW; 2.33 ± 0.2 vs. 2.32 ± 0.2 %BW*H, respectively) and YC (0.55 ± 0.1 vs. 0.56 ± 0.1 %BW; 2.29 ± 0.2 vs. 2.32 ± 0.2 %BW*H, respectively) groups, $p > 0.05$. Conclusions: The cause of the observed asymmetrical gait pattern for the OP group is not known, however, there is evidence supporting the concept that chronic pain can create peripheral and central neuronal reorganization, altering gait. Importantly, these asymmetrical patterns were not observed in the YC group. The cause of this difference between patient groups, although only speculative, could be explained by a more acute progression of osteoarthritic degeneration for the YP group, and thereby the time required to enact these changes in the brain might not have existed. Research is needed to explore neuroplastic changes and the possible relationship to persistent gait abnormalities in younger and older TKR patients. [1]

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P1-T-106 Cerebral network subtending proprioceptive processing in children from 7 to 10 years

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Background and aim: Acting with the environment is based on internal representation of the body in action. This internal representation, called the body schema, is construct through ontogenesis and is mostly based on proprioception. An improvement in proprioceptive acuity have been evidenced from childhood to adulthood (Goble et al. 2005). Moreover, 8-year-old children start using more efficiently proprioceptive inputs for on-line movement control (Contreras-Vidal et al. 2006). Taken together, these studies sign a late maturation of proprioceptive integration during ontogenesis. At the brain level, much remains to be discovered about the development of the proprioceptive network, especially during childhood, which is the topic of the present fMRI study. Methods: Eighteen children (n = 18; 11♀ mean age= 8.9±1.1 years) and eighteen adults (n=18; 9♀; mean age= 33.2±4.4) took part into the experiment. They underwent a muscle tendon vibration protocol, supine into a 3-Tesla fMRI scanner. Pneumatic vibration devices were placed on the right and left tendons of the tibialis anterior muscles, providing low- (30 Hz) and high-frequency (100 Hz) stimulations. These parameters were selected as 30 Hz stimulation drives weak discharges of the primary endings and 100 Hz frequency optimally activates primary endings. Contrasting the two vibration conditions reveal the base network of proprioceptive-related activity. fMRI time series were analysed using general linear models. Results: Our results show that children and adults activate a similar network, including sensorimotor regions (S1, M1, SMA) and higher-order association regions (i.e. frontoparietal). Moreover, a larger spatial extent of activation has been reported in children compared to adults. Finally, several brain areas show an age-dependent level of functional activation, with an increased activation in children especially in SMA. Conclusion: Our findings reveal that the proprioceptive network in 7 to 10 years old children is already established. However, this functional network undergoes a refinement until adulthood. Further investigations are warranted to establish whether such age-related brain changes may explain the developmental trend in proprioceptive acuity reported in behaviour.

P1-U-108 Hypersensitivity to visual cues during quiet standing in persons with Mal de debarquement: Preliminary report from a case-control study

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BACKGROUND AND AIM: Mal de debarquement syndrome (MdDS) is a rare disorder that results a continuous feeling of swaying, rocking, and/or bobbing (phantom motion), generally follows travel on the sea (e.g., a cruise). While MdDS is often characterized as a balance disorder, its effects on postural sway patterns remain relatively understudied. The aims of this study are: 1) to compare postural sway pattern in persons with MDDS (n=10, 61±7 years, 165.2±7.7 cm², 72.1±10.0 kg) with BMI-, gender- and age-matched healthy controls (n=10, 62±3 years, 168.0±5.0 cm², 80.7±11.4 kg), and 2) to examine how occlusion of visual cues affects postural control in persons with MdDS. METHODS: Subjects were asked to stand as still as possible on a force platform for 20 seconds under two conditions: 1) eyes-open (EO), and 2) eyes-closed (EC) (three trials per condition). Center of pressure (COP) motion was measured in the anteroposterior (AP) and mediolateral (ML) directions. Magnitude of postural sway variability was examined by 95% confidence ellipse (A95). Additionally, detrended fluctuation analysis was performed to obtain α-values to the dynamic pattern of sway variability. A 2 (Group) x 2 (Condition) analysis of variance (ANOVA) was performed for each dependent variable and post-hoc pairwise comparisons were performed whenever a significant interaction was observed. Partial η^2 values were also calculated to examine effect sizes. The level of significance was set at p=0.05. RESULTS: No significant Group main effect was observed for any dependent variables; however, a trend-level Group x Condition interaction with a moderate to large effect size was observed for α-values in the ML direction (p=0.07, partial η^2= 0.17). Post-hoc tests revealed that occlusion of visual input resulted in postural sway that was biased toward slower fluctuations (i.e., increased α-value) for persons with MdDS (EO: 1.47±0.09, EC: 1.51±0.07). This phenomenon was not observed in healthy controls (EO: 1.52±0.05, EC: 1.52±0.05) who exhibited no difference in α-value between EO and EC. Additionally, both groups exhibited similar patterns of sway with their eyes closed. A significant Condition main effect for A95 was observed in which suppression of visual cues significantly increased sway area (from 0.64±0.46 to 1.52±1.44cm² for MdDS, and from 0.69±0.51 to 1.03±0.90cm² for controls; p=0.02). No significant Group x Condition interaction for A95 was observed. These results indicate that the MdDS subjects were able to adapt their magnitude of sway variability to visual conditions at a level similar to their matched counterparts. However, a difference emerged in such a way that the adaptation of postural dynamics was altered (i.e., faster COP fluctuations with visual information) in the MDDS subjects. CONCLUSION: Our preliminary results suggest that the balance disorder of MdDS is driven at least in part from hypersensitivity and over-reactiveness of the motor system

P1-U-109 The Effect of a Visual Manipulation on Navigating a Virtual Reality Environment in Older and Younger Adults

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Falls incidence and falls-related injuries are prevalent in older adults. This may, in part, be due to a non-optimal use of dynamic visual information (optic flow) during walking. Purpose: To determine how younger and older adults use optic flow when making judgements related to safe locomotion through a closing gap in a virtual reality environment. Methods: 17 younger adults (23.9±3.0 years; 0 males) and 6 older adults (73.7±4.8 years; 0 males) were instructed to walk on a treadmill at a constant speed of 1m/s down a virtual hallway which contained a set of elevator doors approximately 10m from the start. At some point along the hallway, the doors began to close at varying rates of speed. Prior to passing through the doors, the scene went blank and participants were asked to judge whether they could safely pass through the gap without changing their body orientation. Across trials, optic flow rate was manipulated to either move faster (1.5x), equal to (1.0x), or slower than (0.8x) participants' physical walking speed. Kinematic data was collected on anterior trunk, head, and foot markers. Results: A main effect of age was found ($p<.05$) such that, overall, younger adults judged they could pass through narrower gaps than older adults. A main effect of optic flow rate was found ($p<.05$), such that all participants judged that they could pass through smaller gaps at the optic flow rate that was slower than their actual walking speed. An interaction between age and optic flow rate was found, such that older adults displayed different judgement strategies across the three different optic flow conditions compared to young adults who did not significantly vary across the optic flow rate conditions ($p<.05$). Specifically, older adults demonstrated more cautious judgments during the faster optic flow rate trials as they judged that they could only safely pass through larger gaps, compared to their perception of safe passage through smaller gap widths at optic flow rates that were equal to and slower than physical walking. We are currently conducting an analysis of gait variability (step length and width) and center of mass control to enable further understanding of age-related differences associated with different dynamic visual inputs during walking. Significance: Older adults were more influenced by the visual manipulation than younger adults, resulting in a more conservative aperture crossing behaviour when optic flow rates were faster. This may be a result of older adults being more susceptible to sensory discrepancies and/or weighing visual information higher than younger adults. This could result in older adults having an increased risk of falling. As such, our findings may ultimately help to inform intervention strategies to reduce falling incidences in older adults.

P1-U-110 Assessment of interhemispheric interactions between shoulder and trunk muscle representations of the primary motor cortex

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Background and aim: After a unilateral stroke, 30% of individuals have decreased arm function. One mechanism that can support recovery of the arm after stroke is the reorganisation of interhemispheric interactions. Most studies of these interactions, as well as rehabilitation strategies, focus on the hand.

However, postural control of proximal arm and trunk muscles are essential to elicit purposeful arm movements. As such, cortical areas involved in the control of these movements are likely to also play a crucial role in recovery of arm after stroke. Hence, the goal of this study is to characterize interhemispheric interactions between cortical representations of proximal arm and axial muscles in M1 of the two hemispheres. Methods: Eleven healthy subjects participated in this study. In the first paradigm, ipsilateral silent period (iSP) was assessed in right Anterior Deltoid (AD) and Erector spinae at L1 (ES L1) during right isometric shoulder flexion. As a control, iSP in a distal hand muscle, the right First Dorsal Interosseous (FDI), was assessed during isometric abduction of the index. The iSP was elicited by stimulation of the motor cortex ipsilateral to the recorded muscles with current intensities of 130% of active motor threshold (aMT). In the second paradigm, a paired pulse (PP) protocol was applied during the same tasks. A conditioning stimulus (CS ; 130% of aMT) was given over the right M1,10 ms prior to a test stimulus delivered at 120% of aMT on left M1 (5 subjects). Results: iSP could be clearly elicited in FDI in 70% of subjects, in AD in 54% of subjects, and in ES L1 in 45% of subjects. The iSPs area, latency and duration for FDI, AD and ES L1 were not significantly different from each other. Ipsilateral motor evoked potential (iMEP) could also be evoked in ES L1 (in 70% of subjects). For the paired pulse paradigm, the CS decreased the amplitude of the MEP evoked by the TS in FDI (amplitude= 90% of test MEP) and AD (82%). Contrastingly, it increased the MEP in ES L1 (135%). We further assessed paired pulse using different interstimulus intervals in AD and ES L1 (2, 4, 6, 8, 10, 12, 40 ms) in 5 subjects. In AD inhibition was strongest at an ISI of 8ms. In ES L1 an interhemispheric facilitation occurred at ISI of 10 and 12ms but an inhibition could be induced at 6ms and at 40 ms. Conclusion: These preliminary results suggest that IHI between distal, proximal and axial muscles are different. Intercortical interaction between distal (FDI) and proximal (AD) muscle representations are mostly inhibitory. In contrast both excitatory and inhibitory interactions are present between axial muscles used to maintain stability of posture during arm movement. Supported by Sensorimotor rehabilitation research Team (SMRRT-CIHR)

P1-U-111 A differential games approach to analyse the influence of moving obstacles on locomotor avoidance strategies post stroke

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BACKGROUND AND AIM: An individual's locomotor trajectory may be shaped by the presence of an obstacle and may vary depending on the obstacle motion characteristics (stationary vs. moving; approaching from left vs. right). This dynamic interaction can be expressed using the differential games approach. Further, the effect of obstacle influence on locomotor strategies in post-stroke individuals is not known. The objective of this work is to explore the influence of an obstacle with the differential games approach on locomotor avoidance strategies in post-stroke and healthy age-matched individuals, under different obstacle motion characteristics. METHODS: Four post-stroke (age: 55.3±6.4 years;

chronicity: 2.2±0.9 years) and four healthy participants (age: 52±6.7 years) walked in a virtual room towards a target while avoiding obstacles that were either stationary (S) or approached randomly from head-on (HO), 30° left (L) and right (R). Participants' locomotor strategies were recorded using the CAREN-3 virtual reality system and a 12-camera Vicon-512 motion capture system. These avoidance trajectories were then fitted to the differential games model (within an error of 0.05m) to estimate changes in obstacle influence during the avoidance strategy. The obstacle influence was modelled by a Gaussian 2D distribution with constant amplitude and flexible elliptical horizontal cross-sections, oriented such that the longer diameter lay along the direction of obstacle motion. Appropriate fitting of the experimental data with the model trajectory was achieved by suitably changing the long and/or the short diameter of the elliptical influence. The coefficient of variation (CV) of the instantaneous difference between the long and short diameters was used to compare obstacle influence in response to the four obstacle motion conditions. RESULTS: Preliminary results show that the CV was smaller under stationary condition as compared to the moving obstacle condition in post-stroke (S: 6.06±4.65%; HO: 9.50±3.75%) and control participants (S:11.92±9.19%; HO:12.09±10.80%). For diagonal obstacle approaches, CV was greater when the obstacle was approaching from the paretic side (post-stroke: 40.54 ± 15.47 %) or L (controls: 36.88 ± 10.79%) as compared to approaching from the non-paretic side (post-stroke: 36.76 ± 11.81 %) or R (controls: 33.20 ± 7.96%). Although differences in obstacle influence were observed between groups, both groups showed similar trends across obstacle motion conditions. CONCLUSIONS: Increased CV indicates larger changes in the long and/or short diameters of the elliptical obstacle influence. In this small sample of post-stroke and healthy individuals, obstacle influence increased from stationary to moving obstacles and was the largest for an approach from the paretic (stroke) or left side (healthy). Thus, obstacle influence is shaped by its motion characteristics and as a consequence, the locomotor strategies could be adapted accordingly.

P1-U-112 Associations between measures of structural brain connectivity and the sit-to-stand-to-sit performance in individuals with non-specific low back pain and healthy controls: a diffusion MRI based network analysis

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BACKGROUND AND AIM Individuals with non-specific low back pain (NSLBP) show an impaired sensorimotor control. They need significantly more time to perform five consecutive sit-to-stand-to-sit (STSTS) movements compared to healthy controls. Optimal sensorimotor control depends on the co-activation of many brain regions, which have to operate as a co-ordinated network to achieve correct motor output. Therefore, the examination of brain connectivity from a network perspective is crucial for understanding the factors that drive sensorimotor control. In addition, since NSLBP is an important socio-economic health problem and since the current treatment of NSLBP provides only modest short-term success, research related to the mechanisms and causes of NSLBP is recently considered as one of the priorities in NSLBP research. Therefore, potential alterations in structural brain networks of individuals with NSLBP and the correlation with the performance of the STSTS task were investigated. METHODS Seventeen individuals with NSLBP and 17 healthy controls were instructed to perform five consecutive STSTS movements as fast as possible. Based on the center of pressure displacement, the total duration of the STSTS task was determined. In addition, data of diffusion magnetic resonance imaging (b-value of 1300 s/mm², 60 non-collinear directions and an average of 5 b0-images) were acquired and analyzed using a graph theoretical approach. RESULTS Results showed that individuals with NSLBP needed significantly more time to perform the STSTS task compared to healthy controls (p= 0.002). In addition, an increased duration of this STSTS task was associated with decreased mean degree (unstable support surface: r= -0.53, p= 0.002), decreased nodal degree of the primary visual cortex (stable support surface: r= -0.56, p= 0.001; unstable support surface: r= -0.55, r= 0.001) and decreased local efficiency of the caudate nucleus (unstable support surface: r= -0.50, p= 0.003) across the total group. However, no significant group differences in the network measures were observed (p> 0.0006). CONCLUSIONS Both global and regional network measures were associated with the performance of the STSTS task. At regional level, the decreased nodal degree of the primary visual cortex and the decreased local efficiency of the caudate nucleus were correlated with a longer duration to perform five consecutive STSTS movements. These findings suggest that the connectivity of these sensorimotor areas, related to the processing of sensory signals, plays an important role in sensorimotor control. Moreover, the findings suggest that optimal brain connectivity from a network perspective is crucial for sensorimotor control.

P1-U-113 Mild Head Impacts Induce Immediate Increase in Trunk Motion during Treadmill Walking

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BACKGROUND AND AIM: Current thinking views mild head impact (i.e., subconcussion) as an under-recognized phenomenon that has the ability to cause significant current and future detrimental neurological effects. However, repeated mild impacts to the head often display no observable behavioral deficits based on standard clinical tests (e.g., BESS). There is a paucity of research examining mild-head impact with more sophisticated behavioral measures that relate to everyday function. METHOD: We examined changes in upper trunk motion of experienced college-aged soccer players after heading 10 soccer balls shot at a velocity of 11.2 m/s over 10 minutes. Twenty subjects walked on the treadmill with a visual feedback system that tracked and displayed the subject's trunk orientation in real time with respect to vertical. Trunk orientation was represented as the position of a cursor within a bullseye target on a LCD screen mounted directly in front of the subjects while walking on a treadmill. The center of the bullseye corresponded to upright vertical. Subjects were instructed to walk for three trials on the treadmill at 1.4 m/s for two minutes while maintaining the cursor as close to the center of the bulls-eye as possible. The amount of time the cursor was within the center of the bulls-eye was converted to a performance score out of a maximum of 1200 points, displayed after each trial. The experimental group (N = 10) performed this task 24 hours prior (baseline), 0 to 2 hours immediately after (H0-2), and 24 to 48 hours after soccer heading (H24-48). A control group (N = 10) followed the exact same schedule with no soccer heading. Root mean square (RMS) velocity and low frequency variance (LFV; < 0.75 Hz) of subjects' trunk orientation were calculated in the anterior-posterior (AP) and medial-lateral (ML) directions. ANOVA and student's pair t-tests were used to analyze changes between baseline, H0-2, and H24-48. RESULTS: Mean performance score and LFV for experimental and control score showed no significant changes. BESS test also showed no significant changes due to heading. RMS of the trunk orientation velocity from baseline to H0-2 for experimental group increased by 4.23 cm^2/s (p = .04) in AP direction and .89 cm^2/s (p = .02) in ML direction. RMS of trunk velocity from baseline to H0-2 for control group showed no significant changes for either direction. CONCLUSIONS: The lack of changes in performance scores suggests that both groups maintained a similar level of performance. However, the increase in trunk orientation velocity for the experimental group suggests that mild head impact leads to a possible alteration within the control system involving visual and vestibular processing

P1-U-114 Coordination in Self-Paced Tapping of Upper and Lower Limbs with Four Touch Pad Device

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BACKGROUND AND AIM: Human locomotor movement is generally established via the rhythmic, cooperative movement of the limbs. Therefore, the accuracy of cooperative limb motion is an essential element for movement. Coordination studies of these movements are performed in the upper and lower extremities tapping task. This study aims at examining the coordination of upper and lower limbs in the tapping task using simple equipment. Variable periodicity in tapping tasks by ipsilateral and contralateral hands and feet reveals whether change occurs due to tasks and speed. METHODS: Fifteen healthy and young individuals (mean age: 22.3 ± 0.5 years) were instructed to tap their fingers and feet at a self-selected rate in the following six manners: (1) using the index finger of one hand, (2) using index fingers of both hands alternately, (3) using one foot, (4) using both feet alternately, (5) using the hand and foot on the same side of body (ipsilateral) alternately, and (6) using the hand and foot on different sides of body (contralateral) alternately. These tapping tasks were measured for 1.5 min using a computer with a hand four wireless touchpad. Data was analyzed by performing a comparative investigation of tapping speed and variability in tapping interval for each task, conducted using two-way repeated measures analysis of variance (ANOVA). In addition, the relationship between tapping speed and variability of tapping intervals for each task was investigated using Spearman's rank correlation coefficient. RESULTS: Two-way ANOVA demonstrated a significant interactive effect. Therefore, it was subjected to multiple comparisons between tapping speed and variability. The contralateral pattern in four limbs was slower than in other tasks. Furthermore, alternate tapping tasks for index finger and foot were faster than in other tasks. The variability of tapping task increased most for the contralateral task of upper and lower limbs. With regard to hand and foot coordination, ipsilateral and contralateral patterns in four limbs were associated with speed of hand and foot coordination. Furthermore, contralateral patterns were associated with variability. The relative result was speed and variability in the four limb ipsilateral pattern. CONCLUSIONS: Tapping tasks exclusively for upper or lower limbs were not of observed relevance to hands-feet coordination. Therefore, there were suggested timing effects regarding the use of different upper and lower limbs. However, the variability of alternating tapping tasks of the ipsilateral condition by limb was dependent on speed. It can be said that the coordinated movement of the timing affects upper and lower extremities. In addition, contralateral alternate tapping task exhibits slower speed. Therefore, for the coordination of the tapping tasks, the contralateral tapping task of the upper and lower limbs has been suggested to extract the problems other than the tasks.

P1-U-115 Comparison of Postural Control in Participants with Chronic Fatigue Syndrome and Fibromyalgia Syndrome

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BACKGROUND AND AIM: There is a great symptom overlap (70%) between fibromyalgia syndrome (FMS) and chronic fatigue syndrome (CFS) and it is questioned whether this is an effect of comorbidity of different syndromes or differing expressions of the same syndrome. Impaired postural control has been reported in participants with FMS compared with healthy controls (HC), and CFS compared with healthy group, but, to the best our knowledge no one has compared postural control in FMS and CFS. Traditionally, postural control has been examined by measuring migration of center of pressure (COP) during a balance task. Recently, structural analysis has been proposed which decomposing the COP trajectory into a unique supra-spinal component (rambling) and a spinal reflex component (trembling). The aim was to investigate the effect of modulation of visual and kinesthetic information during quiet standing using structural analysis of the CoP signal, in order to explore how CFS and FMS affect postural control and if these expressions differ from healthy individuals along the spectra from mainly pain to mainly fatigue. METHODS: Eighty one subjects (CFS, FMS and HC, 27 in each group), age 19-49 years, performed 60 s of quiet standing for each of three conditions: 1) firm surface with open eyes (C1), 2) firm surface with closed eyes (C2), and 3) standing on a Airex balance pad with open eyes (C3). Tests were performed in the standing on a Kistler force-plate (sample rate 100Hz) without shoes, feet parallel, and arms folded across the chest. Decomposition of the medial-lateral (ML) and anterior-posterior (AP) components of the CoP into rambling (Rm) and trembling (Tr) was performed and expressed as magnitude and frequency of Rm and Tr. RESULTS: HC had the lowest magnitude and highest frequency of Rm and Tr in all three conditions. C3 had significantly the highest magnitude of Rm and Tr in both AP and ML directions in all three groups ($p < 0.001$). Comparing conditions, no significant difference was found in the magnitude or frequency of Rm and Tr in both AP and ML directions between FMS and CFS. HC had significantly higher frequency of Rm and Tr in both AP and ML compared to two other groups ($p < 0.001$). There were significant differences in the magnitude of Rm in AP direction in C3 between FMS and HC ($p < 0.02$), and CFS and HC ($p < 0.03$). CONCLUSIONS: The results indicated that subjects with CFS and FMS had similar pattern of controlling postural sway which was different from HC especially in more unstable condition. Generally, HC used higher frequency of Rm and Tr in all three conditions, but instead both groups of patients used bigger magnitude of Rm and Tr. Moreover, structural analysis extracts more information about the way of controlling postural sway.

P1-U-116 Humans Continuously Optimize Energetic Cost During Walking

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BACKGROUND AND AIM: People prefer to move in ways that minimize their energetic cost. This phenomenon has been established for decades, and now represents a central principle of movement science. Yet, it remains unclear how people discover their optimal patterns. Much theorizing has focused on optima being established over evolutionary and developmental timescales. An alternative hypothesis--one that underpins many modern theories of motor control--is that people can constantly adjust their movements to continuously optimize energetic cost. Here, we test this hypothesis by creating novel energetic optima and determining if subjects will discover and adopt the necessary gait adaptions to reach them. METHODS: To accomplish this, we manipulated the relationship between step frequency and energetic cost using lightweight robotic exoskeletons to apply resistive torques to the motion of the knee joints (Figure 1A). To shift the optimum to lower step frequencies, we had the exoskeleton controller use a penalize-high control function that applied a resistance, and therefore an added energetic penalty, that was minimal at low step frequencies and increased as step frequency increased. To shift the optimum to higher step frequencies, we used a penalize-low control function, where the slope of the penalty was reversed. The control functions were designed to create a clear energetic gradient about the subjects' initial preferred step frequency, yet keep resistive torques low enough to allow a relatively natural gait. To distinguish between energetic cost optimization and simply

minimizing the resistance applied to the limb, we also designed the control functions to ensure that the energetic cost optima occurred at step frequencies distinct from those that minimized exoskeleton resistance. RESULTS: When presented with novel energetic landscapes, subjects adapted their step frequency to converge on the new energetic optima (Figure 1B). They did so in response to energetic landscapes that incentivized them to adapt to both high and low step frequencies (-5.7% and %2B6.9%), and remarkably, in response to relatively small cost savings (< 5%). The time-course of these step frequency adaptations provides insight into the mechanisms underlying energy optimization and gait selection. The initial optimization process occurred on the order of minutes and required broad experience with the energetic landscape. Following this, when transiently perturbed from their new optimal gait, subjects relied on an updated prediction to rapidly re-converge within seconds. CONCLUSIONS: Despite a lifetime of experience walking under natural conditions, people readily adapt fundamental characteristics of their gait to minimize energy expenditure. Our collective findings indicate that energetic cost is not just an outcome of movement, but plays a central role in continuously shaping it.

P1-U-117 Effects of subsensory electrical noise applied to the legs on postural sway in older adults

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BACKGROUND AND AIM: Proprioceptive impairment due to natural aging processes is suggested to contribute to larger body sway in older individuals, mainly when visual information is manipulated. Recent approaches have shown that optimal levels of electrical noise can enhance the detection and transmission of neural signals, thereby improving the performance of sensorimotor tasks in young adults. In this sense, the question that arises is whether older adults could also benefit from the application of electrical noise. Specifically, we are interested in the effects on postural control of older individuals subjected to the application of random electrical stimulation (ES) to their legs under a visual conflict condition (moving room paradigm). METHODS: Postural control was assessed in twenty-eight participants (14 older adults) during the upright stance in two conditions: (1) eyes closed; and (2) eyes open with a complex movement of the visual scenario. For the last condition, the movement of the room consisted of a sum of three sinusoids, with frequencies 0.1, 0.3 and 0.5 Hz. For each postural condition, two experimental sub-conditions were randomly presented: (1) no stimulation; and (2) electrical noise stimulation. The ES consisted of a band-pass filtered noise with a bandwidth from 5 to 2,000 Hz. Pairs of flexible silicon stimulating electrodes were fixed bilaterally over the subjects' calf muscles. The stimulus intensity was individually set at 90% of the sensory threshold, thus the subjects were not aware of the treatment condition. The mean sway amplitude was compared between the groups and between the stimulation conditions. RESULTS: The results indicated that the mean sway

amplitude was larger in older adults only for the condition with movement of the room. For this same condition, the application of ES over the legs induced a reduction in body sway amplitude and this effect was similar between the age groups. No effects of ES in the body sway was observed for the condition with eyes closed. CONCLUSIONS: From these results, it is concluded that both the age-related differences and the effects of ES in postural control are evident in more demanding tasks, i.e., during visual manipulation. The application of ES is believed to lead to improvements of proprioceptive signaling which is particularly important when the visual source is manipulated. These findings may have important clinical implications for older adults, whose proprioceptive and postural changes make them more susceptible to falls.

P1-U-118 Effect of dominant and non-dominant sides on the cervical joint position sense in healthy adults

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BACKGROUND AND AIM: The neck joint position sense (JPS) during the rotational repositioning accuracy task is associated with chronic pain, injury, and muscle fatigue. On the other hand, the reliability of these task has been reported in previous studies, the low reliability may be due to the specificity toward either the right or left sides, similar to the dominance in case of the arms and legs. The purpose of this study was to clarify the effect of the dominant and non-dominant sides on the cervical JPS during the condition with eyes of healthy adults open and closed. METHODS: Nineteen healthy males and females participated in the study. Their ages ranged from 20 to 21 years. The neck active JPS test involved making the subjects sit on a chair with their head in the natural upright position. The subjects were firmly strapped to the chair across the shoulders and pelvis using a inelastic belt. A triaxial angular velocity meter was mounted on a helmet. In this study, the dominant side, was defined as the side having a higher angle using the passive cervical rotation range of motion (ROM) among the right and left sides. The neck active JPS test involved the following 2 visual conditions: eyes open and eyes closed. The subjects were asked to perform the test neck movement within comfortable limits and to return to the starting position as precisely as possible. The movement from right to left was repeatedly performed. In each condition, a set of three trials was executed. Kinematics were evaluated during the head rotation task by measuring ROM, the repositioning accuracy after cervical rotations, and the movement duration in each condition. The cervical JPS was assessed using the absolute errors (AE) and variable errors (VE). RESULTS: Cervical rotation ROM and movement duration were not significant in visual conditions. In the two-way analysis of variance, CE demonstrated a significant interaction between the dominant and non-dominant sides and visual conditions. Analysis of simple main effects showed that the non-dominant side showed a significantly lower CE than the dominant side in the condition with eyes closed. On the other hand, AE showed a significant interaction between the dominant and non-dominant sides and

visual conditions. Analysis of simple main effects revealed that the non-dominant side showed a significantly higher VE than the dominant side in the condition with eyes open, but showed lower VE in the condition with eyes closed. While changing the visual conditions, only non-dominant VE improved significantly in the condition with eyes closed as compared with the condition with eyes open. CONCLUSIONS: The finding that laterality of cervical ROM did not effect the cervical JPS in the condition with eyes open and remarkably effects the same in the condition with eyes closed, suggests that the cervical JPS in the condition with eyes closed is related to the specificity of the right and left neck rotational muscle activation.

P1-U-119 Using postural sway to identify adults with high functioning autism

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Background and aim: Autism spectrum disorders (ASD) are neurodevelopmental disorders which affect the person's ability to interact with the world around him/her. Emerging studies have shown abnormal postural control in people with ASD. While a force plate is often used by researchers to measure postural steadiness, limited array of measurements derived from the force plate are commonly used in analysis. The aim of this study was to enable classification of adults with high functioning ASD (HFA) and typically developed (TD) adults based on force plate measurements of centre of pressure. Methods: The Centre of Pressure (COP) position of twenty adults (aged 19-35) and twelve adults diagnosed with ASD primarily high function autism or Asperger's syndrome (HFA) (aged 19-40) was recorded during 60 seconds of quiet standing with vision available and with vision occluded using plasma goggles (PLATO, Model P1, Translucent Technologies Inc., Toronto, ON, Canada). Results: Of the thirty two adults who participated in this study, two adults (one TD adult and one adult with HFA) were excluded due to hardware issues. Since the recording was over 60 seconds, the sample size was expanded by generating more samples with shorter duration and 50% overlap. The 40 second and 60 second sampling durations were ignored due to small sample size for classification. The samples in each dataset were passed to an in-house custom made Matlab 2014a (Mathworks Inc, Natick MA, USA) program which generated a range of commonly used COP measurements. Five classifiers (decision tree, random forest, naïve Bayes, multilayer perceptron and Bayesian network) (Weka) were used to classify whether a person is TD or has HFA from the aforementioned COP features. Among the thirty three COP features, not all features were significant or relevant to discriminate the classes. Thus, the top five features were selected from decision tree executed on the three datasets with different sampling periods (5s, 10s and 20s). The top five features selected achieved 0.894 classification accuracy based on just standing with eyes open on the force plate for 20 seconds. In the eyes closed condition the HFA adults were indistinguishable from the TD adults. Conclusions: Using a combination of mean velocity of COP in both AP direction and ML direction, mean frequency of COP in medial-lateral direction, 95% power frequency and frequency dispersion the study was able to classify adults with HFA with 89.4% accuracy. The classification was only possible in the vision condition and with vision occluded the groups were indistinguishable. The exciting aspect of this work is that adults with high functioning autism can be differentiated from typical adults based on their postural sway alone. Further research need to explore the development of a tool for screening for HFA using postural sway.

P1-V-120 Can a single lower trunk body-fixed sensor differentiate between straight line walking and stair descent and ascent?

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INTRODUCTION: Stair ascent and descent are common, everyday forms of ambulation that may be challenging to detect automatically. Here, we propose the first step towards differentiating between this activity and between level walking using a single body-fixed sensor. METHODS: 20 healthy older adults (age: 62.5¡À9.3 yrs, 65% women) wore a 3D accelerometer on their lower-back while performing straight line walking (~1min) and climbing up and down the stairs (~20sec). Acceleration axes included: vertical (V), anterior-posterior (AP) and medio-lateral (ML). Angular velocity axes included: yaw, pitch and roll. Measures included median and range of all 6 axes, step duration, and step regularity. We compared between the measures of gait, stair ascent and stair descent using non-parametric Wilcoxon two-related samples tests. Stepwise binary logistic regression was applied to check for classification accuracy of each condition. RESULTS: Step duration was highest during stair ascent (0.61¡À0.10 sec) compared to level walking (0.52¡À0.04 sec) and stair descent (0.56¡À0.09 sec) ($p<0.002$). During level walking, subjects tended to have higher V, AP and yaw ranges compared to stair ascent and descent ($p=0.09$-0.0001). V, ML, pitch and roll range were higher in stair descent than ascent (p¡Ü0.006).Trunk tilt (i.e., median AP), was significantly different between conditions (ascent: -0.103¡À0.06g; level walking: -0.001¡À0.07g; descent: 0.03¡À0.08g, p¡Ü0.001). V and AP step regularity were significantly higher for level walking than for stair ascent and descent (p¡Ü0.005). Interestingly, the AP and ML step regularity were higher for stair ascent than descent (p¡Ü0.04), while no differences were observed in the V axis ($p=0.455$). Binary logistic regression was able to detect level walking, compared to ascent or descent, with 91.5% accuracy (84.2% sensitivity and 95.0% specificity) with the yaw range, AP and ML step regularity as significant predictors (p¡Ü0.121). Stair ascent and descent were each detected with 89.8% accuracy (80.0% sensitivity and 94.9% specificity), with the V range, median AP. AP and ML step regularity remaining significant for stair ascent ($p<0.041$) and the median AP and AP step regularity remaining significant for stair descent ($p<0.004$). DISCUSSION AND CONCLUSION: Stair climbing and descent seem to result in longer step duration and a less consistent stepping pattern compared to normal gait, as reflected by the reduced acceleration ranges and step regularity. When ascending stairs, subjects seem to be slower, as depicted by their lower acceleration ranges and higher step duration compared to stair descent. Their gait pattern is also more stable, as depicted by a higher step regularity. The change in trunk tilt during these three movements is also significantly reflected by the acceleration measures. These findings suggest that a single worn body-fixed sensor can be used to differentiate between level walking and stair ascent and descent.

P1-V-121 Impact of vision on left and right foot Centre of Pressure Relationship during a postural task on a passive frontal and sagittal plan unstable platform. Contribution of cross-correlation study.

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BACKGROUND AND AIM: A frontal and sagittal plan unstable platform commonly called Freeman Platform (FP) is usually used in proprioceptive and balance re-education and rehabilitation . The purpose of this study is to assess postural control on FP. Both postural performance and coordination of centres of pressures (CoP) oscillations for each foot will be assessed in two conditions vision /no-vision. METHODS: Seventeen young right-footed adults, with no visual, neurological or orthopaedic defect volunteered for this study. These subjects performed a postural task on FP in two conditions, vision and no-vision. CoP oscillations for each foot and their combination in medio-lateral (ML) and antero-posterior (AP) ranges were measured using a stabilometric twin platform positioned on FP. Combined CoP spatiotemporal parameters were calculated to compare postural performance in each visual condition. Cross-correlations (CC) at phase shift ʈ = 0 (Winter, 1996) were calculated between AP and ML CoP oscillations of the left foot (CoPl) and CoP of the right foot (CoPr) to determine their phase according to visual conditions. RESULTS: i. CoP surface area and AP and ML mean speed are significantly superior ($p<0.01$) in no-vision condition.ii. In vision condition CoPl AP and CoPr AP oscillations are highly antiphase correlated (CC mean : -0.69). In no-vision condition, they are phase correlated (CC mean: 0,41).iii. CoPl ML and CoPr ML oscillations are highly phase correlated in both conditions. Correlations increase significantly in vision condition (vision CC mean : 0.91; no-vision CC mean : 0.78; $p<0.01$).iiii. In both visual conditions, CoPr AP and CoPr ML are phase correlated and CoPl AP and CoPl ML are antiphase correlated. These correlations are higher quality in visual conditions ($p<0.01$) . CONCLUSIONS: Vision is a strong contributor to bipodal posture control on FP. Its availability modifies coordination strategy for both feet. Specifically, it generates a postural control with antiphase AP oscillations of both feet. Cross-correlation (phase shift ʈ = 0) study is a useful tool to highlight this strategy. Further studies are being carried out with left-footed subjects and on single plan unstable platforms.

P1-V-122 Self- selected gait speed - over ground versus self-paced treadmill walking, a solution for a paradox

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Background: The study of gait at self- selected speed is important. Traditional gait laboratories are relatively limited in space with subsequent insufficient path length, while treadmill (TM) walking compromises natural gait by imposing speed variables. Self-paced (SP) walking can be realized on TM using feedback-controlled belt speed. We conducted two experiments in which we compared self-selected gait speed from over ground walking with self-selected gait speed from SP TM. In one experiment (EXPERIMENT A) we provided no visual flow, and in the second (EXPERIMENT B) the subjects were immersed in large virtual reality (VR) environment which induced natural visual flow. Methods: Young healthy subjects were instructed to walk in self-selected comfortable speed, first over ground and then on SP TM system without (n=15), and with the presence of VR visual flow (n=11), covering 96 meters in continuum in all conditions. Gait speed values were compared across conditions for four 10 m long epochs (7.5 - 17.5 m, 30.5 - 40.5 m, 55.5 - 65.5 m and 78.5- 88.5 m). Results: During over ground walking the mean value (± SD) of gait speed was equal for both experimental groups (1.50 ± 0.13 m/s). Without visual flow, gait speed over SP TM was smaller in the first and second epochs as compared to over ground (e.g., for the first: 1.15 ± 0.18 m/s vs. 1.53 ± 0.13 m/s; $p<0.05$), and was comparable in the third and fourth segments (e.g., for the third: 1.45 ± 0.19 m/s vs. 1.49 ± 0.15 m/s; $p>0.3$). In the presence of visual flow, gait speed reached a value comparable to the over ground performance already in the first epoch (1.43 ± 0.22 m/s; $p>0.17$). Curve fitting analyses predicted a tendency for reaching earlier a steady state velocity in SP TM walking in the presence of visual flow (24.6 ± 14.7 m; dashed line in the figure) versus the absence of visual flow (36.5 ± 18.7 m, $p=0.097$; solid line in the figure). Steady state velocity was predicted as higher in the presence of visual flow (1.61± 0.17 m/s) versus its absence (1.42 ± 1.19 m/s, $p<0.05$). Conclusions: The SP TM walking is a reliable method for recording typical self-selected gait speed, provided that sufficient distance is first passed for reaching steady state. In the presence of VR visual flow, steady state of gait speed is reached faster. We propose that the gait research community joins forces in order to standardize the use of SP TMs, e.g., by unifying protocols or gathering normative data.

P1-V-123 Effects of Variations in Electrical Parameters on Bradykinesia of Patients after Subthalamic Deep Brain Stimulation

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Background and Aim: Deep brain stimulation of the Subthalamic Nucleus (STN-DBS) is an effective surgical treatment for advanced Parkinson's disease (PD) patients, leading to a significant improvement in motor symptoms. Currently, there are few guidelines for selecting stimulus parameters and optimized tuning is essentially a trial and error process. Our aim is to systematically and objectively identify the clinical effects on the motor symptoms, including bradykinesia of 15 PD patients undergone STN-DBS over successive DBS programming sessions. Methods: Fifteen PD patients and 15 healthy controls are being recruited. The study has been approved by the local ethic committee and all the participants give informed consent. Each patient is assessed pre-operatively and is followed for 6 months post-operatively. At each visit, we test three DBS settings with enough time between the sessions. The UPDRS is also performed for each setting change. The settings are pre-defined and cover the whole range of device settings in common practice. The settings are randomized for each patient. The patients are recorded in the lab environment during scripted tasks while wearing a full-body kinematic recording suit including 17 inertial measurement units (IMUs). The data from IMUs is then mapped into a joint angles space using commercially available fusion software. A variety of features are then extracted from the data using signal processing methods. This allows for the quantification of a variety of symptoms and signs including bradykinesia. Results: Currently there are 11 patients enrolled in this study and preliminary analysis has been performed for 3 patients who have finished all the 9 lab visits as well as 3 healthy controls. We analyze forearm angular displacement during a hand pronation-supination task. The extracted features are: standard deviation (STD), range of motion (ROM), angular velocity (Vel), and variability in terms of time (Time_Var) and amplitude (Amp_Var). We define a new bradykinesia index which considers all the features: B-Index = sqrt(STD*ROM*Vel/Time_Var*Amp_Var). Our analyses reveal that increasing the frequency of stimulation (while both voltage and pulse width are fixed) generally decreases the B-Index. Increasing the pulse width (while both voltage and frequency are fixed) does not generally cause a consistent effect on the B-Index. Increasing the voltage (while both frequency and pulse width are fixed) increases the B-Index. On average, the B-Index of healthy controls is higher than the patients. Conclusions: We conclude that our method provides an effective approach for monitoring of PD patients' bradykinesia after DBS surgery which overcomes some of the shortcomings of the other studies. We showe that the proposed configuration of IMUs and mapping their outputs to the body joint angles, along with the proposed index form an accurate tool to compare the slowness of movement of PD patients and healthy people.

P1-V-124 Validity, reliability, and clinical utility of an open access Wii Balance Board-based posturography

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BACKGROUND AND AIM: Posturography systems incorporate force plates to objectively measure balance and postural control while assessing sensory integration. The Nintendo Wii Balance Board (WBB) is an inexpensive and portable force platform that has proved to have similar performance to those used in laboratory grade posturography systems. We have developed a web-based tool that would create a clinical posturography system based on the WBB. The aim of this study was to determine the psychometric properties of this experimental assessment tool and to characterize a cohort of stroke individuals with respect to a sample of age-marched healthy subjects. METHOD: A total of 144 healthy individuals (43.34±18.59 yo) and 53 individuals with stroke (52.11±13.70 yo) were enrolled in this study. Individuals with stroke presented with ischemic (n=24) or hemorrhagic (n=29) etiology, and chronicity of 788.75±692.15 days. Inclusion criteria were ability to stand unassisted for 30 seconds and to understand instructions (Mini-Mental State Examination>23). Subjects with severe aphasia (Mississippi Aphasia Screening Test<45), arthritic or orthopedic conditions affecting the lower limbs, or severe hemispatial neglect were excluded. All participants were assessed on the WBB-based system, which consisted of three standardized posturography tests: the modified Clinical Test of Sensory Interaction on Balance (mCTSIB), the Limits of Stability, and the Rhythmic Weight Shift. Performance of individuals with stroke was compared to that of healthy subjects and classified in each test as not altered, mildly altered, or severely altered. To determine concurrent validity of WBB-based posturography, individuals with stroke were also assessed within 5 days with the laboratory grade NedSVE/IBV posturography system (IBV, Spain), and with a battery of standardized clinical scales. A group of 10 subjects were assessed twice in the same day by the same physical therapist and another 10 subjects by two different physical therapists to determine intra and inter-rater reliability, respectively, using the intra-class correlation coefficient (ICC). RESULTS: Measures from the WBB-based system successfully ranked individuals with stroke according to severity of their symptoms, thus characterizing them in comparison to a healthy population. The system demonstrated high to excellent concurrent validity with the NedSVE/IBV system for velocity of COP motion during the mCTSIB (r=0.911, p<0.01). Responses to other clinical scales trended in the expected direction, but correlations with WBB results were not strong. All measures other than directional control exhibited excellent inter- and intra-rater reliability (ICC>0.8, p<0.01). CONCLUSIONS: Comparison of a WBB-based posturography system to a commercially available posturography system suggests that this more economic, freely available system can be relied upon to assess changes in the balance abilities of individuals following a stroke.

P1-V-125 Portrait of the accuracy of Inertial Measurement of Motion for Clinical Biomechanical Evaluation: An analysis of the effect of segment, joint and task on the accuracy of the orientation data.

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Background & Aim: Attitude and heading reference system (AHRS) consists of a set of inertial sensors (accelerometers, gyroscopes and magnetometers) whose outputs are fed into a fusion algorithm in order to deduce the orientation of the device in a global reference frame based on gravity and magnetic North. Popularity of AHRS as motion tracking devices for biomechanics has been growing rapidly over the past few years. However, studies on the accuracy of such systems are limited and often concentrate on a specific task measured at a specific segment. The objectives of this study are: (1) to characterize the accuracy of orientation estimates from AHRS positioned at different segments during a multitask scenario (5m Timed-Up and Go - TUG); and (2) to evaluate the variation of the accuracy during the different tasks included within the TUG (Sit-to-Stand, Walk, Turn). Methods: 10 participants (mean_age = 50.9 years old) performed a 5m TUG in the laboratory at varying speeds, repeatedly (n=3 trials per condition for a total of 60 trials). AHRS modules (ISG-180, Synertial) were positioned on multiple segments (head, upper trunk, pelvis, thigh, shank and foot). Rigid bodies with markers were secured to AHRS modules and tracked simultaneously by an optical motion analysis system used as a gold standard (Vicon Motion System). Absolute accuracy (AC), corresponding to the change in orientation of a segment, and relative accuracy (RA), referring to the accuracy in the tracking of a change in orientation for a specific joint, were assessed as root-mean-square error (RMSE) between the AHRS orientation quaternion and the orientation quaternion of the gold standard. Results: Analysis of the TUG trials showed a mean RMSE of 6.8° for AC across all AHRS (variation between 4.1° and 15.5° according to the segment tracked). Joint kinematics accuracy (RA) over the same trials was slightly less, with a mean RMSE of 8.5° (variation between 2.7° and 20.4° depending on the joint). Non-inferiority analysis revealed that the ankle is significantly less accurate than the rest of the lower limbs joints during a TUG. At a task level, AC was shown to vary between 1.1° and 6.4° while RA varied between 1.4° and 12.2° depending on the task performed and the segment or joint tracked. Conclusion: The current study highlights the fact that accuracy of AHRS orientation data differs according to the segment/joints tracked as well as the task performed, with the ankle being less accurate. With a mean RMSE of 5.1° (AC) and 4.6° (RA) during a TUG (ignoring foot/ankle), AHRS seems to be a suitable solution for clinical evaluation of biomechanics under controlled conditions. However, it is worth pointing out that the current accuracy portrait shows a tendency for AHRS to perform better when the segment is stimulated in angular motion above a certain level during a task (e.g. thigh vs head during walk) which raises questions about the effect of velocity on accuracy.

P1-V-126 Inter- and intra-person variability of plantar pressures during walking

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BACKGROUND AND AIM: Measuring and analysing plantar pressures contributes to the investigation of gait properties. These properties varies from one person to another, but also for a given person. These inter- and intra-person variability is reflected in plantar pressures data. Indeed, it has been shown that plantar pressures may be used to uniquely identify subjects (e.g., Pataky et al. 2012), and to be influenced by walking speed and footwear (e.g., Deepashini et al. 2014). These findings are mostly based on laboratory measurements and may thus not reflect the true variability. In this study, we aim at investigating and comparing these inter- and intra-variability of plantar pressures during walking in everyday-life conditions. METHODS: Plantar pressure data are collected using the FeetMe insole, which is made of pressure sensors and which is connected via Bluetooth to a smartphone or a computer. It contains 70 sensors and has a sampling frequency of 100Hz. Plantar pressures are first collected from 50 subjects, walking straight in a corridor. A cluster analysis is then performed to find the classes, which best group people having a similar gait and best separate people having different plantar pressure distributions. For each identified cluster, a person representing the cluster is selected. Plantar pressure data from these cluster representatives are collected in different conditions: on different grounds (on grass, on a rocky ground, and on tar), with different footwear, and at different speeds. Variability of these plantar pressure measurements is then studied and compared to the inter-person variability. RESULTS: We are currently collecting plantar pressure data from the 50 subjects, walking straight in a corridor. CONCLUSIONS: It is important to investigate inter- and intra variability of plantar pressure distribution not only in controlled, such as with laboratory measurements, but also in uncontrolled environments, such a in everyday-life conditions. Our study compares these views, based on a new smart insole. Pataky et al. "Gait recognition: highly unique dynamic plantar pressure patterns among 104 individuals." Journal of The Royal Society Interface 9.69 (2012): 790-800. Deepashini et al. "An insight into the plantar pressure distribution of the foot in clinical practice: Narrative review." Polish Annals of Medicine 21.1 (2014): 51-56.

P1-V-127 Validation of a new algorithm for detection of step durations in short episodes of gait using a single accelerometer in healthy elderly and patients with Parkinson´s Disease.

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Aim: To assess the validity of a new algorithm for detection of step durations in healthy elderly and PD patients from acceleration signals measured on the lower back during short episodes of gait. Background: Studies suggest that quantitative analysis of gait with body-fixed-sensors (BFS) may differentiate stages and symptoms of Parkinson's Disease (PD) [1]. However, only a few studies have analysed short episodes of gait with the use of BFS to date. Subjects who cannot participate in long gait protocols due to limited mobility might be able to perform short gait episodes instead. Moreover, short gait protocols are also well suited to studying the initiation of gait, which may provide useful information for the characterization of patients in early stages of PD [2]. The location of the sensor on the lower back is near to the center of mass, it permits to assess postures and transitions in daily-life activity, and it may predict risk of falling in PD patients [3]. Methods: Eighteen healthy elderly subjects (74.0 ± 8.0 years old) and eighteen PD subjects (60.3 ± 10.7 years old, H&Y: II-III) walked a distance of 5 meters wearing a BFS (DynaPort McRoberts) on the lower back, and a BFS (DynaPort MiniMod McRoberts) on the outside of each heel (reference system for validation purposes, see below). All data were recorded at a sample rate of 1 sample/10 ms. For step duration detection, we developed an algorithm that defines a template signal based on the autocorrelation of the raw acceleration signal in the anterior-posterior (AP) direction. Subsequently, it calculates a signal, which is the difference in amplitude between the template and a windowed AP signal. The normalization of this signal to the SD of the template gives "SD normalized". A second signal called "Correlation" is obtained from the cross-correlation between the template and the windowed AP signal. The ratio between "Correlation" and "SD normalized" contains peaks, close in time to heel-strikes. Thus, the intervals between these peaks define step durations. Step durations obtained from low-back accelerometry were compared to step durations calculated from the combination of right and left heel accelerometry (reference system). Results: Absolute differences in step durations between both methods were calculated for every step and averaged within episodes and over subjects. Thus, the average difference was 28.7 ± 14.5 ms (in the controls cohort), and 37.4 ± 16.3 ms (in the PD patients cohort). Equalling the deviation of the results obtained from low-back data to the reference system, the deviation per step was 5.1% (controls) and 6.5% (PD patients). Conclusions: A novel method for detection of step durations in short episodes of gait based on a single accelerometer placed on the low back is described. The validity of the estimates of this method seems acceptable, however, it depends on the clinical acceptance of errors associated to parameters within steps.

P1-V-128 FOUR FUNCTIONAL TESTS IN HV SUBJECTS USING A WEARABLE INERTIAL SENSOR

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Background and aim: The problems related to elderly people walk have often a multifactorial origin. The reduced mobility decreases the quality life, but increases fall odds and mortality. This study investigates differences and relation in motor performance of four functional tests between four groups of elderly, three with Hallux Valgus (HV) at different severities and one control group. We used an easily wearable inertial sensor and a smartphone for quick and non-invasive data collection of those four tests analyzing some motor tasks of everyday life. Methods: 30 Elderly Subjects [ES; 27 females; age: 60±14 (ES1= 6 no pathology; ES2=10 mild HV severity; ES3=10 moderate HV severity; ES4= 4 high HV severity)] have been totally recruited for this study. A commercial smartphone (Motorola RAZR XT910) was connected via

Bluetooth to a wearable inertial unit (pERhl) including a triaxial accelerometer, a gyroscope, and a magnetometer. The sensing unit was worn on the lower back (L5) by an elastic belt. An application (uPerhl) was used to start/stop the recording and to insert temporal markers. Subjects were asked to perform 3 repetitions of four functional tests: Standing test (QS), Time up and go (TUG),10M walking (10MW) and Stairs climb test (SC). A set of parameters have been extracted from the measured signals. ANOVA was used to identify differences between groups. Results QS: ES2,3,4 show higher sway area in Eyes Open and Eyes Closed (EO R=0.35 - EC R=0.37) than the ES1 and Medio-lateral (M/L) main velocity tends to increase with the disease severity (EO R=0.3 - EC R=0.3).TUG: Angular velocity range around the vertical axis in standing-to-sitting transition with turning is lower in HV groups. 10MW: Gait Cycle Regularity (Stride) in the vertical direction is greater in ES4 subjects compared to the others (R=-0.3). SC: ES2,3,4 significantly reduce their cadence both in ascending (R=0.33) and in descending (R=0.3) stairs compared to ES1. Discussion: ES2,3,4 sway area and M/L velocity are positively correlated with the HV severity, greater area and velocity may indicate instability. HV trend transition in TUG is lower when they turn on the spot and sit. 50% of the power acceleration in M/L is higher in HV. ES1 have slower postural responses than those with HV, they don't require balance quick fixes. Trunk oscillation in M/L - A/P direction is reduced in patients with HV both in ascending and descending stairs and subjects with severe HV tend to spend more time in climbing stairs. All these parameters indicate greater tendency to instability. Conclusion: Our results are coherent with the expected and observed motor performances and many parameters are sensitive to age-related motor changes and HV severity. These findings support the idea that wearable inertial sensors and modern smartphone can help researchers to detect ES2,3,4 instability in performing normal daily activities, that may increase the risk of falling.

P1-V-129 Recommendations for a Core Outcome Set for Measuring Standing Balance in Adult Populations: A Consensus-Based Approach

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Background: Standing balance is imperative for mobility and avoiding falls. Use of an excessive number of standing balance measures has limited the synthesis of balance intervention data and hampered consistent clinical practice. Objective: To develop recommendations for a core outcome set (COS) of standing balance measures for research and practice among adults. Methodology: A combination of scoping reviews, literature appraisal, anonymous voting and face-to-face meetings. Consensus was sought over three rounds using pre-established criteria. Participants: Invited experts from a range of disciplines with international recognition in balance measurement and falls prevention. Data sources:

The scoping review identified 56 standing balance measures validated in adult populations and these were considered for inclusion in the COS. Results: Fourteen experts participated. Fifteen measures were excluded after the first round of scoring and a further 36 after round two. Five measures were considered in round three. Two measures reached consensus for recommendation, and the expert panel recommended that at a minimum, either the Berg Balance Scale or Mini Balance Evaluation Systems Test be used when measuring standing balance in adult populations. Limitations: Inclusion of two measures in the COS may increase the feasibility of potential uptake, but poses challenges for data synthesis. Adoption of the standing balance COS does not constitute a comprehensive balance assessment for any population, and users should include additional validated measures as appropriate.

P1-V-130 Agreement in Measures of Gait Between an Inertial Measurement System and a 3D Motion Analysis System.

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BACKGROUND AND AIM: Three dimensional motion analysis systems (3DGA) are considered to be the gold standard in gait analysis, and is widely used both for clinical and research purposes. Inertial measurement systems (IMS) utilize 3-axial accelerometers, gyroscopes and magnetometers to identify spatiotemporal (STP) characteristics during gait, and are increasing in popularity and availability. Recently, newer IMS also give the possibility of joint kinematic measurements (i.e. Dejnabadi et al. 2006).The level of agreement between assessment methods are important to evaluate, both for normal and pathological gait patterns, because of the potential of IMS's to provide a low-cost non-laboratory based gait assessment. The aim was therefore to investigate the agreement between a) an IMS (APDM Inc., Portland, USA), and b) a 3DGA (Vicon Motion Systems, Oxford, UK) for both STP and kinematic parameters. METHODS: 8 healthy adults (Mean age 31.2 yrs, 5 females) performed 6 walking trials in three situations in a randomized order: normal, right knee locked with an orthosis in 45º, and in 0º. Data was collected with 3 Opal APDM monitors (IMS) and 6 Vicon MX13 infrared cameras (3D) simultaneously. The Plug-in-Gait biomechanical model was used to generate 3DGA STP and kinematic data. The results from 4 trials were included in the preliminary analysis, and the right leg data is presented. The assessed variables were: Knee range of motion (KROM, º), walking speed (WS, cm/s), stride length (SL, cm) and stance (St, % of GC). Mean difference and standard deviation (SD) between methods was calculated, and Bland-Altman plots with limits of agreement (LOA) were constructed. RESULTS: The preliminary results from 4 participants during normal gait and knee locked in 0º, show that for the STP, the mean difference in WS was 6.4 cm/s (SD 9.4) during normal gait and 29.6 cm/s (SD 2.8) with knee in 0º. The mean difference in SL was 5.8 cm (SD 9.6) in normal gait, and 33.0 cm (SD 3.3) with knee in 0º. The mean difference in St was 1.16% (SD1.39) in normal gait, and 4.2% (SD 1.5) with knee in 0º. For kinematics, the mean difference in KROM in normal gait was 11.3º (SD 2.3º), and 42.5º

(SD 3.3º) with knee in 0º. The LOA of STP in normal gait was for SL from -13.5 to 25.0 cm, and with knee in 0º from 26.4 to 39.5 cm. For WS in normal gait LOA was from -12.4 to 25.2 cm/s, and with knee in 0º from 18.0 to 41.2 cm/s. The LOA for St in normal gait was from -1.6 to 3.9%, and with knee in 0º from 1.1 to 7.2%. The LOA for KROM in normal gait was from 6.8º to 15.8º, and with knee in 0º from -49.1º to -35.9º. CONCLUSIONS: Preliminary results from the first 4 participants may indicate fair agreement for STP during normal gait, but poorer agreement for both the kinematic and STP measures with the knee locked in 0°. However, the number of subjects in this preliminary analysis was small, this limiting further conclusions.

P1-V-131 Middle- and high-frequency power spectrum display method for stabilometry

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[BACKGROUND AND AIM] Frequency power spectrum analysis of the stabilometry unrest index to describe the power distribution ratio shows a greatly imbalanced power ratio in a low-frequency spectrum. Therefore the frequency power evaluation of a high-frequency spectrum is difficult. It was believed that the evaluation of a high-frequency spectrum required the frequency power distribution peculiar to a disease and examined an indication method for high-frequency power spectrum. [METHODS] Frequency power analysis was conducted using the Maximum Entropy Method (MEM). Average power spectrum distribution of 20 healthy subject very age is made as standard power spectrum. This power distribution is divided from power spectrum distribution of the case as common normal power spectrum. It's possible to emphasize and indicate power spectrum distribution of the case as power except for a normal value by this operation. For the power distribution to change by the age of the healthy subject, the healthy subject standard power value was calculated by age every 10 years old until the generation 80 years old from the generation 10 years old. The calculation used power by the ratio of the case power level divided by the normal power value (every 20 healthy subjects). The frequency bands were 0.02-10 Hz. As an analysis example, we used data of the progression of a 61-year-old patient with vestibular neuritis. [RESULTS] The MEM power spectrum of the case demanded the ratio with the age healthy subject standard power level in its 60years old generation that we revised. We showed the progress when power distribution changed together in progress from the immediate nature period. By this method, we can show a change of the power of a high frequency spectrum so far from the inside where it was difficult to confirm it. Figure 1 show the conventional MEM power spectrum indication. Figure 2 show the MEM power spectrum indication that we corrected with the power level of the healthy subject. [CONCLUSIONS] As this analytical method is the ratio of the healthy subject's average, it is different from the real power level. However, we understood that we could demonstrate the frequency power spectrum distribution of the small high-frequency area of the power distribution as the ratio.

P1-V-132 Postural control in healthy subjects using visual feedback

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[BACKGROUND AND AIM] Visual input is necessary for postural control. The examination was conducted by asking a subject to stand on a stabilometer and move his/her center of foot pressure (COP) such that it enters into a circle shown on a monitor. To apply this technique in clinical settings, it is first necessary to determine the size of the circle used. In this study, we varied the size of the circle displayed and determined the most suitable size. We conducted the evaluation using the visual feedback test of the Body Tracking Test (BTT) system:Fig1. [METHODS] A total of 29 healthy subjects (14 males, 15 females; average age: 29.7 years) in the age group of 20-30 years and an additional group of 23 healthy subjects (12 males, 11 females; average age: 67.1 years) in the age group of 60-75 years participated in this study. None of the participants had vertigo or a history of balance disorders. During the tests, the subjects stood with their feet closed together and parallel and maintained an upright posture. Examinations were performed for 60 s on each subject. The circle used for the test was projected on a 15-inch monitor and the diameters were set to 1.5, 2, 2.5, and 3 cm, depending on the test. Habituation was avoided by choosing the circle size randomly from a set of closed envelopes. A Bonferroni test was used for statistical comparisons and a p-value of <0.05 was considered statistically significant. We conducted investigation during the analysis using the total distance (cm), area (cm2), locus length per unit area (cm/s), and the proportion of COP that enters a circle (%). [RESULTS] The total distance (cm), area (cm2), and locus length per unit area (cm/s) remained approximately constant regardless of the diameter of the circle used. For the 20-30-year-old group, the proportion of COP entering the circle reached 40% for a 1.5-cm circle, 62.5% for a 2-cm circle, 79.3% for a 2.5-cm circle, and 87.7% for a 3-cm circle. For the 60-75-year-old group, the proportion of COP entering the circle was 24.7% for a 1.5-cm circle, 42.6% for a 2-cm circle, 63.8% for a 2.5-cm circle, and 72% for a 3-cm circle. In all cases, the proportion of COP entering the circle increased with the circle size; however, this difference was not significant for circles with a diameter of 2.5 and 3 cm:Fig2. [CONCLUSIONS] Visual input is an important peripheral receptor in postural control. We believe that both the deep perception system of the lower extremities and visual receptors are involved in the maintenance of COP within a circle. Stable feedback is easy when the size of the circle is large, but it is difficult when the size of the circle is small. Thus, our results show that a circle of 2.5 cm is appropriate to evaluate the effect of visual feedback on postural control.

P1-W-133 Medio-lateral Head on Trunk Stability Depends on the Vestibular System

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BACKGROUND & AIM: Angular head rotation and linear translation of the trunk have a well described anti-phasic relationship. This relationship has been shown to degrade following space flight and also following vestibular loss. However, the relationship between trunk angle and head motion is not well described during walking. The role of the vestibular system for head on trunk stability is not completely understood. METHODS: Nine healthy subjects and nine individuals with vestibular loss walked on a treadmill at 2 km/hr while fixating a target presented on a widescreen LCD 2.2m in front of them. Head and body kinematics were recorded (Optotrak, Inc). Fourier transforms of head and trunk angles with respect to vertical were computed. One-sided power spectral densities (PSDs) and cross spectral densities (CSDs) were then calculated with these transforms. Magnitude squared coherence and co-phase were calculated to characterize the relationship between head and trunk angular motion. RESULTS: Below 2 Hz, AP head and trunk angle are roughly in-phase with each other and above 2 Hz there is a shift to approximately anti-phase head leading the trunk motion. The Individuals with vestibular loss did not differ in phase from the healthy individuals. For most frequencies below 3 Hz individuals with BVL displayed stronger coupling between the head and trunk. Healthy individuals show a stronger coupling between AP head and trunk angular motion. The transition from in-phase to anti-phase occurs more gradually in the ML plane, starting at .6 Hz. Individuals with vestibular loss show a head lagging trunk response from .6-2 Hz, but transition back to the same head leading trunk at frequencies above 2 Hz. Individuals with vestibular loss also have higher coupling between trunk and head angular motion than healthy individuals in the ML plane. CONCLUSIONS: Mid-frequency head lagging trunk in the ML direction for individuals with vestibular loss suggests the vestibular system contributes to head on trunk stabilization specifically in the ML direction. The frequency range with disrupted head on trunk stability in the ML direction corresponds to the gait cycle and step cycle. Changing whole body acceleration at heel strike appears to be uncompensated at the neck. Head on trunk stability in the AP plane may be more mechanically stable, requiring less vestibular input. ACKNOWLEDGEMENTS: This work has been supported in part by a 2013 PODS II Scholarship, Foundation for Physical Therapy. Figure 1. Magnitude squared coherence and co-phase of head and trunk angular movement in the AP (top plots) and ML (lower plots) planes. Black diamonds represent individuals with vestibular loss and black circles represent healthy individuals. Error bars are SEM.

P1-W-134 Psychological factors, not vestibular impairment, are associated with impaired balance, gait and falls in people with dizziness aged 50 years and over

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BACKGROUND AND AIM: Dizziness is a frequent complaint, increasing with age and attributed to a multitude of causes, including vestibular impairment and psychological factors. Here, we investigated their relationship to balance, gait and falls in a large sample of people with dizziness aged 50 years and over. METHODS: 223 community-dwelling adults aged 50-92 years (61% females) who reported a significant episode of dizziness in the 12 months prior, completed the dizziness handicap inventory (DHI) scale (physical, functional and emotional burden) and questionnaires regarding medical history and falls in the past 12 months. They also undertook assessments of sensorimotor function, postural sway, dynamic balance and gait. Benign Paroxysmal Positional Vertigo (BPPV) was identified with the Dix-Hallpike test. Vestibular hypofunction was determined with a positive head shaking test and/or a positive head impulse test. Scores greater or equal to 7 on the Generalized Anxiety Disorder -7 Items Scale (GAD-7) and/or 9 on the Patient-Health Questionnaire-9 Items (PHQ-9) indicated anxiety disorders and depression. RESULTS: At least one potential cause of dizziness was identified for the majority of participants (81%, n=180): one cause, n=83; two causes, n=69; three to four causes, n=28. Higher scores on the DHI scale were associated with increased number of dizziness causes ($p<0.05$). Eighty-six participants (39%) presented with a peripheral vestibular problem: BPPV (n=51) or unilateral hypofunction (n=35). Compared to participants with dizziness from non-vestibular causes, they did not differ in any of the sensorimotor, balance, gait, psychological or falls-related outcome measures ($p>0.05$). Compared with the rest of the dizzy participants, those with psychogenic dizziness (anxiety disorders and/or depression) (n=41, 18%) did not differ in age but had lower knee extension strength, poorer dynamic balance and greater DHI scores ($p<0.05$). Significantly more participants with psychogenic dizziness reported fall compared with the rest of the sample (55% vs. 28% respectively, $p=0.002$). CONCLUSIONS: Multifactorial dizziness was prevalent (44%) in middle and older age community-dwellers and associated with increased emotional, functional and physical burden. Psychogenic dizziness was associated with lower limb weakness, poorer dynamic balance and an increased risk of falls. In contrast, dizziness from deficient vestibular system did not manifest in an increased risk of falls, gait dysfunction or poor balance. These unexpected findings might relate to the episodic and overt nature of vestibular problems, especially in the case of BPPV, or well-compensated systems in the case of hypofunction. These findings highlight the need for multifactorial screening of people with dizziness and subsequent targeted interventions for addressing underlying causes and conditions.

P1-W-135 Postural instability and bone quality in the elderly with vestibular disorders

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[Background & Aim] Vertigo and dizziness are quite common symptoms in the elderly population. Vertigo and dizziness in the elderly is multi-factorial and complicated. Benign paroxysmal positional vertigo (BPPV) is one of the most frequent vestibular diseases in the elderly. Recently, association of osteoporosis with BPPV has been discussed mainly from the viewpoint of calcium metabolism. However, association of bone quality with vertigo and dizziness should be widely surveyed. For this purpose, we studied association of postural instability with bone quality in the elderly patients with vestibula disorders. [Subjects & Methods] Patients with vertigo and/or dizziness older than 65 years of age were enrolled in this study. Their diagnoses are BPPV, meniere's disease, vestibular neuritis, presbystasis (disequilibrium due to aging) and so on. They underwent assessment of equilibrium and bone quality. Assessment of equilibrium included stabilometry, electronystagmography (ENG) and vestibular evoked myogenic potential (VEMP) testing. ENG included caloric testing. VEMP testing included ocular VEMP as well as cervical VEMP. They also underwent assessment of bone quality using ultrasound technique. Speed of sound (SOS) was measured in the calcaneus and calculated percent young adult mean (%YAM). [Results] Among the subgroups, the group of presbystasis was the most unstable and showed the slowest SOS, which suggests the lowest bone density. Patients with BPPV showed the second slowest SOS. Almost of all the patients with presbystasis showed no response in VEMP testing. Their stabilometric performance were worsened by closing of the eyes. [Conclusion] Although vertigo and dizziness in the elderly is multifactorial, dysfunction in the otolith organs and degradation of bone quality are important factors. In other words, disequilibrium in the elderly is due to disoders of the locomotorium as well as the sensory organs

P1-W-136 First Trial Reaction in peripheral vestibulopathy: the effect of compensation

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Aim: to test the hypotheses that performing a repetitive balance perturbation stimulation under eyes open or closed does not interacts with the results according to the trial order (first or latest) and, that the first trial response can differentiate compensated vs non-compensated patients. Methods: we have studied the magnitude of displacement in roll and pitch of normal subjects and patients with well-compensated or uncompensated unilateral vestibulopathy when the support surface is linearly or angularly displaced forward or backwards. The differences between results in the first and subsequent trials in the eyes open or closed condition were used to cope with our objectives. Results: we have not seen interaction between the visual condition and the order of the test results. We found the normal subjects and well compensated subjects show a larger response under the eye conditions mainly for linear displacement of the support surface; uncompensated patients show that behaviour for linear and angular displacements. The first trial response is exaggerated in normal subjects for angular displacements and in uncompensated patients for all displacements; in the well compensated patients the response is irregular and no conclusions were possible. The angular displacements clearly differentiate the three groups of subjects in the study: the responses to the backwards angular displacement (toes-up) are greater but those to forward (toes-down) better discriminate them. Conclusion: we have been able to show that the first trial response is different for patients with unilateral vestibulopathy according to whether or not they get a clinically well compensated status. This is independent of the condition (eyes open/eyes closed) of examination. This is relevant for the instability in these subjects as FTR is maladaptive.

P1-W-137 Interactions of position and forces on the gait cycle in bilateral vestibulopathy

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Background: Vestibular disorders present with symptoms such as imbalance which is usually compensated with an increase in sensory loading to the visual and proprioceptive systems. This compensation is often insufficient in cases of increasing demands during turning, different gait speeds and cognitive loading. In this study, we investigated the relationship of the position and forces acting on the semicircular canal (Reid's plane) during such gait tasks and its effects on gait trajectory and stability. Furthermore, we attempted to quantify the effects of these forces and positions on the gait cycle. Methods: 10 young healthy subjects (20-40 years), 10 older healthy subjects (40-60 years), and 10 bilateral vestibulopathy patients (BVP) were recruited for the study. Motion capturing was achieved using Qualisys® with 8 Oqus 100 cameras sampling at 128 Hz. 11 retro-reflective markers were attached to the head and trunk (4 for the Reid's plane) of each subject (Figure 1a.). 2 Synchronized Opal® sensors (tri-axial accelerometers, gyroscopes, magnetometers: Mobility lab® - APDM Devices) were attached to the head and trunk of the subjects sampling at 128 Hz. Subjects were asked to walk along an elongated circle (circumference: 12.6 meters) at three different speeds: preferred, slow, and fast, at tandem gait, and during cognitive dual task (serial subtraction). Data analysis was performed using MATLAB® R2012a. Results: Accumulated step to step deviations from the optimal path in BVP patients (slow speed: 5.23±0.96 m; preferred speed: 4.48±0.78 m; maximal speed: 3.19±7.36 m) was larger than that of younger healthy subjects (slow speed: 3.78±0.76 m; preferred speed: 3.12±0.37 m; maximal speed: 2.72±0.38 m, p=0.037; 0.002; 0.267; respectively) and older healthy subjects (slow speed: 2.95±0.37 m; preferred speed: 2.95±0.08 m; maximal speed: 2.83±0.36 m, p=0.006; 0.002; 0.600; respectively) for all gait speeds except maximal speed gait. Phase difference between head and trunk angles revealed significant differences between groups during slow speed gait (F=5.306, p=0.013) and maximal speed gait (F=3.455, p=0.048) but not at preferred speed gait (F=2.871, p=0.077). While post-hoc analysis was not significant within groups, BVP had higher deviations during slow speed and preferred speed (7.81 deg) compared to maximal speed gait (2.83 deg). In comparison older healthy subjects had greater deviations during maximal speed gait (8.0 deg) compared to slow (0.5 deg) and preferred speed gait (3.37 deg). Conclusions: This study confirms the speed dependent nature of sensory processing during gait and demonstrates its relationship to gait trajectory. Aging leads to a loss of dynamic range in trajectory correction. Significant differences between head and trunk phase angles is seen during non-preferred gait signifying requirement of additional visual sensory information to maintain stability during these modes.

P2-A-1 Defining ambulatory bouts in free-living activity: Impact of brief stationary periods on walking bout metrics

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Background and Aim: Body worn monitors are readily used to objectively quantify community-based ambulatory activity [1-2]. A bout of walking has been identified as a discrete measure from which changes in the volume and pattern of bouts can be used to understand the effect of disease and interventions that aim to increase levels of activity. Recommended volumes of daily activity state individuals should accumulate at least 150 minutes per week of exercise in bouts longer than 10 minutes [3]). This raises the problem of classifying what constitutes a single continuous bout of ambulation. For example, if a person stops walking for a brief period (e.g. 15s) due to environmental factors (pedestrian crossing, opening a door, etc.), should this be classified as one long or two short bouts of ambulation? Decisions regarding the maximum resting period (MRP) between consecutive bouts of ambulation may impact on respective outcome measures of the volume, pattern and variability of activity bouts. There are no guidelines on which to base this decision or evidence regarding the extent to which altering the MRP affects ambulatory outcome measures. Therefore, the aim of this study was to assess the effect of the MRP on the volume, variability and pattern measures on bouts of community-based ambulatory activity in a cohort of healthy older adults. Methods: Ambulatory activity was assessed in 97 community dwelling older adults (mean (SD); age 69.2 (7.7) years) using an activPAL (20 g; 53.0 × 35.0 × 7.0 mm; 10 Hz) worn on the upper thigh for 7 consecutive days. A bespoke MATLAB® program was used to calculate the number of walking bouts from which the volume (% time spent active), accumulation of activity in bouts ≥ 10min), pattern (alpha) and variability (S2) of ambulatory bouts was determined with respect to a range of MRP (1-30s in 1s increments). Results: Results showed no difference in any of the outcomes using an MRP of 1-6s (due to activPal's thresholding algorithm for activity recognition). Non-linear regression (power law, r2 >.99) showed that increasing the MRP from 6 to 30s resulted in changes of activity volume (% time spent active increased, number of bouts decreased), variability (S2 increased) and pattern (alpha decreased). With a MRP of 6 seconds, 6% of the cohort achieved at least 150minutes of exercise per week with bouts >10minutes. This increased to 40% using a MRP of 30s. Conclusions: Modifying the MRP impacts on volume, pattern and variability measures of community based ambulatory activity, including whether people fulfil the activity guidelines. This highlights the need for standardised algorithms to aid interpretation of community-based activity data. Prior to the development of standardised protocols, we encourage researchers to report the MRP to aid comparisons between studies. References[1] Lord S et al J Neurol 2013; 260: 2973[2] Godfrey A et al. Age Ageing 2014; 43: 386-393[3] ACSM Current Guidelines and Practice, 2008

P2-A-2 The Use Of Multiple Inertial Sensors & EMD Approach For The Auto Segmentation Of Daily Living Activities

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Background & aim: a recent trend in clinical research is the use of inertial sensors-based systems for remote mobility monitoring of daily living (ADL). Segmentation ADL is a key step for assessment of specific dysfunctions of mobility. However, visual segmentation of ADL is time consuming. The aim of this work is to develop an algorithm using the Empirical Mode Decomposition (EMD) approach and discrete-time detection of events for the automatic segmentation of tasks. Method: participants (N=4, Age=73± 4 years old) were asked to perform ADL tasks such as walking, sit to stand, stand to sit, and reaching to the ground to pick or put down objects on the floor. Three trials of 3, 4, and 5-min each were performed by participants wearing a set of 17 inertial sensors (Animazoo IGS-180) positioned strategically on body segments. The proposed method was performed in time domain by using the EMD approach and discrete-time detection of events. After identifying 11 decomposition levels, we proceeded to combine sets of oscillations that represented specific tasks. The resultant signal was later processed by an algorithm for the auto-detection of the waveforms corresponding to the tasks, this within the entire trial. Our auto-segmentation algorithm consisted of two phases. Firstly, we localized the pattern from the sensor signal by detecting the most prominent set of waves corresponding to a specific task. We did this by setting of a threshold (50% of the higher Amplitude) to detect Sit-Stand (Trunk Sensor: Acceleration), for Walking detection (Shin Sensor: Gyratory Velocity) & Reach-Ground (Trunk Sensor: Acceleration). The extraction of the pattern is based on the peaks detection according 2 criteria, Minimum peak high & Minimum peak distance for each a specific task. Secondly, to detect the transitions we used a rectangular function (constant inside the task time range interval, derived from previous step, and zero elsewhere), which had the same length of the original signal. Afterwards, the derivation and normalization of this function gave us the task transition flag (%2B1 the beginning and -1 the end of the task). Three performance indicators were used to evaluate the method: accuracy, sensitivity and specificity. Results: despite the variation in the occurrence of the tasks, and how they were performed, the results obtained showed good performances of the proposed approach to detect automatically different tasks: Stand-to-sit-to-stand (Acc. =100%, Sens. = 100%, Spec. = 100%), Walking (Acc. =99%, Sens. = 99%, Spec. = 97%), Reach Ground (N=164, Acc. =99%, Sens. = 99%, Spec. = 95%). These results were obtained for 56 Stand-to-sit-to-stand, 378 Walking and 164 Reach-Ground separate events. Conclusion: the proposed approach is able to detect different ADL tasks with high accuracy. This provides a basis for the auto-detection of more complex ADL, as well as potentially help differentiate populations based on their mobility patterns and symptoms.

P2-A-3 Auto detection and segmentation of physical activities during a Timed-Up-and-Go (TUG) task in healthy older adults using multiple inertial sensors

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BACKGROUND AND AIM: With an increasingly aging population of older adults, promoting and maintaining a healthy mental and physical lifestyle is crucial for their quality of life. People suffering from motor degenerative diseases often experience limited mobility, which could lead to physical and mental deterioration further compounding the effects of aging. Recently, much attention has been given to the use of inertial motion sensors for remote monitoring of individuals with limited mobility. However, the focus has been mostly on the detection of symptoms, not specific activities. The objective of the present study was to develop and test an automated recognition and segmentation algorithm from inertial sensor data to identify common gross motor patterns during a continuous trial of different daily living tasks. METHODS: A modified Time-Up-And-Go (TUG) task was used since it is comprised of four common daily living activities; Standing, Walking, Turning, and Sitting, all performed in a continuous fashion. Sixteen healthy older adults performed two trials of a 5 and 10 meter TUG task. They were outfitted with 17 inertial motion sensors covering each body segment. Data from the 10 meter TUG were used to identify pertinent sensors on the trunk, head, hip, knee, and thigh that provided suitable data for detecting and segmenting activities associated with the TUG. Raw data from sensors were detrended to remove sensor drift, normalized, and band pass filtered with optimal frequencies to reveal kinematic peaks that corresponded to different activities. Segmentation was accomplished by identifying the time stamps of the first minimum or maximum to the right and the left of these peaks. Segmentation time stamps were compared to results from two examiners visually segmenting the activities of the TUG RESULTS: Using the selected set of sensors, we were able to detect these activities with 100% sensitivity and specificity (n=192) during the 10 meter TUG. The rate of success was subsequently confirmed in the 5 meter TUG (n=192) without altering the parameters of the algorithm. When applying the segmentation algorithms to the 10 meter TUG, we were able to parse 100% of the transition points (n=224) between different activities that were as reliable and less variable than visual segmentation performed by two independent examiners. The average difference between segmentation of these sub-tasks using the inertial sensors (automated) and visual inspection across all transitions was approximately 93 ms. CONCLUSIONS: The present study lays the foundation for the development of a comprehensive algorithm to detect and segment activities in more naturalistic activities using inertial sensors, in hope of evaluating automatically motor performance within the detected tasks.

P2-A-4 UADL: A SMARTPHONE APPLICATION FOR UBIQUITOUS ACTIVITY OF DAILY LIVING MONITORING WITH REAL-TIME PARAMETER COMPUTATION

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BACKGROUND AND AIM: The Activities of Daily Living (ADL) are the basic tasks of everyday life, such as eating, dressing, walking and transferring. ADL can be objectively measured (e.g. by means of wearable inertial sensors) to compute a set of parameters able to more subtly investigate subject mobility (i.e. gait, turning, risk factors, etc.). We present here a novel Smartphone (SP) application, called uADL, that makes use of inertial sensor embedded in the SP (e.g. accelerometer, gyroscope). The app performs real-time signal processing, computes a set of significant ADL parameters and sends them to a remote server. Moreover, uADL makes the parameters extracted available to any Telemedicine App installed in the SP by means of Android Intent technology. METHODS: We implemented the uADL application on an Android SP to keep all the advantages in terms of high-performance computation and the availability of an open platform; the validity of the embedded accelerometer has been proven in a previous work (Mellone S. et al, ICAMPAM 2011; pp 32). A set of sensor-based features was extracted from the signals including the percentage of sedentary, active, and walking time, duration and intensity (metabolic equivalent, MET) of the activities, mean gait and turning characteristics. Data collected during all the monitoring time has been analysed every 20 minutes to provide feedbacks about subject's ADL. All the raw signal and ADL parameters are stored on the Smartphone memory. uADL has a friendly interface designed to account for usability of older users. By default, the application run in background and it is automatically started: 1) when the SP is turned on; 2) when the SP is unplugged from charger. With this choice the user is not asked to interact with the application. The clinician can use the application interface just to set up parameters before leaving the system to the user. Continuous monitoring, including real-time data processing, can last up to 24 hour by means of 2013-Q4 or newer Android SP generation. We monitored 170 subjects for at least 5 days (up to 9) during daytime (80±6.5 years old, 96 females) wearing the SP (i.e. Samsung GS4-mini) on the lower back by means of an off-the-shelf case belt. RESULTS: The results (Tab.1) shows that uADL application calculates the same values calculated by the MATLAB algorithms. We also notice that the time needed to extract ADL parameters of 20 minutes window is less than 5 seconds with a Samsung GS4-mini. This result is prodromal for several real-time signal processing solutions with nowadays SP. CONCLUSIONS: uADL application is easy to use and the SP performances (e.g. computation capabilities, battery duration, form factor) encourage the use of this system for ADL monitoring. Providing ADL parameters to any Telemedicine App can be considered as a crucial added value for its adoption. Future versions of uADL will compute additional clinical-validated parameters.

P2-B-10 Rapid postural changes in patients with cerebellar degeneration

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Background and aim Patients with progressive cerebellar degenerations suffer from cerebellar ataxia due to the damage in cerebellar cortex, cerebellar nuclei, but also from sensorial disturbances connected with affection of the spinal pathways. There was discussion about effectiveness of the rehabilitation in patients with cerebellar degeneration with regard to affected afference and motor learning. Nowadays we have proven effectivity of the long-term training program. Aim of this study is to observe if these patients with sensorial and motor learning handicap are able to manifest rapid changes in postural stability whether on the ground of motor learning or the therapeutic intervention. Intervention consisted of the Sensorimotor training according to Dr. Janda which enhances motor learning through increased proprioception by the training on the labile surfaces. Methods We evaluated 10 individuals with cerebellar degeneration (spinocerebellar ataxia type 1, spinocerebellar ataxia type 2, idiopatic late onset ataxia). Patients uderwent two experiments in the random order. In the first experiment (patients' group 1 - PG1) patients went through the 15-minute sensorimotor training on the Airex balance pad challenging their balance control. Same therapy was applied in to the control group (CG) consisted of 10 healthy subject with equal gender and age with PG1. All subjects were measured before 15-minute training and after it by Synapsis posturography system. We performed Modified Clinical Test for Sensory Integration of Balance (mCTSIB) and monitored changes in the parameters of the center of pressure - mean sway velocity, area, sway path. In the second experiment (patients' group 2 - PG2) patients were measured twice by the mCTSIB described above before and after a 15-minute pause. For the statistical analysis we have used general linear model of the ANOVA test. Results In the PG1 group we have found significantly lower values in some monitored parameters in mCTSIB. On the other hand, these changes are copied by PG2. Both groups have shown significant but equal changes in comparison with CG. The largest changes were observed in testing without visual control. Conclusions Both PG1 and PG2 groups improved postural stability in comparison with CG during two measures in sequence with 15-minute interval. Equal changes in the PG1 and PG2 suggest, that due to the limitations of the study (small patients' group) we can't bear out rapid effectiveness of the sensorimotor training but state probably large impact of the motor learning in patients with cerebellar degenerations. Our results have shown that individuals with cerebellar degeneration are able to change their postural strategies and use immediate adaptive control mechanisms regardless their spino-cerebellar impairment. Low changes in healthy subjects can be caused by easy examining protocol. Supported by the Charles University in Prague, project GA UK No. 802514

P2-B-5 Role of Hand Contact in Continually Challenged Postural Equilibrium

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BACKGROUND AND AIM: Humans dynamically control balance while standing by using various strategies that depend on individual, environmental and task-specific conditions. Leaning or holding to a support surface is one of these strategies. Contemporary studies include the additional hand contact in balancing situations but they are mostly describing reactive compensatory movements. It has been shown that reactive arm movements always occur in conditions where sudden a perturbation is applied and that they even occur in situations when compensatory movements are not necessary. Such unconditioned reactions mask the identification of motor control mechanisms that govern the motion of the arm. To overcome this limitation we developed a novel experimental paradigm where the balance of the subjects was continuously perturbed in different stability conditions by mild random perturbations that do not provoke reactive arm movements. METHODS: We measured ten healthy male subjects who were standing on a force plate while being perturbed by a mild, random and continuous anteroposterior (AP) pulls at the waist. We measured the EMG activity of two lower leg, two trunk and two upper arm muscles. The AP shifts of subject's center of pressure (CoP) were measured using a force plate. All EMG and force plate data were analysed in a frequency domain and subjected to statistical analysis. RESULTS: Results show that the contribution of lower leg muscles was significantly reduced when the subjects were able to use the additional hand support. On the other hand, the activation of trunk flexors was higher when the subjects used the additional hand support and the activation of the trunk extensors remained unchanged. The CoP displacement in AP direction significantly decreased through the sessions regardless of the additional hand support which indicates motor adaptation in both conditions. Equivalently, the activity of most muscles gradually dropped through the sessions, where the biggest drop was just after the first session. The exception was the trunk flexor muscle, where the activity was substantially higher in the handle condition. CONCLUSIONS: The lowered activity of leg muscles in handle conditions suggests that the postural equilibrium was dominantly obtained by the use of hand muscles. The adaptation of muscle activity to the perturbation is immediate and tends to continue through the sessions which indicates possible optimization of muscle utilization. The CoP(AP) shifts were reduced in both conditions but remained more constant through sessions in the handle condition.

P2-B-6 Previous Experiences and Central Set Development to Complex Moving Environments: Would Dancers Make Good Seafairors?

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BACKGROUND AND AIM: Central or postural set theory suggests that the central nervous system uses past experience or expectation to pre-load descending commands to optimize responses to potential

instability. This is thought to account for short term, trial to trial adaptation associated with repeated exposure to a perturbation; however, it is not known if longer-term prior experiences requiring challenging balance control will carryover as long-term adaptations that influence ability to react in response to novel stimuli. This study aimed to determine if those who had long-term exposure to balance instability such as those who train on specific skills that demand balance control will have improved ability to adapt to complex continuous multidirectional perturbations. We propose that improved balance control to the initial exposure to a novel perturbation would reflect reliance on a central postural set developed through long term exposure/training. METHODS: Three groups (10 participants per group) with varied long term exposure to balance demanding conditions were tested under simulated maritime motion: 1) low exposure (no maritime experience); 2) high task-related occupational exposure (≥6 months maritime work experience); and 3) high skill exposure (≥2 years competitive dance training). Individuals attempted to stand still while being exposed to five, 5-minute trials of induced motion on a 6-degree of freedom motion platform. Trials were videotaped, and frequency of change in support reactions (CS), time spent performing CSs, number of steps, and # of multistep reactions were recorded for each 5-minute trial. Any steps or grasps that occurred within one second of a previous step or grasp were considered to be part of the previous CS response. RESULTS: Experienced workers had lowest time performing CSs and number of multi-step CSs when compared to dancers and inexperienced individuals. Dancers spent less time performing CSs and had fewer multi-step CSs than inexperienced individuals. The number of CS and multi-stepping CS events and total postural correction times were also significantly reduced during repeated exposures to the motion profiles within all groups. CONCLUSIONS: These results suggest that central set development of postural response to novel complex environment may be improved by long-term experience with environments or skills that require sophisticated balance control. Importantly, that the benefits were greatest among those with experience with similar environments (i.e. maritime environments versus dancers) reinforcing the benefits of task specific long-term training. It is also noteworthy that among all groups there was evidence of short-term (trial to trial) adaption of postural set and optimization of control. This information may improve current understanding of the extent to which previous experiences influence central set development and the transferability of experiences from one complex control situation to

P2-B-7 Locomotor adaptation is modulated by observing the actions of others.

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BACKGROUND AND AIM: Neurophysiological studies show that observing the actions of another person stimulates the same brain areas used to execute that action - the so called mirror-neuron system. Here, we explored whether action observation alone can induce automatic locomotor adaptation in humans.

METHODS:To explore this possibility we used the "broken-escalator" paradigm. Conventionally this involves stepping upon a stationary sled after having previously experienced it moving (MOVING trials). This history of motion produces a locomotor aftereffect when subsequently stepping on to a stationary sled. RESULTS: We found that observing an actor perform the MOVING trials was sufficient to generate a locomotor aftereffect (P=0.002), the size of which was significantly correlated to the size of movement observed (R=0.530, P=0.003). Crucially, the effect is specific to watching the task being performed, as no motor adaptation occurs when simply viewing the sled move in isolation. CONCLUSIONS: These findings demonstrate that locomotor adaptation in humans can be driven purely by action observation, with the brain adapting motor plans in response to the size of the observed motion. We suggest that this mechanism is mediated by a mirror neuron system for motor control that automatically adapts behaviour to minimise movement errors and improve motor skills based on social cues. This non-verbal adaptive mechanism may have evolved to encourage automatic congruent group behaviours with respect to environmental hazards or risks.

P2-B-8 Adaptive modulation of pendular energy-saving mechanism during bipedal locomotion on a split-belt treadmill

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BACKGROUND AND AIM: Locomotor adaptation during split-belt treadmill walking has recently been regarded as an important paradigm for investigating neuronal mechanisms underlying modulation of interlimb and intralimb coordination in human bipedal locomotion. Previous studies demonstrated that quick reactive adjustment of stride length and duty factor, and slow predictive adaptation of step length and double support phase occur during adaptation to split-belt walking. However, little is known about possible change in energetic aspect of bipedal locomotion during the adaptation process. In the present study, therefore, we analyzed fluctuation of potential and kinetic energy (PE and KE, respectively) of the center of body mass during bipedal walking on a split-belt treadmill and investigated how the locomotion is adaptively modulated in terms of energetic efficiency. METHODS: Adult male participants were asked walk on a split-belt treadmill with the two belts moving at the same speed (2, 4, 6 km/h) and different speeds (2 vs 4 km/h and 4 vs 6 km/h) and adaptive changes in gait parameters, gait kinematics and trunk acceleration were measured using a motion capture system and a triaxial accelerometer placed on the sacrum. The participants wore a harness while walking on the treadmill for safety. Time change of PE was calculated based on the kinematic data, while that of KE was estimated by integrating the measured longitudinal acceleration. The rate of energy saving via the inverted pendulum mechanism, %Recovery, was then calculated based on the instantaneous PE and KE. The harmonic ratios (HR) of the trunk acceleration were also calculated to quantify step-to-step symmetry of trunk movements during locomotion. RESULTS: In normal human walking, PE is highest at the mid-stance phase and lowest at the double support phase, and vice versa for KE, resulting in the out-of-phase fluctuation of PE and KE and high %Recovery in tied-belt walking. Although %Recovery was relatively lower in the split-belt walking, we found that the %Recovery increased during the adaptation process. We also observed that the HR increased over the course of adaptation, indicating that the asymmetry of the trunk movement was corrected. CONCLUSIONS: During adaptation to the split-belt walking, the walking pattern seems to be modulated such as to improve energetic efficiency of locomotion by symmetrizing the trunk movement.

P2-B-9 On-line Balance Control and Adaptation in the Context of a Virtual Force Field Illusion

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BACKGROUND AND AIM: The balance subsystem is an integral part of the sensorimotor system. It contributes to the ongoing perception-action loop that allows us to be real-time interactive beings. When performing goal-directed hand movements, the balance subsystem is involved in both anticipatory and compensatory postural adjustments. Usually, spatio-temporal sensory information is synchronised. In virtual environments (VE), this synchrony can be maintained [Ma03], but also be broken up, either "by accident" or on purpose. We have spatially dissociated visual and proprioceptive information about the position and dynamics of one's own hand in an interactive virtual force field application [Pu08]. We have shown that an illusion of force at arms and hands can be evoked, even though no real force has been applied by the system. Our insights gave rise to balance-related questions about on-line control and adaptation, bottom-up vs. top-down effects of VE on multi-sensory interaction, as well as about the ergonomics of VE using such conflicts. METHODS: We have studied the centre of pressure (CoP) over time (e.g., velocity profiles and trajectory features). Participants were standing upright and wore a video see-through head-mounted display (HMD) through which they saw their own upper limbs, captured by stereo cameras built into the HMD. When being exposed to a virtual particle flow, a visual hand shift took place producing a dynamic visuo-proprioceptive conflict that became static over the course of a trial (for further details, please refer to [Pu08]). The experiment was composed of pre, main, and post sessions. Visual perturbations only occurred during the main sessions. Balance data have been recorded at 1 kHz from a custom force plate, then been filtered and consolidated for behavioural analyses. RESULTS: Despite the perceptual challenges of our immersive protocol, balance data show the capacity of the postural system to react and adapt (although not completely) to visuo-proprioceptive conflicts during reaching movements. Subjects performed near ecological compensatory postural adjustments in response to the visually induced force illusion. However, we observed carry-over effects between trials, represented by shifted CoP. CONCLUSIONS: These results show both the inner effects of perceptual illusions on the unconscious control of adaptive movement-balance co-ordination and the influence of manipulated visual stimuli on cross-modal

integration in the absence of real world references. We conclude that on-line balance control and adaptation in sensorily manipulative VE are possible and promising, but limited, and should thus be handled with care, particularly in clinical contexts. REFERENCES: [Ma03] O. Martin, B. Julian, L. Boissieux, J.-D.Gascuel, & C. Prablanc. J. Vis. Comput. Animat., 14 (5), Special Issue: VR in Mental Health and Rehab., pp. 253-260, 2003. [Pu08] A. Pusch, O. Martin, & S. Coquillart. Proc. of IEEE 3DUI, pp. 59-66, 2008.

P2-C-11 Factors associated with the increased perceptual reliance on the visual reference frame with age

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BACKGROUND AND AIM: When interacting with their environment, humans select alternative reference frames (RF) for spatial orientation, depending on the setting/task. Greater reliance on the visual RF is extensively reported in the elderly, termed visual field dependence (VFD). Alterations of the internal model with age [1] and the decline of proprioceptive and vestibular systems for postural control [2] inevitably upweight visual input. The proprioceptive chain from eye to foot [3] plays a major role in egocentric perception. Oculomotor control is affected by age [4] which may alter both extra-retinal and peripheral visual information (PVI) for spatial orientation. In particular, eye fixation instability (EFI) with age could impact PVI processing. It is known that the useful field of view (UFOV), a visual attention measure related to PVI processing, shrinks with age. Moreover, it has been suggested that the elderly may develop oculomotor strategies to compensate this effect [5]. Our study aims at better understanding increased VFD with regard to egocentric dependence (ED), UFOV and EFI, in the context of ageing. METHODS: 20 young, 18 middle-aged and 20 old adults participated in the study. Subjective vertical estimation (SVE) tasks were performed to assess VFD by disturbing the static (RFT) or dynamic (RDT) visual RFs respectively and ED by imposing a body tilt of 70°. The cognitive dimension of VFD was evaluated by the ability to overcome embeddedness (GEFT). EFI and UFOV were assessed with a target fixation task and with the UFOV® test, respectively. RESULTS: We found a strong relationship between greater VFD and lower ED as well as larger intra-individual variability in SVE with age. EFI increased and UFOV declined with age and both were correlated with increased VFD. Greater EFI correlated with reduced ED. CONCLUSIONS: The progressive shift with age to greater VFD is associated with decreased egocentric referencing, increased EFI and reduced PVI processing and attention capacities. [1] M. Boisgontier and V. Nougier, "Ageing of internal models: from a continuous to an intermittent proprioceptive control of movement" AGE, vol. 35, no. 4, pp. 1339-1355, 2013 [2] D. Manchester, M. Woollacott, N. Zederbauer-Hylton, and O. Marin, "Visual, Vestibular and Somatosensory Contributions

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P2-C-12 Subjective visual and haptic vertical in young and elderly

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BACKGROUND AND AIM: Space perception (proprioceptive, visual and vestibular) is gradually deteriorating during aging, however its behavioral consequences are not easily recognized due to a substitution process in CNS. Deviation of subjective visual vertical (SVV) is a sensitive sign of vestibular system imbalance. The subjective haptic vertical (SHV) assessment task requires subjects to adjust the vertical orientation of an object, mostly using proprioceptive input. The aim of this study was to compare accuracy of perception of SVV and SHV between groups of young and elderly healthy subjects. METHODS: Binocular examination of SVV was performed using the bedside test - bucket method. Tactile device described by Tarnutzer et al. (2012) was used to assess perceived SHV. Measurements of SVV and SHV were made in 27 young healthy right-handed subjects (age 24.6±1.5 years, mean±SD) and 30 elderly right-handed subjects (age 74.8±7.8) without neurologic impairment. RESULTS: The groups did not differ significantly on estimated position and range of SVV. But we found statisticaly significant difference ($p<0.01$) in SHV estimated position and range ($p<0.01$). The difference in SHV is caused by supination part of the task ($p<0.001$) with no difference between groups in pronation part of the task. CONCLUSIONS: These findigs suggest that proprioceptive perception of verticality is more affected by aging than vestibular perception and that the descrease in proprioceptive accuracy is more pronounced in motion which involves supination.

P2-C-13 Simulation of a real world task to study motor, cognitive and metabolic aspects of performance of complex daily tasks in young and older adults: comparison with real world performance

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BACKGROUND AND AIM: Decline in function due to aging has been widely investigated. However the interrelationships between age-related impairments of cognitive, motor and physiological processes that impede the ability of elderly to accomplish complex daily tasks have not been sufficiently studied. The aim of this study is to compare motor, cognitive and metabolic aspects of performance of complex daily tasks carried out in simulated and real world environments by young and older adults. METHODS: To date, 9 young (aged 26.1±4.7 years, 6 women) and 10 older adults (aged 73.5±6.1 years, 7 women) participants performed the Multiple Errands Test (MET), a complex shopping task, in both simulated (virtual, VR) and real shopping malls (real world, RW). In the simulation, participants walked on a self-paced treadmill (VGait) facing a large monitor and navigating through the simulated mall with a joystick. Metabolic variables were recorded with the Cosmed, $K4^2$ system and gait variables were recorded with the Mobility Lab (APDM) system in both environments. RESULTS: Initial analysis showed that the young group performed the MET significantly better and faster than the older group in both RW and VR environments. Time to complete the task was significantly longer in the RW than in the VR environment only for the younger group (RW= 12.6±2.1; VR= 9.3 ± 3.4 minutes,$p<.05$). Metabolic equivalent values indicated that performing the task in both environments involved activity at a light intensity. Comparison of the metabolic equivalents showed no significant differences between the young and older participants for both the RW and VR environments (RW young=2.26±0.18; RW older=2.08±0.47; VR young=1.93±0.34; VR older=2.02±0.05). However while for the young group values were significantly higher for the RW relative to the VR ($p<0.05$), no significant differences between environments were found for the older participants. Gait speed was significantly slower ($p<0.05$) in the simulation with no significant differences between young and older groups in both environments (RW young=1.31±0.21; RW older=1.12±0.16; VR young=0.66±0.12; VR older=0.65±0.14- m/s). CONCLUSIONS: The design of the simulated and real world environments allows multidimensional comparison of performance of complex daily activities. The combination of metabolic, gait and cognitive data provides an opportunity to explore the complexity of strategies used by participants to accomplish functional tasks such as shopping. Differences between the performances in the two environments will be discussed.

P2-C-14 Effects of ageing on the attentional demands of step adjustments to perturbations in visually cued walking

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BACKGROUND AND AIM: A reduced capacity to rapidly and accurately change foot landing positions during walking is a probable determinant of falls in older populations. This capacity has been typically assessed in relation to step initiation or walking with a limited number of steps. However, in daily life

such adjustments often need to be made during ongoing gait and while simultaneously performing another task (such as talking). In the present study we investigated the effect of age on the attentional demands of visually guided step adjustments in response to unpredictable shifts of stepping cues with and without a secondary task. Stepping cue shifts occurred in forward (FW), backward (BW), or sideward (SW) direction, at varying levels of difficulty (difficulty increased with a decrease in available response distance; ARD). We hypothesized that stepping accuracy would deteriorate with increased difficulty. In addition, we expected the influence of dual tasking to be more prominent in elderly adults than in young adults. METHODS: Fifteen older adults (69.4±5.0 yrs; M±SD) and fifteen young adults (25.4±3.0 yrs) walked at a speed of 3 km/h on a treadmill belt augmented with stepping cues. Cues for either leg could unpredictably shift in FW, BW or SW direction at three levels of difficulty (ARD 90, 110 or 130% of step length). In total 180 cues shifted randomly during a long sequence of non-shifted cues. The walking task was repeated concurrently with an auditory Stroop task. Baseline Stroop performance was determined for cued walking without cue shifts. Step adjustment was quantified by the median of the anteroposterior distance (FW/BW shifts) and mediolateral distance (SW shifts) between the center of stepping cue and the center of foot at midstance. This value was corrected by subtracting the stepping inaccuracy of the last step before the shifted cue. RESULTS: For all directions, step adjustments were smaller than imposed. This discrepancy was larger for older adults, under dual task condition and with more difficult ARD. For FW/BW shifts, this effect was further exacerbated by dual tasking in older adults. Step adjustment was smaller for BW compared to FW shifts. In young adults, this difference was more prominent in conditions with smaller ARD whereas in older adults this effect was more pronounced for the larger ARD. CONCLUSIONS: Older adults were less successful than young adults in adjusting foot landing position in all three directions. This deficit was more prominent during dual task performance, indicating that dividing attention over the two tasks was detrimental for rapid adjustments in stepping performance in this age group. This might impair their capacity to cope with walking surface hazards in real life situations and might represent a potential determinant of increased fall risk.

P2-C-15 GAZE BEHAVIOR AND POSTURAL CONTROL PERFORMANCE IN YOUNG ADULTS AND ELDERLY

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BACKGROUND AND AIM: Previous studies have shown disagreement on effects of saccadic and smooth pursuit eye movements on body sway of young adults and elderly. Also, it is little known how these eye movements modify the stability as compared to fixation. Gaze behavior appears to be associated with changes in stability when the bases of support are more challenging for the postural control system. In particular, the effects of aging on the relationship between gaze and posture since the sensorimotor systems are deteriorated over the years are still unclear. The aim of the study was to investigate the relationship between eye movements and the performance of postural control in different conditions of saccadic direction and bases of support in young adults and elderly. METHODS: Ten young adults (20.7 ± 3.4 years) and 10 older adults (71.6 ± 3.1 years) remained in upright stance on a force platform using an eye tracker device. The participants performed twelve 30 s trials according two bases of support (bipedal and semi-tandem basis) and three gaze behavior (fixation, horizontal and vertical saccades) conditions. The dependent variables of the postural control performance were: mean amplitude, mean velocity in the anterior-posterior (AP) and medial-lateral (ML) axis and area of center of pressure (CP). The dependent variables of gaze behavior were: mean latency between eye movement and visual stimulus, variability of latency, number and duration of fixations. MANOVAs and ANOVAs were used to compare groups at bases of support and gaze behavior conditions. Pearson's correlations were performed between the gaze and postural control variables for both the young and older adults in all conditions. RESULTS: Both groups showed higher number of fixations and lower fixation duration ($p<0.001$) at semi-tandem basis ($p<0.05$). The results also showed higher variability of latency at vertical saccades ($p<0.0001$) for elderly compared to young adults ($p<0.001$). In addition, elderly presented higher mean velocity at AP and ML axis ($p<0.0001$) and area of CP ($p<0.05$) at semi tandem basis than young adults. For correlations, elderly people showed a larger number of correlations between gaze behavior and bases of support, which occurred to more challenging ST basis of support and more usual horizontal saccades or less challenging BP basis of support and less usual vertical saccades (Table 1). Conversely, young adults showed correlations between less usual vertical saccades and both the bases of support. CONCLUSIONS: These results indicated that posture and gaze control systems were affected by the aging process. In addition, challenging postural tasks seemed to modify the postural and gaze behavior of young and older adults, suggesting some deterioration in both postural control and gaze tasks performance for the elderly.

P2-C-16 Aging, Central Nervous System and Mobility: Findings and Strategies to Prevent or Improve Late Life Gait Decline from a 3 Year Conference Series

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Background and Aim: Evidence from basic, clinical, and epidemiological studies indicate that changes in the central nervous system (CNS) are important contributors to gait decline in older adults without overt neurologic disease. However, the mechanisms underlying these associations are understudied, and treatments have been largely ineffective at reducing gait decline with older age. Methods: A three year conference series was launched in collaboration with the National Institute on Aging and Gerontological Society of America. The overarching goal of the conference series was to facilitate the translation of research results into interventions that improve gait for older adults. The workshops, both individually and as a whole, aim to move beyond discipline-specific and disease-based approaches to promote research on CNS-related mechanisms of mobility limitations and to identify successful prevention and intervention strategies. Results: The conference series identified gaps in knowledge barriers to progress and strategies to promote new research.. First, the variability in gait decline between older individuals may be due to capacity for brain plasticity,,a potential buffer from the disabling impact of other impairments; this differential brain compensation could potentially explain variable response to rehabilitative intervention.. Second, few studies examine CNS- mediated mechanisms of gait decline in the absence of clinically overt neurological disease. These few studies propose neurovascular, inflammatory and metabolic mechanisms, with genetic polymorphisms and energetics also playing important roles. Last, interventions targeting multiple domains appear promising, including drug therapies to reduce cognitive impairment, transcranial magnetic stimulation, mild to moderate goal-directed physical and cognitive activity combined with distracting tasks, and noise-based approaches to enhance sensory function. Conclusions: These workshops have disseminated new knowledge from multiple disciplines, and suggested priority topics and strategies for future research. Future research opportunities include the identification of specific phenotypes due to age-associated CNS abnormalities; the development of standardized assessment tools for mobility, CNS imaging, and cognition that can be applied to large databases and multicenter trials; the use of complex systems and systems biology approaches to the understanding of age-associated mobility disorders; exploration of the role of cognitive reserve and repair in preventing some people from developing mobility impairments in the presence of CNS pathology; and the development of novel interventions based on genetic, inflammatory, oxidative, and other mechanisms. There is also a need to train new investigators to conduct cross-disciplinary research in this important field.

P2-C-17 "Standing Tall" - an engaging home-based exercise program using iPad technology for preventing falls in older people

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Background and aim: Current evidence suggests that older people have to exercise for at least 2 hours per week for 6 months, with a strong focus on balance exercises [1]. Adherence to such programs is often low for reasons including motivation, access and cost. Therefore, novel and engaging methods for delivery of exercise programs are needed to enhance long-term motivation and adherence without

increasing the cost. We have developed and tested an individually tailored, home-based balance program for older adults delivered through iPad technology, called Standing Tall (ST). Our program incorporates a variety of behavioural techniques based on the health belief model [2] to increase self-efficacy and promote long-term adherence. The balance exercises comprise of evidence-based and best-practice principles used in effective falls prevention exercise programs [3,4]. Methods: A pilot study was conducted to examine feasibility, acceptability and safety of ST in ten community-dwelling adults aged 65 years and over (6 women) with limited experience with technologies. Participants were encouraged to use the program 20 minutes per day for two weeks unsupervised. Semi-structured interviews were then conducted to further investigate participants' experience and suggestions for improvement. Results: Adherence to ST was excellent, with participants completing an average of 5.3 (SD=1.3) sessions per week; no adverse events were reported. Overall, ST was rated excellent (n=6) to good (n=4). An average score of 80.5 (SD=16.4) on the System Usability Scale (max score is 100) indicated that ST was easy to use. Nine participants agreed that the app had "clear instructions" and reported "feeling very confident" in using ST. An average score of 30.9 (SD=7.8) on the Physical Activity Enjoyment Scale (max score is 40) indicated that the provided exercises were enjoyable. All participants agreed (n=10) that the program was engaging (one participant called it 'addictive'), and the majority (n=8) reported that they could easily incorporate it into their daily life. Semi-structured interviews revealed all participants felt motivated by the novelty of using iPad technology and most participants reported 'Standing Tall' would help them exercise more regularly, improve their balance performance and balance confidence. Conclusion: Our Standing Tall program is designed in line with evidence-based, best-practice principles for fall prevention in a form that will maximise long-term adherence (i.e. home-based, individually tailored, progressive, engaging and incorporating behavioural techniques). Results from our pilot study indicate that Standing Tall is feasible and safe to be administered independently by older people in their home, with excellent adherence (objectively measured through the app). [1]SHERRINGTON, C., et al. 2011. NSW Public Health Bull [2]BANDURA, A. 2004. Health Ed Behav [3]BARNETT, A., et al. 2003. Age Ageing [4]CLEMSON, L., et al. 2012. BMJ

P2-C-18 Sub-threshold plantar vibrations enhance the multiscale complexity of postural sway in older adults

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BACKGROUND AND AIM: The dynamics of standing postural control (i.e., postural sway) are complex; they contain non-random fluctuations over multiple scales of time. Age-related lower-extremity somatosensory impairments have been linked to a loss of this "complexity." Sub-threshold vibratory noise improves both somatosensory function and postural control in older adults. We therefore hypothesized that this type of vibration, as delivered by a novel piezo-electric insole, would increase the complexity of standing postural sway in older adults. METHODS: Twelve subjects aged 65-90 years completed three study visits to test the effects of foot sole vibratory noise set to 70%, 85% or 0% (i.e., control) of sensory threshold on standing posture and mobility. Subjects and investigators were blinded to vibratory condition. Postural sway was assessed during multiple trials of eyes-open and eyes-closed standing on a stationary force plate. Multiscale entropy was used to quantify the complexity of each postural sway (i.e., center-of-pressure) time-series. The timed up-and-go (TUG) was recorded to assess mobility. RESULTS: In the control condition, subjects with greater postural sway complexity had better somatosensation (i.e., lower vibratory thresholds, r2=0.49, p<0.001) and better mobility (i.e., lower TUG times, r2=0.38, p<0.001). As compared to this condition, subthreshold vibration at both 70% and 85% increased postural sway complexity under both eyes-open (p=0.001) and eyes-closed (p=0.003) conditions. Moreover, the percent increase in sway complexity correlated with the percent improvement in mobility (r2>0.15, p<0.03). CONCLUSIONS: These results suggest that sub-threshold vibratory noise may effectively counteract the age-related loss of complexity in postural control dynamics and furthermore, improve mobility in older adults.

P2-D-19 Question on the cross-correlation function

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▪ Background and aim ▪ The cross-correlation function between the L/R and Fd/Bd stabilograms has sometimes a regular aspect of damped sinusoid, then it is usual to think that the subject supports voluntarily his postural control (Gagey & Weber, 2005). Guidetti (1992), indeed, showed that such regular sine waves may be generated, by simulating an instability, provided you keep the same frequency of simulated oscillations for the total duration of the recording. In addition, Ferrey et al. (1988) showed that anxious subjects may also have regular sinusoidal cross-correlations. To fight against their anguish, they support consciously their postural sway. This is the usual interpretation about these regular plots of damped sinusoid. ▪ But there are also pseudo-sinusoidal lines of the cross-correlation function and that is the problem we want to present to our society, hoping some help during the congress. The problem arises from the comparison of two experiments. ▪ Methods ▪ 1) In a specialized consultation on postural functional disorders of children with learning disabilities (Villeneuve et al., 2014), 30 children were recorded on a platform of stabilometry in the standard conditions of the French Association of Posturology (Normes85). ▪ 2) At the 122th kilometer of the annual ultra trial around the Mont Blanc (Gely, 2014), 17 riders were recorded on a platform of stabilometry in the standard conditions of the French Association of Posturology (Normes85). ▪ Results ▪ 1) Pseudo-sinusoidal cross-correlations were observed for 85% of the children with learning disabilities. ▪ 2) Pseudo-sinusoidal cross-correlations were observed for 100% of the riders. ▪ Discussion ▪ One could say that these pseudo-sinusoidal cross-correlations are unimportant, meaningless lines, insofar as their layout is not really that of a damped sinusoid. ▪ But the riders were recorded at a time they had an oxygen debt. The ventilatory rhythm was observed on all the FFT of their recordings, slightly shifted to a frequency a little greater than 0,2Hz, it was seen also on the autocorrelations and the cross-correlation. It is difficult not to relate these pseudo-sinusoidal cross-correlations to the conscious care of their ventilation function. Here, the pseudo-sinusoidal intercorrelations are a manifestation of a conscious support of a normally automatic function. But what about the children with learning disabilities? ▪ From which criterion can we speak of pseudo sinusoid? ▪ References ▪ Gagey P.M. Weber B. (2005) Posturologie Régulation et dérèglements de la station debout. Masson, Paris. ▪ Guidetti G. (1992) Aspetti medico-legali dei disturbi dell'equilibrio. Bi & Gi, Verona : 163-178. ▪ Ferrey G., Gagey PM (1988) Encycl. Méd. Chir. (Paris), Psychiatrie, 37520 A10. ▪ A.F.P. (1985) Normes 85. ADAP, Paris. ▪ Gély A. (2014) Mémoire pour le DIU de Posturologie clinique. ▪ Villeneuve

P2-D-20 Effect of step length on upper body dynamics using an inverted double pendulum model

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BACKGROUND AND AIM: Bipedal walking is one of important characteristics of human beings. A better understanding of the gait control mechanisms is essential for health promotion. The upper body appears to play an important role in regulating angular momentum around the whole-body center of mass (COM) to maintain dynamic stability during walking. We have previously demonstrated the use of the upper body to improve walking performance based on a bipedal walking simulation using an inverted double pendulum model (Fig.1). The upper inverted pendulum angle (UIPA, Fig.1) was found to be a key factor affecting walking performance, where increased UIPA was observed with increased walking speed and step length. Considering that step length increases as walking speed increases, the increased UIPA seems to result from increased step length. This study investigated the effect of step length on the upper body dynamics during walking. METHODS: Nine healthy young male adults (age: 22.0±0.5 years, height: 1.71±0.06 m, body mass: 59.78±5.27 kg) participated in this study. The subjects were instructed to walk with the following four different walking conditions: normal walking (NW) at self-selected speed, fast walking (FW), long step walking (LSW) and fast long step walking (FLSW). Whole body kinematic data during walking were collected to calculate angular momentum (L) around the COM in the sagittal plane, UIPA, walking speed and step length. The angular momentum was normalized by height, weight, and walking speed. The mean value of the UIPA was calculated over the gait cycle. The Friedman's repeated measure non-parametric test followed by Scheffe's post hoc test was performed to detect differences in the outcome measures among the four walking conditions. RESULTS: The step length of LSW and FLSW was significantly longer than that of NW. The walking speed of FW and FLSW was significantly faster than that of NSW and the walking speed of FLSW was significantly faster than that of

LSW. The normalized angular momentum was highly regulated during all the walking conditions (|L|<0.03). The UIPA during FW and FLSW was significantly larger than that during NW. However, no significant differences were found in the UIPA between NW and LSW, and among FW, LSW and FLSW. CONCLUSIONS: It was found that the UIPA was similar between normal walking and long step walking conditions when the walking speed was similar, while the UIPA was larger when the subjects walked faster. These results suggested that the UIPA is dependent on walking speed, but not on step length. This implies that the upper body is being utilized when we intend to walk faster, and a longer step does not always require such utilization. Forward tilt of the upper body seems to be utilized when greater forward propulsion of the body is required during walking.

P2-D-21 Does perturbation training improve control of quiet standing in individuals with chronic stroke?

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BACKGROUND AND AIM: Individuals with stroke have greater postural sway and reduced between-limb synchronization in quiet standing than healthy individuals[1]. Reduced temporal synchrony of the centre of pressure (COP) of the individual limbs at frequencies >0.4Hz is indicative of poor reactive balance control of quiet standing[2]. Preliminary work suggests that perturbation-based balance training (PBT) may improve reactive control of stepping responses among individuals with stroke[3]. This study aimed to determine if PBT can also improve reactive control of quiet standing. It was hypothesized that PBT would be associated with increased between-limb anteroposterior (AP) COP synchronisation and reduced root mean square (RMS) AP and mediolateral (ML) COP displacements within frequency bandwidths representative of reactive control. METHODS: This preliminary analysis included data from 16 individuals with chronic stroke (>6 months post-stroke). Participants were randomly allocated to PBT or 'typical' balance training (TBT) (two 1-hour training sessions/week for 6 weeks). The PBT program involved 60 external perturbations per session (push or pull from a physiotherapist). The TBT program consisted of task-oriented balance and mobility exercises without induced instability. At intake, and again after completion of training, participants stood on 2 force plates (1 foot on each) for 120s. The AP COP of each limb and the net AP and ML COP were calculated, and discrete wavelet transforms were applied. For each bandwidth of interest (D4: 1-2 Hz, D5: 0.5-1Hz, D6: 0.25-0.5Hz), cross-correlations at zero lag ($\rho 0$) were calculated between the limbs[2]. The net RMS of AP and ML COP were also calculated for each bandwidth. Mixed-factor ANOVAs (time, group) were used to determine if the PBT group experienced greater improvements than the TBT group. RESULTS: A significant main effect of group was identified for the ML net RMS at the D5 level ($p=0.031$), with higher RMS values in the PBT group. Similar non-significant trends were identified for the D4 (p=0.064) and D6 (p=0.051) levels. A trend toward a significant group x time interaction was observed for the net AP RMS at the D6 level (p=0.087), with a decrease in the TBT group and increase in the PBT group. There were no significant effects for ρ0. CONCLUSIONS: The results suggest that the RMS of the COP signal at certain bandwidths may be affected by training. In addition, the nature of the changes in the RMS of the COP signal (i.e. increase or decrease) may be dependent on whether the training program focuses on maintaining stability or responding to instability. Further work is required to better understand the implications for reactive balance control of these differential changes in the RMS of the COP due to type of training program. REFERENCES: [1]Mansfield et al. Clin Biomech 2011;26:312-7. [2]Singer & Mochizuki. IEEE Trans Neural Syst Rehabil Eng (in press). [3]Mansfield et al. Phys Ther 2011;91(6)

P2-D-22 Effect of walking speed and turning angle on required coefficient of friction during turning

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BACKGROUND AND AIM: The required coefficient of friction (RCOF) is the peak value of the traction coefficient (the ratio of the shear force component (fh) to the vertical force component (fz) applied to the floor) obtained shortly after a heel contact. RCOF is recognized as the minimum coefficient of friction needed at a shoe and a floor interface to sustain human locomotion. Thus, RCOF is a critical factor that relates to slip incidents during walking. Most studies on RCOF values during walking focuses on walking in a straight line at a constant speed (steady-state movement). Direction or velocity changes during walking are usually required for everyday activities and in workplaces. The purpose of this study was to investigate the effect of walking speed and turning angle on RCOF values during turning. METHODS: The study involved eight healthy young adult males with an average age of 22.4 yrs. The gait trials comprised five blocks: straight walking, i.e. turning angle was 0°, 60° step turn to the right, 60° spin turn to the right, 90° step turn to the right, 90° spin turn to the right. In turning trials, subjects were instructed to walk in a straight line and turn to the right with their left (step turn) or right foot (spin turn) on the force plate. The subjects were also asked to walk at their slow, natural, and fast speed. Each trial was replicated five times (i.e., 75 trials per subject). Two force plates and a three-dimensional motion capture system were used to measure body kinetics and kinematics. The whole body COM position was estimated using a seven-segment model and COM velocity was calculated. The traction coefficient was calculated using horizontal and vertical components of the ground reaction force. RESULTS: The RCOF values were significantly affected by the turning angle ($p < 0.001$) and walking speed (approaching speed in turning trial) ($p < 0.001$). The RCOF values increased with an increase of turning angle for step turn and spin turn ($p < 0.05$). Step turn tended to cause larger RCOF values than spin turn. The RCOF value was not significantly affected by walking speed during straight walking; however, the RCOF values during turning tended to increase with an increase of approaching speed. These results indicate that turning with large turning angle and at high walking speed would increase risk of slip. CONCLUSIONS: This study investigated the effect of walking speed and turning angle on RCOF values. We demonstrated that the increase of walking speed and turning angle increased RCOF values, i.e. risk of slip. The findings may ultimately be used to understand how people walk to prevent slip and fall during turning. Acknowledgement: This work was partially supported by JSPS KAKENHI Grant Number 25420080.

P2-E-23 White matter abnormalities in dizzy patients: A retrospective cohort multi-centre study

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Hena Ahmad*1, Niccolò Cerchiai*2, Michelangelo Mancuso3, Augusto P Casani2, Adolfo M Bronstein1 1 Academic Department of Neuro-otology, Division of Brain Sciences Imperial College London, Charing Cross Hospital, London, United Kingdom. 2 Department of Medical and Surgical Pathology, Otorhinolaryngology Unit, Pisa University Hospital, Pisa, Italy. 3 Neurological Clinic, University of Pisa, Pisa, Italy. [*Both authors contributed equally] Background and aim: A large proportion of elderly patients in dizzy (neuro-otology) clinics remain undiagnosed. Although cerebral small vessel disease is a significant contributor to the development of imbalance and falls in the elderly, whether it also contributes to the development of dizziness is not known. Although a previous study (Colledge et al BMJ 1996) reported no significant differences in white matter changes between dizzy and control subjects, herewith we re-assess this question. Methods: A retrospective case analysis was conducted for 125 dizzy patients referred to two neuro-otology tertiary referral centres in London and Pisa. Specific search criteria of "white matter disease" was applied to the patient database. Case notes were reviewed by a neuro-otologist who divided patients into two groups based on history, examination and tests. Group 1 consisted of patients with explained causes of dizziness (ie BPPV, Meniere's and other causes including stroke, orthostatic hypotension, CANVAS) and Group 2 had patients with unexplained cause of dizziness. Brain imaging was reviewed by a neuro-otologist blinded to the clinical details, in conjunction with the neuro-radiologist report. White matter hyperintensities in T2 weighted and FLAIR sequences were qualitatively rated according to the Fazekas scale. Results: There were 61 patients (mean age 72, SD: 7.95) in the unexplained group and 64 (mean age 72.01, SD: 8.28) in the explained group. The overall frequency of lesions (Fazekas scores 1-3) differed between the unexplained and explained dizziness groups ($p=0.015$). The frequency of severe lesions (Fazekas 3) was higher in the unexplained group (21%) than in the explained group (5%; chi squared test, $p=0.005$). Gait and postural abnormalities were more frequent in the unexplained group (44%) as compared to the explained group (25% - half of which were explained by the underlying diagnosis). Conclusion: The increased severity of white matter abnormalities in cases of unexplained dizziness suggests that such abnormalities are contributory or causal to the development of the dizziness. We postulate that white matter lesions may induce dizziness either because patients perceive a degree of objective unsteadiness or by a cortical-subcortical disconnection syndrome.

P2-E-24 Brain metabolic pattern during gait with freezing in Parkinson?s disease

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Background and aims: Freezing of gait (FoG) is a debilitating gait disorder in Parkinson's disease (PD). In advanced PD patients with FoG, the supraspinal locomotor network may be dysregulated during gait (relative to similar patients without FoG). Here, we aimed to clarify the metabolic locomotor networks involved in FoG. Methods: Twenty-two PD patients (11 with off-drug FoG and 11 without) each underwent two [18F]-fluorodeoxyglucose PET brain scans in the off-drug state: once at rest and a second after activation by a standardized gait trajectory reproducing the usual triggers for FoG during radiotracer uptake. Results: For the 11 freezers, FoG was present for 39% (±23%) of the time during the gait task. The FoG pattern was characterized by (i) hypometabolism in frontal regions: the associative premotor, temporopolar and orbitofrontal areas (Brodmann area 8, 6) and (ii) hypermetabolism in the paracentral lobule (Brodmann area 5) (iii) deregulation of the basal ganglia output (globus pallidus and mesencephalic locomotor region). Conclusion: FoG during a real gait task was associated with a disrupted frontoparietal cortical activation: abnormally low activity of the premotor area (involved in the indirect locomotor pathway) and abnormal parietal hyperactivation (reflecting harmful external cueing).

P2-E-25 Different motor cortical processing between voluntary and postural tasks in both young and old adults

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Background and aim: When humans voluntarily activate a muscle, intracortical inhibition decreases. Intracortical inhibition also decreases in muscles involved in postural control under conditions of increased postural challenge. This decrease in intracortical inhibition with increasing postural challenge is more pronounced in old adults. Our goal was to re-examine the possibility that motor cortical control differs between postural and voluntary contractions and extend these previous findings obtained in young individuals to old adults, a population known to have altered control of intracortical circuits. Methods: Healthy young (age 23, n=14) and old adults (age 73, n=12) participated in this transcranial magnetic brain stimulation (TMS) study. Subthreshold TMS (sTMS) was applied to the soleus motor area to suppress motor cortical output while subjects were either sitting or leaning forward with and without support at the chest. Subjects matched the soleus EMG activity during supported leaning and sitting with EMG recorded during unsupported leaning. In all conditions, using the same stimulation parameters, we measured the magnitude of suppression in the EMG induced by sTMS. We measured center of pressure (CoP) variability (standard deviation) and CoP error (average CoP position - target CoP position) in unsupported leaning. Results: CoP variability during unsupported leaning was ~40% greater in old compared with young adults ($t(21) = -2.7$, $p=0.013$), indicating worse performance. Also, maximum lean was lower in old compared with young adults ($t(21) = 2.6$, $p=0.018$). However, the error from the target was similar in both groups. There was a significant condition effect on the duration ($F(1.5, 35.2) = 16.7$, $p<0.001$) and level ($F(2, 48) = 9.9$, $p<0.001$) of EMG suppression. Suppression duration was ~40% shorter and suppression level ~20% lower in unsupported vs. supported leaning and sitting. EMG suppression was similar in supported leaning and sitting. Age did not affect the EMG suppression. Greater CoP error correlated with less EMG suppression during unsupported leaning (expressed as a percentage of the amount of suppression during sitting) ($r = -0.42$, $p = 0.044$). That is, leaning past the target resulted in less EMG suppression. Conclusions: The decrease in sTMS-induced EMG suppression during unsupported leaning suggests that motor cortical processing differs between voluntary and postural contractions. The negative correlation between EMG suppression and CoP error suggests that it is not only the contraction type, but also the context of instability that modulates EMG suppression. Furthermore, this correlation implies that the modulation is caused by a decrease in intracortical inhibition, probably to place the motor cortex in a readiness state to be able to react to perturbations. Age does not affect this modulation in motor cortical processing.

P2-E-26 fNIRS imaging of step initiation in older adults

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BACKGROUND and AIM: Study of the effect of aging on the functional neuroimaging of posture and gait has only recently been undertaken.(Zwergal et al. 2012) Previously, we examined the control of step initiation in young adults using functional Near Infrared Spectroscopy (fNIRS), and found greater activation of the middle frontal gyrus during an inhibitory reaction time task, suggesting greater use of executive function regions.(Huppert et al. 2012) Therefore, the purpose of the current study is to examine the control of stepping in older adults using fNIRS. METHODS: Functional NIRS imaging of 17 older adult subjects (mean age 77 + 5 y, 9 females) was conducted as they performed simple reaction time (SRT) and inhibition reaction time (IRT) step tests. A 32-channel continuous wave fNIRS instrument was used to record the hemodynamic changes bilaterally over the dorsolateral frontal cortex and temporo-parietal cortex. During separate blocks of the SRT task, subjects performed 24 left or 24 right step trials, in response to left or right arrows appearing on a monitor, respectively. Subjects were classified into two groups based on how many postural adjustments (PA) they produced during the SRT task (1 PA or 2 PA). Subjects performed two blocks of the IRT task, stepping in the direction that an arrow was pointing. The stimuli for step direction were either congruent (left arrow on left side of the monitor, right arrow on right) or incongruent (left arrow on right, right arrow on left). During the incongruent stimuli, subjects were required to inhibit a prepotent response toward the direction of the arrow location. In total, 24 steps for each stimulus were performed. Statistical analysis of changes in brain activity was done using a canonical general linear model. We have developed a random-effects reconstruction model for group-level inference which is based on estimating the group-level images that simultaneously minimize data-fit errors across all individual subjects. Between-group differences were tested using voxel-wise ANOVA analysis with group as the primary regressor. RESULTS: Older adults had increased fNIRS activation in parts of the middle frontal, inferior frontal, and precentral gyri when performing the incongruent trials compared with the congruent trials, consistent with motor planning and attention functions (Figure 1, top). Moreover, compared with subjects who typically produced 1 PA, subjects who made 2 PAs had greater activation in the inferior frontal and precentral gyri, as well as greater activation in the superior temporal gyrus, a part of the vestibular cortex (Figure 1, bottom). CONCLUSION: In general, the inhibitory reaction time task engaged the same brain regions as young adults, (Huppert et al. 2012) consistent with the engagement of inhibitory processes. Additionally, subjects who had a more conservative step strategy, had greater vestibular cortical activation, perhaps needing more sensorimotor integration resources.

P2-F-27 Dual-Task Timed Up and Go Test as Part of Memory Assessment - A pilot study

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BACKGROUND AND AIM: According to the WHO one of the main goals for supporting people with dementia is focusing on early diagnosis. There is, however, no simple way of identifying early signs of cognitive impairments. Though, studies have shown that impaired cognition is associated with declined performance in gait related tests, including the Timed Up and Go test (TUG). TUG is a well-established and simply administrated test of one mobility sequence: time is recorded when an individual starts from a seated position, stands up, walks 3 meters in comfortable speed, turns around walks back and sits down again. Moreover, dual-tasking such as combining a mobility test with a cognitive task (e.g. enumerating animals); TUG cognitive (TUGc), is significantly more challenging for people with dementia. Our group has shown that persons with mild Alzheimer's disease show obvious dual-task costs in terms of impaired gait performance during dual-tasking and increased time difference between TUGc and TUG. This may indicate that TUG can be useful for predicting future cognitive dysfunction The aim was to investigate if TUG and TUGc outcome (s) correlates with those from cognitive tests and to evaluate differences in TUG performances, based on being diagnosed with dementia or not. METHODS: Forty-three patients visiting a memory clinic performed both TUG and TUGc (enumerating animals). Their mean age was 74 years, 17 were women and 25 were diagnosed with dementia. Their cognitive status was assessed by the Mini Mental State Examination (MMSE) and the Clock Drawing Test (CDT). Dual-task cost as percent was calculated according to the formula: Dual-task cost = (TUGc-TUG) x 100 TUG Correlations were assessed by Spearman's rank correlation coefficient. Fisher's test was used for categorical variables to assess differences between the groups. Mann-Whitney U test was used for continuous variables to assess differences in results on cognitive tests and TUG between the participants with a dementia diagnosis and those without. To calculate the difference between TUGc and TUG for each individual the Wilcoxon Signed-Rank test was used. All tests were two-tailed and the significance level was set at $p<0.05$. RESULTS: Significant correlations were found between MMSE and TUG ($p = 0.036$), MMSE and TUGc ($p = 0.010$), and MMSE and TUG dual-task cost ($p = 0.027$). Participants diagnosed with dementia had a lower score on MMSE ($p = 0.009$) and an increased time on both TUG ($p = 0.014$) and TUGc ($p = 0.013$) compared to participants without a dementia diagnosis. CONCLUSION: These results support the indicated decline in dual task performance when affected by cognitive insufficiency. The evaluated methodology in this pilot study can be applied in future research investigating the possibility of using TUG tests as a means to discover signs of cognitive decline and potentially predict dementia.

P2-F-28 Vestibular training intervention for individuals with post-concussion syndrome

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Title: Vestibular training intervention for individuals with post-concussion syndrome Authors: Alyssa Prangley, Michael Cinelli, Matthew Aggerholm Background: A previous study revealed that concussed individuals experience balance deficits that are more prominent in the AP direction[1] as indicated by increased Center of Pressure (COP) displacement and velocity. This deficit may be due to potential damage to the vestibular system, primarily the impairment of the lateral vestibulospinal tract which sends signals to control ankle extensors. This may lead to increased compensatory torques about the ankle1. The purpose of the research is to investigate whether a vestibular training intervention can assist in decreasing persistent post-concussion symptoms in a concussed individual. Methods: Participants (N=6), minimum 29 days symptomatic, were tested during their first appointment with a registered physiotherapist (PT) and during each follow up appointment. Participants were prescribed balance, visual, and neck strengthening exercises by the PT that were to be completed daily between appointments. Balance testing consisted of a series of 4 conditions: 1) narrow Romberg stance eyes open (REO); 2) narrow Romberg stance eyes closed (REC); 3) single leg stance eyes open (SEO); and 4) single leg stance eyes closed (SEC). Participants stood upon a Nintendo Wii board which recorded ground reaction forces at 100Hz. This data was used to calculate RMS of COP displacement and velocity in the AP and ML directions. Results: Preliminary results revealed a significant decrease in ML displacement between Follow-Up 1 (i.e., following a two week treatment plan) and Intake ($p < .05$) during the REO condition. Conclusion: To-date there has not been any significant differences in balance between Intake and Follow Up 1 during any of the other conditions for a number of reasons: 1) two weeks may be too short of time to display significant findings across all participants as the healing process is different for everyone; 2) all participants have been living will symptoms for extended period of time and exercises would alter current lifestyle; or 3) variations in compliance to treatment plan. To determine if the participants have experienced improved balance, further data collection will include more balance measures during additional follow-up appointments to allow a more comprehensive assessment of the changes in COP displacement and velocity. References: [1]Powers, K., Kalmar, J., & Cinelli, M. (2013). Gait & Posture, in press

P2-G-29 Emotional exposure duration and its influence on gait initiation

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BACKGROUND AND AIMS: The interaction between the processing of emotional information and the regulation of balance has been demonstrated in a multitude of studies. Motivational tendencies (approach and avoidance) can become apparent in motor output, such as the control of quiet standing [1] and the initiation of gait (GI) [2]. Specifically, humans are faster to move in a forward direction ('approach') in response to pleasant stimuli compared to unpleasant stimuli. This is in line with the Motivational Direction Hypothesis (MDH). However, conflicting evidence in the literature challenges the universality of this effect. This could be due to the fact that earlier research failed to take into account the temporal dynamics of affective information processing, and its resultant effects on postural behavior [3]. Stins et al. [3] found that with short exposure duration participants initiated gait faster towards pleasant pictures compared to unpleasant pictures, while the opposite was true when the stimuli were processed for a longer duration prior to gait initiation. Our aims are: (1) To systematically explore the relationship between the temporal aspects of emotional processing and the control of gait initiation, and (2) to link personality traits to this relationship. METHODS: We are at the final stage of collecting data. The Center-Of-Pressure (COP) profile of gait initiation is recorded (using a balance board) while participants step in the anterior direction, towards pleasant, unpleasant and neutral pictures. Exposure duration of the affective stimuli is varied, ranging from 30 ms to 3000 ms. In addition, participants fill out two questionnaires (BIS-BAS and trait-state anxiety). RESULTS: Data collection will be completed in January. COP analyses will focus on initiation time, and the trajectory of the anticipatory postural adjustments. CONCLUSIONS: The findings will permit us to answer the following questions: (1) What is the influence of exposure duration of affective (pleasant and unpleasant) stimuli on the dynamics of GI?

(2) To what extent does anxiety further modulate the relationship between affective picture viewing and the control of GI? ACKNOWLEDGEMENTS: This research was supported by the Netherlands Organisation for Scientific Research (NWO). Grant number: 406-14-077. REFERENCES: [1] Roelofs K, Hagenaars MA, Stins J. Facing freeze: Social threat induces bodily freeze in humans. Psychol Sci 2010; 21(11): 1575-81. [2] Stins JF, Beek PJ. Organization of voluntary stepping in response to emotion-inducing pictures. Gait Posture 2011; 34(2): 164-68. [3] Stins JF, Van Gelder L, Oudenhoven L, Beek PJ. Biomechanical organization of gait initiation depends on the timing of affective processing. Gait Posture 2015; 41(1): 159-63.

P2-G-30 Increased threat influences the conscious perception of postural sway

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BACKGROUND AND AIM: Posture is influenced by increased postural threat. When standing quietly at the edge of an elevated platform sway amplitude decreases and frequency increases [1-3]. These threat-related postural changes occur in conjunction with significant increases in vestibular and proprioceptive gain [4,5]. However, what is unclear is how conscious perception of sway during threatening conditions is affected by a decrease in sway amplitude and a concomitant increase in sensory gain. Therefore, the aim of this study was to examine how changes in threat influence conscious perceptions of postural sway. METHODS: 15 young healthy adults stood on a forceplate mounted to a hydraulic lift placed at two heights (0.8m and 3.2m). At each height, subjects stood quietly with eyes open (EO) and eyes closed (EC) for 60s. Center of pressure (COP) total sway path (TSP), mean power frequency (MPF) and root mean square (RMS) were used to quantify postural sway. Subjects were instructed to focus on body movements/sway associated with quiet standing and simultaneously track their perceived sway in the AP plane by rotating a hand-held potentiometer. TSP was used to quantify the perceived sway (PS) tracked by the potentiometer. Psycho-social questionnaires were used to record balance confidence, fear, anxiety, and perceived sway for each balance task. Physiological arousal was recorded from electrodermal activity of the hand (EDA). RESULTS: Threat significantly increased EDA, fear and anxiety, and decreased balance confidence ($p<0.05$). Self-report of perceived sway did not change with threat. COP was influenced by main effects of threat and vision. Threat significantly increased COP TSP and MPF, and decreased RMS independent of vision. Removing vision significantly increased COP TSP and MPF independent of height. Although COP changes between EO and EC were of similar magnitude at each height, the correlations with PS were different between heights. In the low condition, the change between EO and EC conditions in TSP of PS was uncorrelated to TSP of COP ($r=-0.046$, $p=0.872$); however, at high height, the changes in TSP of PS and COP were correlated ($r=0.573$, $p=0.026$). CONCLUSIONS: When standing under conditions of increased postural threat, changes in perceived sway are more strongly related to changes in actual sway. In addition, when sway amplitude is reduced, sway perception appears to remain unchanged specifically with eyes closed. Therefore, when threat is increased, sensory gain may be increased to compensate for postural strategies that reduce sway (i.e. stiffening strategy), thereby ensuring sufficient afferent information is available to maintain, or even increase the conscious perception of postural sway. REFERENCES: [1] Carpenter et al. (1999) J Vestib Res; [2] Davis et al. (2009) Gait Posture; [3] Cleworth et al. (2012) Gait Posture; [4] Horslen et al. (2008) J Neurophysiol; [5] Horslen et al. (2014) J Physiol. ACKNOWLEDGEMENTS: Funded by NSERC.

P2-G-31 Attentional demand of balance in persons with low back pain: Effect of dual-tasking on balance response following perturbation

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BACKGROUND AND AIM: Individuals with non-specific low back pain (NSLBP) demonstrate altered postural responses following perturbations that may have consequences for their stability. [1] Deficit in neural system (including sensory input and motor output) has been proposed to be associated with these alterations. [2, 3] It is known that control of balance as well as experience of pain is under the influence of attentional factors. [4, 5] However, the role of cognitive processes as another element of neural system affecting control of balance in this group remains unclear. The aim of this study was to investigate the effect of a concurrent cognitive task on the ability to execute feet-in-place postural response in presence of perturbation. METHODS: Twenty individuals suffering from NSLBP and 20 matched controls between the ages of 18 and 45 years old participated. Subjects stood at the center of a moveable platform, with each foot on one of two force plates, and maintain their balance in response to sudden forward directed perturbation. Perturbation magnitude was scaled to the subject's height, while maintaining the translation duration across all subjects. The sway induced by this movement had a fixed 6°/sec angular momentum. Faceplate signals were used to determine anteroposterior excursion of center of pressure (COP) to find Reaction time, Latency, initial velocity and Max amplitude of response (Figure1). After familiarization trial, subjects performed balance task without a cognitive task (ST-balance) and while performing cognitive task (DT). The cognitive task (auditory stroop) was also performed while standing (ST-cognition).The mean of 3 trials of COP parameters and cognitive reaction times was used for statistical analysis. RESULTS: LBP sufferers had delayed reaction time and latency of response. ($p<0.05$) Also, Performance of stroop task caused increase in Max amplitude and velocity of postural response in this group. ($p<0.05$) Reaction time of stroop task was significantly increased in DT compared to ST-cognition conditions. Analysis on stoop reaction time revealed LBP group was slower than the controls. CONCLUSION: Besides altered postural response following perturbation, adaptation of response variables occurred under influence of an attention demanding task in LBP sufferer. This finding, in combination with overall poorer performance of cognitive task provides evidence that LBP may be considered as another factor modulating cognitive regulation of balance. Also, suggests altered postural control may be associated with disturbances in information processing that have a negative impact on both cognitive and motor performance. So, cognitive abilities should be considered in the management of LBP. [1]Jones et al 2012 Exp Brain Res; [2]Henry et al 2006 Clin Biomech; [3]Jones et al J Electromyogr Kinesiol (2012); [4] Shumway-Cook Motor Control: Theory and Practical Applications.2000; [5]Maki et al 2007 J Neural Transm

P2-G-32 A novel dual task balance test with cognitive cues for the postural control

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Background and aim. There may be significant attention requirements for the postural control, depending on the postural task, the age and the balance abilities of the individual. The use of a dual task approach is therefore believed to be relevant in the assessment of balance. In this context it is common to use a combination of a primary (motor) and a secondary distracting (cognitive) task. It remains a challenge, however, to standardize and monitor the cognitive task. The purpose of this study was to develop a new dual task test with a facilitating rather than distracting cognitive component, and to evaluate the test´s ability to discriminate between young and elderly people. Methods. Thirty-one healthy community-dwelling elderly people (mean age 77 years) and fifteen young people (mean age 22 years) were included in the study. The motor task consisted of 25 repetitive tasks in which the participants should reach out or take a step to touch one out of eights lights (www.fitlighttraining.com). The lights were coded to display the colors red, blue and green and they were placed in different zones indicated by the same three colors. The color cues allowed the participants to utilize cognitive strategies to plan their movements Three different trials were performed: a) Random: lights were lit in a random sequence (baseline); b) Cue: the color of each light indicated the position of the next light; c) Mixed cue: similar to b), but with the cue of the red and green switched around. The performance time for each trial was record and it was evaluated how much faster the tasks was performed in the trials with a cue and with a mixed cue. Results. The elderly performed the baseline test (random light sequence) in 44 (8) seconds while the average time for the young was 29 (3) seconds. Both groups performed the task faster when they were the lights provided a leading cue for the next movement. The improvement was significantly better in the young group: elderly: 5% (8), young: 17% (5); $p<0.001$. There were equivalently different improvements in the mixed cue test: elderly: 4% (9) young: 12% (5); $p<0.01$. Conclusion. The elderly people in this study were not only slower than the young in the motor task. They were also not able to utilize the leading cues in the test as well as the young people did. Dual-task interference will only occur if the available central resource capacity is exceeded, resulting in impaired performance in one or both tasks. The results indicate that the proposed test procedure in a standardized way reveal that the elderly require increased conscious attention to maintain postural control during reaching and stepping tasks.

P2-G-33 Balance recovery while performing cognitive and manual tasks: evidence for participation of high processing levels in reactive postural responses

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BACKGROUND AND AIM: Balance control in quiet stance is known to be affected by performing a simultaneous cognitive task requiring attentional resources, leading to increased body sway. Performance of a task requiring manual stability, conversely, has been shown to induce increased balance stability. In the present study, we assessed the effects of simultaneous performance of cognitive and manual tasks while responding to an unpredictable mechanical perturbation to upright balance. METHODS: For the initial position, participants stood on a force plate while resisting a load of approximately 10% of their body weight pulling the trunk backward at the lumbar-sacral region. To provoke balance perturbation, the load was unexpectedly released, causing a forward body sway. The cognitive task consisted of continuously subtracting three units, starting from a number given by the experimenter. The manual task consisted of keeping a light cylinder on a tray as motionless as possible. In one version of the manual task the cylinder was lying on its flat side, imposing a low manual stability constraint. In the other version, the cylinder was supported on its round surface, imposing a high manual stability constraint to keep the cylinder motionless. In the experiment, we compared reactive postural responses to perturbation between one group in low constraint and another one in high constraint, while performing the cognitive task. RESULTS: Analysis showed that the low manual constraint and the cognitive task induced poorer postural responses. These effects were manifested in increased variation of trunk verticality and increased amplitude/velocity of its oscillation, longer time to revert both direction of feet center of pressure and trunk oscillations, increased ankle and hip mobilization, and diminished activation of the gastrocnemius medialis muscle. For interjoint coordination, we found increased participation of the hip associated with the cognitive task. No significant effects were found for response latency. Results reported here indicate that cognitive and manual tasks performed concurrently with reactive postural responses to balance perturbation have distinct effects on recovery of stance stability. CONCLUSIONS: The findings of a detrimental effect of a pure cognitive task on balance recovery suggest that generation of automatic postural responses is mediated by high levels of processing. Requirement of high body stability by the manual task, on the other hand, seems to impose an abstract constraint on postural control. It is apparent that such an constraint leads to modulation of postural responses in order to minimize manual oscillations. Therefore, in this experiment we demonstrated the divergent effects of distinct concurrent tasks on balance recovery from an unexpected perturbation.

P2-G-34 Threat-induced changes in attentional processing during static and anticipatory postural control tasks

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BACKGROUND AND AIM: Postural threat, manipulated through changes in surface height, influences postural control. However, the mechanisms underlying this relationship are not fully understood. Recent work suggests changes in attentional processing may contribute to threat-induced changes in posture [1, 2]. Young adults self-reported directing more attention towards the internal processes underlying movement control when threatened, and these changes were related to changes in standing postural control [2]. However, these may not reflect the only threat-induced changes in attentional processing, as individuals may also allocate attention towards information unrelated to movement control such as negative or worrisome thoughts [3]. Thus, this study aimed to describe the changes in attentional processing when performing postural tasks under threatening compared to non-threatening conditions. METHODS: Eighty-two healthy young adults completed tests of static (quiet standing) and anticipatory (rise to toes) postural control under threatening and non-threatening conditions induced through changes in surface height. Attention focus during each task was assessed using an open-ended questionnaire. Participants listed the sources of information they directed their attention towards throughout each task and assigned each a percentage value reflecting how much of their attention it occupied. Exit interviews were conducted to confirm where individuals' attention was focused related to each attention source listed. RESULTS: Deductive and inductive qualitative methods were used to categorize and analyze self-reported attention focus data. Categories included: movement process, movement outcome, task instruction, negative thoughts, positive monitoring, and task irrelevant information. When quietly standing under threatening compared to non-threatening conditions, participants reported directing more attention towards the processes underlying movement control as well as negative thoughts and positive monitoring strategies, while less attention was directed towards task instruction and task irrelevant information. Similar patterns were observed for the rise to toes task; however, participants also reported less attention towards the movement outcome. CONCLUSIONS: Self-reported attention shifted not only towards the internal processes underlying movement control, but also towards negative thoughts and mental strategies aimed at coping with elevated anxiety. These findings highlight that there are multiple threat-induced changes in attentional processing and these changes may dynamically interact to influence postural control. Future work will use information from this study to develop an attention focus questionnaire that can be used to explore how threat-induced changes in attentional processing influence postural control strategies. REFERENCES: [1] Gage et al 2003 Exp Brain Res [2] Huffman et al 2009 Gait and Posture [3] Young and Williams 2014 Gait and Posture

P2-H-35 Reactive postural responses as a function of feet orientation and magnitude of perturbation

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Maintenance of orthostatic posture is an important and complex task for the human body. It has been shown that feet orientation might have an effect on quiet standing. However, it is not known how postural responses to an external perturbation are modulated by feet orientation. The aim of this study is to analyze the adaptability of reactive postural responses as a function of angle of feet orientation and perturbation magnitude. Ten young participants were evaluated in a balance recovery task, which consisted of a reactive response to an unforeseen release of load attached to the participant's trunk. Eight experimental conditions, resulting from the combination of load magnitude (5 or 10% of the participant bodyweight) and feet orientation angle (0˚, 30˚, 60˚ and participant's preferred orientation) were evaluated. As an indicator of stability, a force platform was used to record center of pressure. For evaluation of muscle response, wireless electrodes were connected to the medial gastrocnemius muscle. A motion analysis system provided three-dimensional coordinates of trunk displacement and joint mobilization. Results showed that the load of 10% combined with 60˚ feet orientation induced the highest body sway. Furthermore, it was observed that 10% load induced increased muscle activation and a shorter latency of muscular activation onset. These results indicate that feet orientation affects balance recovery only in extreme magnitudes, also, intensity and delay of reactive postural responses are modulated by disturbances magnitude.

P2-H-36 Is altered upper body control during gait in people with Parkinson's disease simply due to altered lower limb mechanics?

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BACKGROUND AND AIM:The ability to attenuate acceleration from inferior to superior located anatomical segments is sensitive to impaired postural control [1], and has recently emerged to be sensitive to Parkinson's disease [2]. However, it has not yet been investigated whether the different patterns in the upper body acceleration attenuations are solely a consequence of altered lower body mechanics [3]. Determining whether the two pieces of information are independent or correlated might provide useful information about how to interpret upper body attenuations in the context of early deficits of postural control in PD. The aim of the current study was to investigate the correlation between the ability to attenuate acceleration during gait and spatiotemporal gait characteristics in people with PD. Methods:Twenty-two people with PD (70±10 years) and twenty-seven age matched controls (71±7 years) walked continuously for two minutes around a 25m circuit. Spatiotemporal gait characteristics were measured using a 7m pressure activated walkway (Gaitrite, CIR systems). Step velocity (SV), step length (SL), step width (SW) and the coefficient of variation were recorded (SVc, SLc and SWc, respectively). Three tri-axial inertial sensors (OPAL, ADPM Inc) were placed on the pelvis (P), at shoulder level (S) and on the head (H). Acceleration signals were used to calculate the amount of acceleration attenuated from the P to the H (CPH), the P to the S (CPS) and the S to the H (CSH) [1]. A series of two-tailed paired t-tests was used to test the difference between groups (significance was set at $p < 0.05$). For the coefficients of attenuation that were able to discriminate between the two groups, a Pearson correlation coefficient was used to quantify the correlation between spatiotemporal gait characteristics and upper body accelerations. Results:The spatiotemporal and upper body variables that were sensitive to PD were SV ($p = 0.02$), SL ($p = 0.04$), SVc ($p = 0.002$) and SLc ($p = 0.001$). The coefficients of attenuation that were sensitive to PD were CPH ($p = 0.002$), CPS ($p = 0.012$), and CSH ($p = 0.017$) in the mediolateral direction and also CPS ($p = 0.003$) in the anterioposterior direction. However, there were no moderate or strong correlations between spatiotemporal gait characteristics and the coefficients of attenuation (i.e. $r < 0.4$). Conclusions:The ability to attenuate acceleration during gait was not strongly associated with spatiotemporal gait characteristics in people with PD. This suggests the measurement of coefficients of attenuation provide unique information about postural control deficits in PD independent of lower body mechanics. These results promote the addition of measuring upper body acceleration attenuation for those with PD when assessing postural control during gait.

References: [1] Mazzà C et al. J Neuroeng Rehabil 2008;10:1-10. [2] Buckley C et al. Biomed Res Int (Under review). [3] Hass C et al. PLoS One 2012;7:1-5.

P2-H-37 Timing Parameters of Gait Coordination, the Effect of Age and Walking Speed

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Background and aim: Healthy human gait is considered to be symmetric and bilateral coordinated. The mechanisms responsible for antiphasing coordination are not fully understood. The purpose of the current study was to investigate the influence of aging, walking speed and the interaction of age and walking speed on phase coordination index (PCI), gait asymmetry (GA) and gait variability. Methods: Forty four older adults were recruited from senior community centers, nine young elderly (age 70-74), 26 old elderly (age 75-84) and 9 very old elderly (older>85). In addition, 13 young adults were recruited from the university population. Subjects were instructed to walk on a treadmill; walking speed was systematically increased from 1.1 to 1.9 mile/hr in steps of 0.2 mile/hr. Each walking speed condition was maintained for 45 seconds. Results: Significant main effects of walking speeds on PCI and borderline significant effects of age, but, with no significant interaction between walking speeds and age groups (4X5 repeated measures ANOVA). There were no significant main effects of walking speeds and age on neither GA nor gait variability with any significant interaction. A significant difference was found in gait variability and borderline significant difference was found in PCI at subjects' preferred walking speed. Conclusions: This study explicitly shows that bilateral coordination of walking is controlled by gait speed

and deteriorates only at the very old age. Unlike gait asymmetry that is much more stable in the different gait speeds, and gait variability that only significantly differ between age groups at preferred walking speed.

P2-H-38 Gait initiation: the frontal-plane control

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Background and aim Gait initiation is a precise task, in which centre of pressure (CoP) and centre of mass (CoM) are tightly controlled. The distance created between CoM and CoP (CoM-CoP gap) in the sagittal plane produces a disequilibrium torque driven by gravity, responsible for accelerating the body forward (Lepers & Brenière, 1995). This torque is braked by the triceps activity (Honeine et al., 2013). We hypothesised that a similar process occurs in the frontal plane, and that selected muscles are put into action for the medio-lateral control of gait initiation. Methods Twelve healthy young adults participated in the experiment. They performed gait initiation in three conditions composed of 10 trials each, starting from: 1) normal step-width at normal velocity; 2) normal step-width at fast velocity; 3) large step-width at normal velocity. Two force platforms, appropriately located, measured CoP position during the stance phase of the first and second step. Twenty-three markers allowed calculation of CoM position in space. EMG activity of Soleus, Tibialis anterior, and Tensor fasciae latae (TFL) on both sides were measured. Dynamic, kinematic and EMG data were analysed during the preparation phase (from onset of CoP displacement to heel-off) and the step-execution phase (from heel-off to next foot-contact). Results Prior to heel-off, CoP briefly moved under the swing leg, in order to allow CoM displacement towards the stance leg. The amplitude of the CoP shift was greater in large with respect to normal step-width condition. Soleus and tibialis activity confirm results we found previously in Honeine et al. (2013). TFL activity of the swing leg just preceded the onset of CoP displacement and persisted for a while after heel-off of the swing leg. TFL of the stance leg just preceded heel-off and persisted during step-execution phase. Incrementing step-width and walking velocity moderately increased EMG activity in TFL. The shear force generated by the disequilibrium torque calculated in the frontal plane was highly correlated with the shear force measured by the force platform ($r2=0.95$; $y = 1.06x - 0.3$). Conclusion In gait initiation, the medio-lateral ground reaction force and thus CoM instantaneous velocity are explained by the disequilibrium torque in the frontal plane. The hip-abductor muscle TFL of the swing leg contributes to shifting CoP under the swing foot during the preparation phase. This displaces the CoM over the stance leg and allows the foot clearance for swing. In the step execution phase, TFL activity of the stance leg counteracts the action of the large disequilibrium torque, created by the lift of the swing foot, thereby providing the braking action against the medio-lateral fall of the CoM.

P2-H-39 Deliberately light interpersonal touch facilitates trunk stability during locomotion in cerebral palsy

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BACKGROUND AND AIM: Deliberately light interpersonal touch (IPT) has been shown to reduce body sway in healthy young and older adults as well as patients with neurological conditions. In this study, we aimed to quantify the benefit of IPT on postural stability during locomotion in children and adolescents with movement disorders. METHODS: A within-subject experiment assessed temporal gait variability and periodicity, interlimb coordination and variability of trunk excursions during walking and running in 10 mildly impaired participants. 3D inertial sensors recorded stepping and trunk sway with light hand contact provided by a carer onto participants' left shoulder. RESULTS: During running, the provision of IPT onto the shoulder improved trunk stability, altered temporal gait variability and made interlimb coordination more symmetrical independent of speed. The effect of IPT facilitation, however, interacted with the ability level in the Gross Motor Function Classification System insofar that more capable participants were more likely to benefit from IPT. CONCLUSIONS: Our findings demonstrate the benefit of deliberately light IPT onto the shoulder to facilitate postural stability during locomotion without disrupting the temporal gait pattern. Deliberately light IPT may reduce the fall risk and therefore play a role in the rehabilitation of balance control disorders during locomotion in juvenile movement disorders.

P2-H-40 An Investigation of the Relationship between Steering Control and Hearing during Goal-Directed Locomotion

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BACKGROUND: Adjustments to steering or changing one's locomotor trajectory is commonly thought to be dependent on re-orientation of the eyes and head from the original goal towards the direction of the new, intended goal (Cutting, Readinger, & Wang, 2002; Land & Tatler, 2001). A recent study on locomotor control that included healthy younger adult participants found that changes in head orientation in response to visual stimuli was not necessary for accurate steering (Cinelli & Warren, 2012). The need to select and implement the appropriate modifications to gait in response to visual information from our surroundings is only one requirement for safe navigation. The ability to accurately localize and identify auditory signal in any environment is also important. The objective of the present study was to investigate the relationship between head orientation and steering control during a sound localization task. METHODS: To-date four female participants (Mean age = 22.75 years, SD=2.22) have taken part in this study. Participants had self-reported normal hearing and did not have health conditions that affect cognitive, visual, vestibular, or motor function. Participants completed trials in which they walked along a 7m path in two experimental paradigms (20 trials per paradigm). In half of the 20 trials in each paradigm, an auditory stimulus was presented from either the left or right. Participants oriented to the sound by either: 1) orienting their head to the left or right to the approximate location of the sound source while maintaining a straight-ahead walking trajectory (Paradigm 1); or 2) steering to the left or right towards the auditory signal (Paradigm 2). In trials in which no auditory stimulus was presented, participants continued to face forward and walk straight-ahead. Each set of 20 trials was completed in a randomized order and the sequence of experimental paradigms was counterbalanced across participants. Kinematic data was collected at 60Hz using an Optotrak motion capture system (NDI, Waterloo, Canada) with IRED markers place on the head (3 markers) and trunk (5 markers) to track head and trunk orientation as well as calculate Center of Mass (COM) displacement. RESULTS: Preliminary results from Paradigm 1 revealed that there was no significant effect of head orientation on mean maximum deviation of COM in the medial lateral direction (COM-ML) in the three possible head orientations (mean: 10.23cm, 10.01cm, and 12.09cm for straight, left, right respectively) [$F(2,3) = 2.31$, $p=0.18$]. CONCLUSION: Preliminary findings further confirm that steering direction is not affected by misalignment of head position with the intended direction of locomotion even in response to exogenous auditory stimuli. However, it is possible that a misalignment of the head on the trunk may lead to dynamic instability, which may be exaggerated in older adult populations and those with hearing deficits. Data collection and analysis is ongoing.

P2-H-41 Further study of a Balance Geometry underlying obstacle crossing

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Background and aim: Different spatial relationships between the whole body, its end-points and the environment have been put forward to explain locomotor stability. While we are beginning to understand the importance of such geometric relationships to gait adaptation, specifically in relation to the supporting limb, they are still not fully understood. The aim of this work was to study whether stereotypic geometrical relationships exist between the feet and pelvis within the axis of progression by perturbing obstacle position. Methods: Ten healthy young adults stepped over an obstacle 190 mm high (about 21% of leg length) and 22 mm deep with their right leg first. The obstacle could be static or unknowingly advanced one step beyond the expected trail limb position at either the second to last (lead contact; early detection) or last (trail contact; late detection) steps prior to clearance. Such an obstacle movement perturbation forced an adaptive reaction and the re-establishment of whole body positioning for continued clearance. Dependent variables included foot-obstacle proximities, minimum foot clearances (MFC), maximum foot heights (MH) as well as the relative position of the centres of

mass of the pelvis and feet at 8 different times during approach and clearance (lead and trail foot contacts before and after the obstacle, lead and trail foot maximum heights and clearances). Results: Trail foot proximity before the obstacle was different between all three conditions. Lead foot proximity after obstacle crossing was closer with obstacle movement, but the same for both early and late detections. MFC of the trail foot was not affected by obstacle movement, but was higher for the lead foot. The relative anterio-posterior distance between the pelvis and feet was significantly different mainly during the lead crossing stride. However, at lead MFC, the relative distance between the stance (trail) foot and the pelvis was greater for both obstacle movement conditions as compared to the static condition, but unchanged between these perturbed conditions. The relative distance between the supporting foot in front (i.e. beginning its contact at double support) and the pelvis was the same across all conditions for 6 of the 8 targeted times. Conclusion: Our results suggest a stereotypical "balance geometry" where the relative distance between the pelvis and the newly established anteriorly positioned supporting foot must be maintained in order to assure stability and safe adaptation for obstacle crossing. Foot placement targeted after the obstacle also appears to be a variable to be controlled perhaps to accommodate such geometry. The importance of such information for gait assessment and training, as well as biped robotics is to be explored.

P2-H-42 Skating Visual Flow Improves Postural Perturbation Response: Potential of Skating as Neurorehabilitation

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BACKGROUNG AND AIM Parkinson's disease patients have a preserved ability to ice skate. This paradoxical kinesia has been observed in other physical activities, but the mechanism of why it occurs is still unknown. One theory is that the visual flow that occurs during the activity may be responsible. Previous experience and interest in the skill may also be required. We wanted to do a preliminary test to determine if skating visual flow influences postural control and muscle activity, and to determine how these influences differ between experienced and non- experienced skaters. METHODS Subjects consisted of 27 healthy individuals (21.9 +/- 10.1 years, 14 females). Each individual completed 9 trials with ice skating visual flow, and 9 without. Skating trial type was alternated across participants. These included quiet standing, sway- referenced platform rotation and an unexpected posterior translation (-6.350cm, 0.318 seconds after ramp delay of 10 seconds). Ground reaction forces and exerted challenges were delivered and recorded by NeuroCom Balance Master. Surface Electromyography (EMG) was taken at peroneus longus, biceps femoris and erector spinae bilaterally for 18 (21.3 +/- 2.7 years, 10 females) of the participants. RESULTS Subjects were divided into experienced and non- experienced groups based on a self- reported proficiency of skating ability. Significant improvements were found for the experienced group with visual stimulation during the translation condition, with increased medial lateral stability, plus reduced M/L center of pressure range, and smaller M/L and A/P maximal velocities. EMG results for these trials provided a significant increase in peroneal and biceps femoris activation. An inverse effect was seen in the other conditions where the visual stimulation increased CoP displacement and velocity in quiet standing and sway. CONCLUSIONS These results suggest that ice skating visual flow increases dynamic stability amongst experienced skaters. This is accomplished by increased activation of the biceps femoris and the ankle stabilizing peroneals, suggesting that a preparatory state is primed by the visual cueing.

P2-H-43 Changes of motor-control strategies in precision jump under varying distance constraints

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AIM: A precision jump (PJ) is a standing jump toward a precise reception area, requiring adaptive motor control to reach accurately the landing zone and then stabilize the posture without any additional step. The aim of the study was to analyze the distance-dependent motor control strategies in PJ, using different jump amplitudes. No study has questioned the effects of distance to jump on the processes controlling PJ. METHODS: 7 male experts in Parkour (6.7±3.2 years of practice) having high level PJ skills performed jumps from one force plate, toward a 44mm wide reception bar fastened on another force plate. Distances were set at 40%, 60% and 80% of their maximal jump distance (Dmax) performed during pre-tests. Each PJ condition was repeated 10 times. Resting period and jump start were at the subjects' decision. Analysis focused on duration of the phases (T), dynamics of the ground forces (antero-posterior forces FAp and their angle FAng) on impulsion and reception, and integrated surface electromyography (iEMG) of tibialis anterior TA, soleus SO, quadriceps QC, hamstring HA, erector spinae ES, deltoidus DE. Data were processed along the 6 phases composing a PJ: preparation PR, counter-movement CM, push-off PO, flight FL, reception RE, and stabilization ST. ST was defined as the phase going from 1 to 2 seconds after RE. T-tests compared the distance effects of 60% vs. 40% (D1), and 80% vs. 60% (D2) for each phase of successful trials, from subject's means of times, iEMGs and force data. RESULTS: The phase's analysis showed significant effects of D1 and D2. Time of PR increased for D2, whereas success rate decreased for D1. During CM, for D2, FAp increased. During PO, for D1, FAp increased, FAng decreased, iEMGs increased; and for D2, iEMGs (in particular QC) increased more. During FL, for D1, T and iEMGs increased; and for D2, T increased less and iEMGs (in particular DE) increased. During RE, for D1, FAp and iEMG TA increased; and for D2, FAp increased. CONCLUSION: Getting to 80% of Dmax is perceived as a major difficulty by the neuro-motor control system, which leads to a more predictive strategy expressed by longer preparation times. This helps to calibrate the PJ, and moreover the flight is long enough for on-line computations: therefore the success rate doesn't decrease anymore. Getting from 40% to 60% of Dmax involves an increase of iEMGs during push-off, as

well as a stronger impulse and a more grazing trajectory; whereas getting from 60% to 80% of Dmax doesn't change the force and the angle much despite an increase of iEMGs. Push-off resources have reached their limits so another energy generation mode takes over, expressed in the stronger counter-movement forces generating pliometric energy and the greater role played by the arms during flight. Increasing the distance to jump modifies the control strategies of the jump, and there seems to be a turning point in motor control strategies of PJ around 60% of Dmax.

P2-H-44 Muscle fatigue affects similarly obstacle crossing step of people with Parkinson's disease and neurological healthy individuals, independent of physical activity level

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BACKGROUND AND AIM: People with Parkinson's disease (PD) and neurological healthy elderly show gait changes that could be interpreted as seeking to improve balance and safety after quadriceps muscle fatigue [1]. However, these adjustments were less pronounced in people with PD, which show higher fatigue symptoms [2]. In addition, physical activity level did not affect the gait changes occurring after quadriceps muscle fatigue, neither in people with PD and nor in healthy elderly. However, this relationship between muscle fatigue and physical activity level may be different in a complex gait, such as obstacle crossing, specially for people with PD. Therefore, the aim of this study was to investigate the effects of muscle fatigue on gait spatial-temporal parameters during obstacle crossing in active and inactive people with PD and healthy elderly. METHODS: Twenty people with PD (PD group - age: 69.35 ± 5.22 years, height: 1.65 ± 0.07 m and weight: 72.88 ± 8.8 kg) and twenty matched-elderly (control group - age: 69.46 ± 64.2 years, height: 1.67 ± 0.07 m and weight: 73.64 ± 11.09 kg) participated in this study. The Baecke questionnaire was used to distribute the participants in active (n=10) and inactive (n=10) groups. The participants performed 3 trials of walking over an 8 m pathway, with an obstacle (15 cm high, 80 cm wide and 2 cm thick) positioned in the middle of pathway. The participants performed a sit-to-stand task to induce muscle fatigue [3]. Step length, duration, width and speed, and leading and trailing heel clearance were analyzed for the obstacle-crossing steps. Optoelectronic motion analysis was used for acquisition of gait spatial-temporal parameters. Three-way ANOVA (group x physical activity level x fatigue), with repeated measure for fatigue, was used to compare these factors ($p<0.05$). RESULTS: There is no interaction between factors. For group (Table 1), the PD group showed lower step length ($p<0.01$) and speed ($p<0.01$) in relation to control group. For the physical activity level (Table 1), active participants showed higher step length ($p<0.02$) than inactive, independently of fatigue and group conditions. Finally, for fatigue (Table 1), both groups increased the step length ($p<0.01$), width ($p<0.03$) and speed ($p<0.02$) after the muscle fatigue. CONCLUSION: Contrary our hypothesis, a more complex gait showed similar relationship between muscle fatigue and physical activity level that unobstructed walking have showed previously [2]. Both groups increased medio-lateral stability (higher step width) and the fore-aft (higher step length and speed) after the muscle fatigue, which was a strategy that may contribute to improve balance and safety during obstacle crossing. In addition, the physical activity level did not interfere in the effects of muscle fatigue on obstacle crossing. REFERENCES: [1] Santos et al. Health 2014;6,1-7. [2] Santos et al. Movement Disorders 2014, Submitted. [3] Barbieri, F.A. et al. Gait Post, 2013;38,702-707.

P2-H-45 Trunk muscle synergies suggest an initiatory rather than stabilising role of predictive postural control during goal-directed reaching

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TRUNK MUSCLE SYNERGIES SUGGEST AN INITIATORY RATHER THAN STABILISING ROLE OF PREDICTIVE POSTURAL CONTROL DURING GOAL-DIRECTED REACHING BACKGROUND AND AIM: As the largest segment of the body, the trunk greatly influences stability and successful movement production during a reaching task. Traditionally, the CNS has been thought to minimise shifts of the centre of mass position by counteracting reactional torques produced by arm movement, thus prioritising stability. Recent research from our group has demonstrated that preparatory lower limb muscle activity generates whole body dynamics for movement. Considering this, and the comparative paucity of knowledge on trunk muscle participation in voluntary movement (as initiators or stabilisers), further investigation is warranted. Therefore, this study aimed to identify if muscle patterns or 'synergies' during the period immediately prior to arm movement were present, and if so, whether they reflected movement initiation rather than postural stabilisation. METHODS: Nine right-handed participants (age: 26.2±6.9 years) stood in the centre of an 180º semi-circular array of 13 light targets at 15º intervals. Participants were asked to reach and point to an illuminated target at their natural speed. Muscle activity of the right deltoid (AD, PD) and multiple muscles of the trunk were recorded bilaterally using surface electromyography. These included; latissimus dorsi (LD), erector spinae (ES), multifidus (Mu), gluteus maximus (GMx), rectus abdominus (RA), external (EO) and internal obliques (IO). Movement onset was determined when finger tangential velocity exceeded 3% of its peak during reaching. Predictive postural adjustments (pPA) were quantified and tuning curves constructed for the 250ms prior to, and 50ms after onset, in order to characterise muscle activity. Principal Component (PC) analysis was applied to this period to determine temporally linked muscular patterns. RESULTS: Pooled results (n=1731 trials) showed that regardless of direction, 2 PC's were sufficient to account for over 90% of the variance for trunk muscle activation patterns within the pPA period. For PC1, temporal waveforms peaked just prior to movement onset and were highly correlated across direction (range: r=0.82-0.99). Muscle weightings for the main orthogonal planes of movement (often analysed in the literature) biased functional agonists, especially for trunk rotation (e.g. contralateral 180°= contra-EO/GMx, ipsi-LD/IO, bilateral-RA).

CONCLUSIONS: Contrary to previous reports, ipsi- rather than contralateral muscle activity was often present for reaching directions within the pPA period. Muscle synergies derived from PC analyses highlighted specialised and coordinated activity of the trunk over multiple directions that contribute to propelling the arm/trunk towards the target. This strengthens the recent notion that pPA's act to produce the necessary dynamics for movement initiation rather than centre of mass stabilisation.

P2-H-46 Differences in temporal gait dynamics due to walking speeds and dual task

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BACKGROUND AND AIM: Gait dynamics analysis uses fluctuations in stride time. The magnitude and structure of the fluctuations are analyzed by using stride-to-stride time for relatively long walking durations. The magnitude of the stride fluctuations indicates gait variability and can be quantitatively expressed using the coefficient of variance (CV). The structural features of fluctuations indicating changes over time during walking describe the fractal dynamics and can be quantitatively expressed using á from detrended fluctuation analysis (DFA). These two variables are different in neurophysiological meanings but have been used as an index of the changes in gait stability due to aging, fall, and neurological disorder. As a basic study for the investigation of influencing factors, this study identified the differences between CV and DFA of temporal variables due to walking speeds and dual tasks. METHODS: Eight male healthy subjects participated in this experiment (age: 25.0±1.5years, height: 172.5±4.2cm, weight: 67.7±5.0kg). All participants walked on the treadmill with 5 speeds (80~120% preferred walking speed) and 2 walking conditions (walking with a dual task using 2-back test or only walking) for 10 minutes. To acquire temporal variables (stride time, stance time, swing time and step time), 3D motion capture system were used. The mean, variability, fractal dynamics for all temporal variables were calculated using Matlab. To compare the differences among walking conditions, two-way repeated ANOVA was used with a significant level of 0.05. RESULTS: The results of mean, CV and DFA in all variables and interactive effect between experimental conditions are shown in Table 1. There were statistical differences in the mean of all variables among walking speeds, and there was no difference in the mean between walking conditions. There were significant differences in CV of stride time and step time among walking speeds, but there was no difference in CV between walking conditions. There was no difference in DFA between walking speeds, but there were significant differences in DFA of all variables between walking conditions. In all experiment, there were no interactive effects between speeds and walking conditions. CONCLUSIONS: From these results, it was confirmed that the mean and variability of temporal variables can be affected by walking speeds, while fractal dynamics of those can be affected by dual task. Since the subjects of this study were young healthy adults, the range of fractal dynamics was in the normal range (á>0.5). It is worth to mention that the dual task showed a significant difference in the structural feature of fluctuations, not in the magnitude of fluctuations. In future

studies, to clearly understand the application of these indices which can be applied to aging, fall, and neurological disorder, it will be necessary to perform additional studies with spatial variables as well.

P2-H-47 Asymmetries in reactive and anticipatory balance control are of similar magnitude in Parkinson's disease patients.

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BACKGROUND AND AIM: In Parkinson's disease (PD) patients the left and the right leg contribute asymmetrically to postural reactions during bipedal stance. Also, PD patients often show a reduced ability to anticipate self-induced disturbances, which could impede gait initiation. We hypothesize that the coupling between reactive and anticipatory balance control is disturbed in PD patients. To investigate this hypothesis, the present study assessed the relationship between asymmetries in reactive balance control in response to external perturbations and asymmetries in anticipatory balance control prior to self-induced perturbations in the same group of PD patients. METHODS: 14 PD patients (63.9 ± 7.3 years, 2 female) and 10 healthy aged-matched controls (66.0 ± 8.1 years, 4 female) were included. Ground reaction forces and torques as well as body kinematics were recorded during bipedal stance to estimate ankle torques and excursions of the body center of mass. Reactive balance control was investigated by applying horizontal platform perturbations and force perturbations at the sacrum in anterior-posterior direction. Frequency response functions (FRF) were estimated, expressing the amount (gain) and timing (phase) of the generated corrective ankle torques in both ankles in response to body sway at the excited frequencies. The symmetry ratio describing the contribution of the gain and phase of the left FRF to the total FRF gain (SR_RBC) was used to express the asymmetry in reactive balance control. Anticipatory balance control was investigated by instructing patients to push with the hands against a force sensor at shoulder level with a force of 10 ± 1 N and to release this force after an acoustic signal sounded. The increase in the left and right ankle torque prior to the hand force release was taken as the anticipatory postural adjustment (APA). The symmetry ratio describing the contribution of the left APA to the total APA (SR_ABC) was used to express the asymmetry in anticipatory balance control. The relation between SR_RBC and SR_ABC was investigated with linear regression analysis. RESULTS: PD patients were more asymmetric in reactive ($t = -2.39$, $p = 0.026$) and anticipatory balance control compared with healthy subjects ($t = -3.32$, $p = 0.004$). SR_RBC was significantly ($\rho = 0.74$, $p = 0.003$) related to SR_ABC in PD patients (Figure 1). CONCLUSIONS: Our results indicate that, next to known asymmetries in reactive balance control, there also exist asymmetries in anticipatory balance control in PD patients. Also, asymmetries in reactive and anticipatory balance control are of similar magnitude. These findings suggest that asymmetric reactive balance control during bipedal stance may share a common pathophysiology with asymmetric anticipatory control prior to

voluntary actions, such as gait initiation. Future studies should investigate the influence of asymmetries in bipedal balance control on gait initiation and the quality of the step.

P2-H-48 Energetic tradeoffs of foot-to-ground clearance during swing phase of walking

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BACKGROUND AND AIM: Control of foot clearance to the ground is an important aspect of walking. The inability to provide adequate clearance during leg swing may increase tripping risk from unexpected ground contact. Subjects walking on uneven surfaces, for example, exhibit greater leg lifting than on flat surfaces to avoid obstacles (Gates et al 2012) and also expend more energy (Voloshina et al 2013). This suggests a preferred clearance height from a tradeoff between energetic cost of leg lift versus risk of inadvertent ground contact during swing. It may be more costly to provide greater clearance, but it may also be costly to momentarily scuff the foot on the ground, for example due to the drag force produced. Since much of gait appears to be energetically optimal, we hypothesize that the preferred clearance height will correspond with the lowest metabolic cost. Lifting the legs higher should be metabolically costly due to greater joint work. Scuffing should require more effort to overcome frictional drag at ground contact. Therefore we expect any deviation from nominal to increase metabolic cost. METHODS: We compared the energetic costs of walking at different foot clearance heights from 9 young, healthy adults. Subjects walked with their preferred clearance and also with three levels of leg lifting, measured through maximum toe height from the treadmill surface, and three levels of scuffing, measured through scuff impulse, the integral of drag (backward) ground reaction force generated over the swing phase. Three subjects scuffed during heel strike instead of swing, and therefore their scuff data was not included. Each subject walked for approximately 6 minutes at a constant speed of 1.25 m/s. We measured metabolic energy expenditure and gait kinematics and kinetics. RESULTS: We achieved three different levels of scuff impulse and toe clearance heights (Figure 1A). The lowest measured metabolic cost coincided with the subjects' preferred clearance height (Figure 1B), and increased approximately linearly with more leg lift or scuff impulse. During swing, imparting more drag of 24 N for 1 second costs about the same as lifting the legs 0.1 m higher. The increase in metabolic cost could be explained by joint work. Lifting the legs higher required more positive and negative joint work. However, scuffing with greater force entailed more positive work only, as negative work did not systematically change with greater scuffing. CONCLUSIONS: Control of foot clearance is vital to fall avoidance, and humans appear to compromise between leg lift work and the cost of overcoming friction at foot-to-ground contact during swing. Both are energetically costly due to increased positive joint work. Thus foot-to-ground clearance may contribute towards greater effort required to walk on uneven terrain and for patients with gait abnormalities, such as drop-foot, and amputees without proprioceptive awareness of their prosthetic foot clearance.

P2-H-49 Is virtual reality a viable tool for examining the affordance of aperture crossing when walking through two people versus two poles?

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INTRODUCTION: In a previous study, we observed that the affordance of aperture crossing changes when walking through two people versus two pole obstacles in a real world setting[1]. Individuals rotate their shoulders at larger relative aperture widths for people than they do for poles. Furthermore, individuals are more cautious when walking between people, as evidenced by larger shoulder rotation angles, earlier onset of rotation, slower walking velocity and crossing speed compared to pole obstacles. The purpose of the current study was to examine this behavior in a virtual world, where virtual avatars and poles replaced human actors and pole obstacles. Since VR has become a popular method of measuring interactions with human obstacles (as it provides greater control of experimental factors and parameters), it is important to determine whether the differences in behaviors observed between people and pole obstacles in real-world settings are also observed in a VR environment. METHODS: Eleven healthy young adults volunteered to participate in the study. While wearing a head-mounted VR display, participants walked at a self-selected pace along a 10m path and passed through a virtual aperture located 5m from the starting location. The participants were instructed to avoid colliding with the obstacles when passing through the aperture. The experiment was conducted in a block design, where the aperture was either created by two virtual pole obstacles or by two virtual avatars. In both conditions, the width of the aperture ranged between 1.0-1.8x each participant's shoulder width in increments of 0.1 and presented in randomized order. RESULTS: Regardless of whether the aperture was created by the virtual poles or the avatars, participants rotated their shoulders for apertures 1.6x their shoulder widths or smaller but walked straight through spaces larger than this value. In comparison to the 1.3 for poles and 1.5 for human actors observed in the real-world[1], these results show no distinction between the conditions. Additionally, analysis revealed no significant differences in shoulder rotation angle, onset of rotation, walking speed or crossing velocity between the virtual poles and virtual avatars, unlike that observed in the real-world setting[1]. DISCUSSION: It appears that the differences observed in real-world settings between people and pole obstacles is not translated to a VR environment, as demonstrated by the fact that there was no significant differences in how individuals passed through the avatar and pole apertures in VR. Not only did individuals behave similarly between the two obstacle types but the behavior was much more cautious in virtual reality compared to that observed in the real-world environment. Therefore research should proceed with caution when using VR to examine affordances, as the behaviors observed in real-world settings may not be translated to VR.

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P2-H-50 Determination of gravicorder parameters for evaluation of dizziness symptoms in vertigo follow-up

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Introduction: Peripheral vertigo diseases, such as Meniere's disease, are characterized by repeated vertigo attacks, which can be accompanied by vomiting, inability to walk, and disruption of dietary habits. In addition, nystagmus is observed in many extreme cases of dizziness, as are abnormalities in equilibrium function tests. After severe vertigo attacks, symptoms can still be observed in the course of daily routines. The follow-up used for dizziness symptoms and nystagmus often relies on subjective symptoms, and these methods are regarded as an inaccurate evaluation of recovery. In this study, we determined the most useful gravicorder parameters for observation and follow-up of bouts of dizziness. Subjects: Thirty patients suffering from a variety of peripheral vertigo diseases were evaluated once their symptoms associated with bouts of vertigo had subsided. Clinical examination was conducted in a follow-up period once the patient had reached a point where they had no limitations in everyday life. Methods: We rated dizziness symptom intensity (a rating of 4 indicated disability) and the presence of nystagmus. In addition to routine equilibrium function tests, we used gravicorder (ANIMA GP-5000) examination, and evaluated closed-eye periphery area, Romberg rate, and neural net analysis. Results: Peripheral vertigo diseases, followed by improvement of dizziness, have been classified into two groups: a group in which closed-eye periphery area is reduced, and a group in which decreased labyrinth failure rate in the neural network analysis, with no change in closed-eye periphery area, is observed. Discussion: After acute vertigo attacks, patients often complain of sustained dizziness after nystagmus has disappeared. Periods of lack of coordination are followed by compensatory periods once dizziness has subsided, and we have identified measurable parameters that correlate subjective dizziness symptoms with periods of long-term dizziness in patients.

P2-I-51 Bouts of Steps: The Organization of Infant Walking

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BACKGROUND AND AIM: Traditionally, researchers study the development of walking in terms of periodic gait, with gait initiation and termination--starting and stopping--analyzed separately from steady-state walking. But during natural locomotion, walking is separated into bouts separated by periods of other activity. Starting and stopping are frequent. Recent work on infants' natural locomotion shows that experienced walkers travel longer distances, accumulate more steps, and fall less often than novice walkers. But existing work has not described the pattern of starting and stopping in infant walking. We aimed to characterize the bout structure of walking--when infants started and stopped walking. METHODS: We observed 30 13-month-old and 30 19-month-old infants during natural walking in a laboratory playroom. Based on the video recordings, coders identified each walking bout--a period of walking separated by at least half a second of rest--and counted the number of steps per bout. For every tenth bout, coders also identified how the bout ended (i.e., at an object, at the mother, and so on). RESULTS: For both age groups, most bouts did not end at a discernible goal: In 35% of bouts, infants simply stopped walking in the middle of the floor. Twenty percent of bouts ended near an object that had been within arm's reach throughout the bout--meaning infants did not need to walk to reach the object--and 21% of bouts ended at a change in elevation that necessitated climbing up or down. Only 17% of walking bouts carried infants to an object. Bouts that ended at no discernible goal or object were significantly more common than all other bout types, ps < .001. Locomotor activity was largely composed of brief spurts of walking. Half of 13-month-olds' bouts and 41% of 19-month-olds' bouts consisted of 1-3 steps--too few to carry infants to a distant goal. Survival analyses of steps per bout indicated that the probability of continuing to walk was independent of the length of the ongoing bout; infants showed no bias towards bouts long enough to carry them across the room to a goal. However, 13-month-olds showed an increased probability of stopping after 1-3 steps, and did not initiate walking more often to compensate for their frequent short bouts. Thirteen-month-olds accumulated M=185 bouts each; 19-month-olds accumulated M=194 bouts each, p > .10. CONCLUSIONS: We propose that infants' natural walking is not intentionally directed at distant goals; rather, it is a random process that serves exploratory functions. Relations between the bout structure of walking and other measures of walking suggest that random exploration is constrained by walking skill in younger infants, but not in older infants.

P2-I-52 Stability of gait in children evaluated by inclination angle between CoM and CoP

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BACKGROUND AND AIM: There are few researches dealing with the stability of gait in typically developing children, although over a half of all non-fatal childhood injuries are resulting from falls. In contrast, many researches have been conducted in the past to evaluate stability of gait in the elderly. As a result of these efforts, several methods for this evaluation have been proposed. Inclination angle is one of the simple measures for this purpose. In this research, we computed inclination angle for the longitudinal gait data of children and evaluated its change as the children are gaining stability of gait by growth. METHODS: We conducted 4 years longitudinal measurement from the age of 4 to obtain gait data of typically developing children including 4 boys and 4 girls. As a preprocess, one gait cycle was extracted from the gait data that was then discretized into 101 equally spaced points to compare them in normalized time frame. Center of mass (CoM) of the body and center of pressure (CoP) were calculated by motion analysis software (C-Motion). The inclination angle was defined as the angle between the vertical line of the ground and the line connecting the CoM and CoP. We computed inclination angle in the sagittal and frontal plane by projecting the CoM and CoP position onto each plane. Stability of gait was evaluated by the peak inclination angle in each plane during one gait cycle. RESULTS: In all trials, inclination angle in both planes had their peak value at 99% of the gait cycle. We defined these angle as peak anterior angle (PAA) and peak lateral angle (PLA), respectively. PAA increased significantly between the age of 5 and 6 ($p < 0.05$) while it decreased significantly between the age of 6 and 7 ($p < 0.05$). PLA decreased significantly as the subjects grew up except between the age of 6 and 7. Lee demonstrated that normal elderly had larger anterior inclination angle and smaller lateral inclination angle than the elderly patients. Since children are acquiring the stability of gait as they grow up, they are supposed to show similar trends in the change of inclination angle to the two elderly groups. However as our analysis show, PAA had contradictory trend between the age of 6 and 7. We hypothesized that this inconsistency is due to increase in height by growth. Actually our data show that the vertical distance from CoP to CoM in the sagittal plane as well as height increased significantly ($p < 0.01$) between the age of 6 and 7, while the horizontal distance from CoP to CoM did not have significant difference. These results suggest inclination angle is strongly affected by the change of height by growth in the case of children. CONCLUSION: Our analysis for children revealed that the overall trend in the change of inclination angle was consistent with previous research for elderlies. However, since inclination angle is affected by the change of height, it was not fully consistent with elderlies in the growing phase of children.

P2-J-53 Virtual reality gait training to enhance cognitive and motor function in children with Attention Deficit Hyperactivity Disorder: Preliminary results

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BACKGROUND AND AIM: Attention Deficit Hyperactivity Disorder (ADHD) frequently affects cognitive as well as motor skills, leading to substantial academic and social dysfunction among children. Effective non-pharmacological approach have the potential to provide an alternative to the use of stimulants, minimizing the burden of side effects and medication non-compliance. Virtual reality (VR) can serve as a therapeutic tool that combines elements of physical exercise with cognitive remediation. Therefore, the main goal of this study is to test the effects of a VR gait training program on gait and cognitive function among school-aged children with ADHD. METHODS: Children aged 8 to 12 who were diagnosed with ADHD according to the DSM-5 criteria were recruited for the study. Children on active medication to improve attention and children with other health issues were excluded. Participants received an

intensive and progressive VR gait training program. Training sessions were held 3 times a week for 6 weeks, and included walking on a treadmill while negotiating virtual obstacles. Motor and cognitive function were tested before and after completing the training. A computerized neuropsychological test battery (NeuroTrax?) was used to generate index scores of attention, memory and executive function (EF), normalized according to age and education (i.e., scores below 100.0 reflect poorer cognitive function). Gait was evaluated under usual and and dual task (DT) conditions (i.e., phoneme monitoring), using a 7-meter sensorized carpet (Zeno walkway and PKMAS software). RESULTS: Four children (age 8 to 10 years, 1 girl and 3 boys) who completed the training program were included in this preliminary analysis. When tested after the 6 weeks of training, gait speed was increased under usual and DT conditions compared to baseline (a 7% increase in usual walk, from 1.28 to 1.37 m/sec and an 5.5% change in DT walk, from 1.03 to 1.09 m/sec after the training). Improvements were also observed in all three cognitive domains tested, with an average increase of 6% in the attention score (from 87.2 at baseline to 92.5 after the training), a 28% increase in the memory score (from 79.9 at baseline to 102.0 after the training) and a 12% increase in the EF score post-training (from 81.8 to 91.4). The global cognitive score was increased on average by 15% after the training (from 83.0 at baseline to 95.2 post-training). CONCLUSIONS: The results of this preliminary analysis suggest that VR gait training may have beneficiary effects on both motor and cognitive function in children with ADHD. Additional study of a larger sample, including follow-up assessments to test long-term training effects and retention, is currently underway to further establish these promising results.

P2-K-54 Modular Haptic Belt for Augmented Balance Feedback

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BACKGROUND & AIM: Better balance and mobility skills help to prevent falls that can result in serious injury. In physical and occupational therapy, balance deficits are usually addressed with a set of repetitive exercises adapted to the patient's typical activities. Motor learning and rehabilitation can be improved by providing external feedback that augments the task-specific, intrinsic feedback during an activity [1]. Comparatively little research exists on such systems outside clinical conditions. However, to support the considerable practice needed to make treatment effective, augmented feedback that does not require stationary equipment should also be provided in the homes of patients, thus making it potentially not only more effective, but also more affordable. This motivates a modular platform for the development of in-situ wearable postural feedback applications. METHOD: To this end, we present a belt-integrated vibrotactile balance feedback system. It is based on BRIX2, small, extensible microcontroller modules designed developing body-worn sensor networks [2]. Each module features a nine-axis motion sensor and RF communications. A chest-worn BRIX2 estimates the current trunk orientation based on a fusion of the raw sensor values. This orientation determines the actuation strength of four Tactile Labs Haptuators. These high-bandwidth haptic actuators, placed in the four cardinal directions front, back, left, and right, allow us to render richer stimuli than is possible with commonly used cellphone vibration motors or voice coils. A second BRIX2 in the belt controls the individual synthesizers' parameters based on orientation readings received from a chest-mounted BRIX2 through RF. Leaning the trunk away from an upright equilibrium will increase the stimulus amplitude on the opposite side of the tilt direction, guiding the user back to a more upright position [3]. Each Haptuator is driven by a microcontroller synthesizing an initial 250 Hz sine via the Mozzi library, which feeds into a mono amplifier. RESULTS: Easily programmable, our belt enables the rapid development of body-worn, individualizable postural feedback applications. The hardware underlying our system is open, and can be easily extended to incorporate additional sensors and actuators. The wider range of haptic stimuli that can be rendered provides new flexibility for the integration of relevant sensor information into the feedback signal. CONCLUSIONS: The prototype was informally tested, but further exploration of stimulation parameters is needed. Furthermore, we anticipate extending our system to incorporate more sensor information and to render more complex stimuli. As a proof-of-principle application, we plan to support healthy adults in a challenging balance learning task such as walking on compliant surfaces. [1] Lauber, Keller. Eur J Sport Sci 2012 [2] Zehe et al. 4th Int. Work. Sens. Net. Amb. Intell. 2012 [3] Lee et al. Annu. Int. Conf. Eng. Med. Biol. Soc. 2012

P2-K-55 Effect of foot orthoses on single-leg squat balance performance in adults with patellofemoral pain

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BACKGROUND AND AIM: Patellofemoral pain (PFP) is a common condition that affects participation in daily and exercise activities that load the patellofemoral joint. Studies have highlighted deficits in dynamic single-leg balance performance in people with PFP. Foot orthoses are often prescribed to alleviate symptoms of PFP and optimise lower limb movement patterns during daily activities that can pose demanding balance challenges. While foot orthoses can enhance balance performance in adults with knee osteoarthritis, this has not been investigated in PFP. Using a repeated measures design, this study investigated the immediate effects of foot orthoses on balance during a single-leg squat in adults with PFP. Associations between balance variables, patient-reported outcomes, and physiological measures were also explored. METHODS: 29 adults with PFP (18 women, mean [SD] 35.7 [7] years) performed five single-leg squat repetitions on a force platform, under two conditions, wearing: i) running sandals (Nike Straprunner); and ii) prefabricated foot orthoses (Vasyli International) within running sandals. Centre of pressure (CoP) total path velocity, range and standard deviation (SD) of CoP movement in mediolateral (ML range, MLSD) and anterior-posterior directions (AP range, APSD) were extracted. Patient-reported outcomes were knee pain severity (visual analogue scale, Anterior Knee Pain

Scale) and kinesiophobia (Tampa Scale). Physiological measures of hip muscle strength (dynamometer), hip joint range of motion (ROM) (inclinometer), maximum time of side bridge hold, and foot mobility were collected. Data were analysed using one-way ANCOVA and stepwise multiple regression ($P<0.05$). RESULTS: No significant differences were observed for any CoP measures when wearing foot orthoses compared to sandals only ($P>0.249$). Multiple regression analyses identified shorter side bridge hold time as a significant predictor of greater between-condition change in ML Range ($R^2=0.17$, $P=0.027$) and MLSD ($R^2=0.21$, $P=0.012$). Reduced hip joint external rotation ROM was a significant predictor of greater between-condition change in CoP velocity ($R^2=0.14$, $P=0.047$). No variables were correlated with change scores for AP Range or APSD. CONCLUSIONS: Immediate wear of foot orthoses within running sandals does not appear to improve CoP movement during a single-leg squat task in people with PFP, over and above wearing sandals alone. The therapeutic action of foot orthoses in this clinical group may only become apparent with long-term wear, or be specific to alterations in kinematic measures and symptom control, rather than balance performance. Foot orthoses may have greater capacity to improve dynamic single-leg balance, in the ML direction, in those with less trunk strength and reduced hip external rotation ROM. Further studies are required to identify which individuals may show greatest benefits from wearing foot orthoses, to provide a more targeted approach to PFP management.

P2-K-56 Assessment of guidance modality on weight-shifting balance exercises in individuals with Parkinson's disease

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BACKGROUND AND AIM: Earlier versions of vibrotactile biofeedback systems for balance-related applications were intended primarily to provide "alarm" signals about body tilt rather than to guide rehabilitation exercise motion by reducing the user's performance errors. In addition, there were few attempts to evaluate guidance modalities for balance rehabilitation exercises. The purpose of this study is to evaluate the effects of guidance modalities during common dynamic weight-shifting exercises used in clinical settings. METHODS: A motion guidance system to provide visual, vibrotactile, or multimodal biofeedback during weight-shifting exercises was developed. Eleven individuals (70.0±8.1 yrs; 2 females, 9 males) with idiopathic Parkinson's Disease (PD) having significant postural instability (Hoehn & Yahr stage 2.5 to 3) participated in the proof-of-concept study. The participants wore a six-degree-of-freedom inertial measurement unit (IMU) on the back of the torso at approximately the L3 vertebral level, and four linear vibrating actuators (Tactors) attached to the skin over the front, back, right, and left side of the torso at approximately the level of the iliac crest. The IMU measured angular displacements and velocities of body tilt in anterior-posterior (A/P) and medial-lateral (M/L) directions. The desired movement trajectories for the weight-shifting exercises were virtually generated by measuring the participant's 90% of limits of stability in A/P and M/L directions. Each participant performed 5 repetitions for each direction (A/P and M/L) and biofeedback modality (visual, vibrotactile, and multimodal) for a total of 30 trials. Vibrotactile biofeedback was activated when the absolute desired participant motion error exceeded 1 deg. During the trials involving visual biofeedback, two virtual objects representing the participant's actual movements and desired movements were superimposed and displayed on a screen placed approximately 2m ahead at eye level. For all trials, participants were instructed to 1) move away from the vibration until the vibration ceased and 2) lock knee and hip joints and move in a manner similar to an inverted pendulum. The two outcome measures were cross-correlation and position error between the desired and participant's actual movements. RESULTS: The multimodal biofeedback resulted in significantly greater correlation and significantly lower average position error compared to visual or vibrotactile biofeedback regardless of the movement direction. The pair-wise comparisons in cross correlation and position error analysis were not significantly different between visual and vibrotactile biofeedback. CONCLUSIONS: The results of this study, which is the first attempt to assess the effects of guidance modalities on balance rehabilitation exercises in individuals with PD, suggest that multimodal biofeedback can improve volitional responses during postural tracking tasks.

P2-K-57 "Anchoring" reduces postural sway: effects of different points of haptic contact and support surface

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BACKGROUND AND AIM: Haptic "anchoring" in postural tasks is a dynamic context in which individuals can actively gather information of an adjacent support surface in order to reduce postural sway. During such anchoring task, individuals hold and lightly pull a pair of flexible cables attached to weights that are kept resting on the floor while attempting to maintain balance. Although the experimental designs of previous studies with various groups such as adults and children, adults with intellectual disability and older individuals used hands for the haptic contact during the anchoring tasks, the effects of different points of body contact (i.e., wrist or elbow) with the "anchor system" are largely unknown. Moreover, often anchoring seems to be more efficient when postural tasks are challenging to individuals. Therefore, this study investigated the effects of different points of haptic contact during challenging postural control tasks using an "anchor" system. METHODS: Twenty-nine young adults stood with their feet in tandem position on an elevated surface using a balance beam and on a ground-leveled support surface. In both surface conditions, participants performed two 30-s trials in the following anchor conditions: without the "anchor" system (control condition), while holding in each hand a flexible cable,

and then with cables attached to wrists and elbows. The individuals were instructed to maintain arms extended and parallel to the body forming a 90 degrees angle on a force platform (120 Hz). Amplitudes of center of pressure (COP) displacement in the anterior-posterior and medial lateral directions, mean velocity of COP, and COP path length were measured. Anova two-way (condition x basis of support), with repeated measure for both factors, was used to evaluate the effects of "anchor system" on postural control ($p<0.008$). RESULTS: The "anchor" condition showed reduced values of amplitude of sway compared to the control condition in both support surfaces (Table 1). Anchoring during the postural tasks performed on the elevated surface showed that relative reduction in the amount of sway was larger when compared to the leveled surface of support. Points of contact (hands, wrists and elbows) showed similar amplitude of sway for mediolateral and anterior-posterior displacements, as well as for mean velocity and path length, when postural task was performed on the elevated surface. However, for on the ground condition, only "anchor system" attached to elbow showed reduction of body sway compared to control condition. CONCLUSIONS: Haptic information available via "anchor system" improved postural control of young adults. Benefits of anchoring are greater when postural tasks are more demanding to balance (e.g., elevated surface). Therefore, the haptic system prompts adaptive solutions when task constraints are more demanding. Regardless the point of body contact with the "anchor" tool, individuals exhibited similar outcomes in postural sway.

P2-K-58 Balance telerehabilitation: considering user preferences for the design of a cell phone balance trainer

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BACKGROUND AND AIM: Individuals with balance deficits due to vestibulopathies, head trauma, and advancing age are prone to falls secondary to instability, which can cause injury, limit independence, and be costly. During and following conventional clinic-based balance rehabilitation, physical therapists prescribe home exercise programs. It has previously been shown that in-home exercise training increases physical function and also improves self-perceived fear of falling. However, patient compliance is highly variable and poor compliance is typically associated with lack of confidence about correct execution of the exercises and loss of motivation due to lack of knowledge of performance and/or results. In recent years, several home-based technologies including the Nintendo Wii Fit have been shown to improve balance control as well as compliance. Exercise training compliance is also higher for those using a tablet application as opposed to standard written exercises. Despite the advantages of telerehabilitation technologies, older adults for example, report concerns about security, reliability, cost, and the effort to learn to use such technologies. The objective of this study was to characterize technology usage and preferences, as well as balance exercise instruction modalities among individuals with balance deficits to inform the design of a cell phone balance trainer. METHODS: Participants were recruited from a pool of patients receiving balance rehabilitation therapy at the University of Michigan and University of Pittsburgh including 72 individuals with diagnosed vestibulopathies (23 males, 49 females, 58.7 ± 18.1 years), 95 individuals with concussions or mild traumatic brain injuries (52 males, 43 females, 36.2 ± 20.8 years), and 13 older adults with general age-related balance deficits (5 males, 8 females, 73.6 ± 8.4 years). Participants were surveyed about their cell phone usage, technology preferences, exercise routines, and preferred modality for instructions. RESULTS: The majority of participants (≥75% per patient group) reported that they exercised, but fewer than 40% of participants per patient group use technology while exercising. Video instructions were the most preferred modality for exercise instruction while written instructions were the least preferred among all patient groups. The majority of participants in each patient group also preferred to track their own performance across exercise sessions, as opposed to their best performance result, and preferred not to compare their performance to others within their age group. CONCLUSIONS: Limitations of the study include small sample size, incomplete surveys, and lack of interview data. Future technologies should incorporate video based instructions and knowledge of results that highlight the individual's progress.

P2-L-59 Influence of STN-DBS stimulation frequency on gait performance in Parkinson?s disease.

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BACKGROUND and AIM: Deep brain stimulation of the subthalamic nucleus (STN-DBS) is one of the most successful treatments for Parkinson's disease (PD). However some patients develop gait problems within 3 years of implantation. In clinical practice, the reduction of stimulation frequency to a low level, i.e. 60-80Hz compared to the habitual 130Hz, sometimes improves gait. In this experiment, a quantitative assessment of gait function in PD patients was performed. The aims were: (1) find the optimal frequency for individual patient's gait and (2) give an indication of which frequencies improve gait. METHODS: Fourteen PD patients (63.8±8.3y) with STN-DBS for more than 3 years and with gait and/or balance problems took part. Participants were tested with up to six DBS settings by changing the frequency: range 40Hz-140Hz (20Hz intervals). The total energy of stimulation was kept constant. Patients walked along a 7m-walkway. They were asked to perform 16 trials in total, 8 of which were with a mock doorway placed in the centre. Trial order was randomised. Body kinematics was collected in 3D (CODA). Three main quantities were measured: walking velocity, step length and double support time. To evaluate the best frequency for each quantity, a 2-way ANOVA was run using DBS frequency and doors as factors. Statistical significance was set at 0.05. The results of this analysis were compared across the three quantities: the optimal frequency(ies) was identified as the one which was the best for the majority of the quantities. When more than one optimal frequency was found, if a frequency x door interaction was present, the frequency least affected by the door was preferred to the others. RESULTS:

For 8 patients, this test was able to identify one optimal frequency out of the six tested. For 3 patients, two optimal frequencies were found, and for the remaining 3 patients three optimal frequencies were identified. To assess the relevance of the frequency range, 100Hz was excluded from the group analysis, although it was the single optimal frequency for two patients. The set of frequencies was divided in low (60-80Hz) and high (120-140Hz) range. In 8 cases, patients showed optimal performance in the low range. In 8 cases, patients showed optimal performance in the high range. Of these 16 cases, 4 showed optimal performance in both ranges. CONCLUSIONS: This test successfully quantified the optimal STN-DBS frequencies on a single patient basis. The clinical indication that low frequencies improve gait problems is partially confirmed here. Eight patients clearly showed an optimal low-range frequency, although the same number showed an optimal high-range frequency. Because the clinician has to consider different motor activities when optimising stimulation parameters, this approach should be extended to other axial and limb motor functions.

P2-L-60 Effect of fampyra on walking and mobility in patients with multiple sclerosis with different disability levels

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Background: Dalfampridine extended release (DF) 10mg tab, is a potasium channel blocker that restores conduction of signal on demyelinated fibers in patients with multiple sclerosis and thus leads to an improvement of gait. The goal of this study was to evaluate response to DF 10mg tab in MS patients with different levels of disability in patients starting to use DF prescribed by their treating physician. Methods: We assessed three different mobility tests: Timed 25 foot walk test (T25FW), Timed up and go test (TUG) a step test (how many times is patient able to reach a step in 30 seconds). Patients were evaluated before using fampyra and 3 hours after taking 10mg tab of dalfampridine (DF) extended release p.o. Results: 131 MS patients were enrolled into the fampridine mobility assessment. There were 15 patients with primary progresive MS, 40 patients with secondary progresive MS and 76 patiens with relaps-remiting form of MS. Mean age was 48 years, SD 9,8 years. Mean MS duration was 19,8 years, SD 8,6 years, 58% were women (76 patients). Mean MSWS 12 score was 46/60. The average speed of walking in patients with EDSS 4-4,5 was 6,29 seconds (s) and with DF was 5,43 s. In patients with EDSS 5-5,5 was 10,35 s and with DF was 7,32 s. In group of patients with EDSS 6.0-6.5 was 19,34 s in T25FW and with DF 14,19 s. Improvement of at least 20% on T25FW reached 34% of patients. Most of them have severe impairment of walking characterized by EDSS 6.0 (N= 19, 14%), EDSS 6.5 (N=12, 9%) or EDSS 7 (N=5, 3%). The average speed of walking in patients with EDSS 6.0-6.5 was 19,34 s in T25FW. Only a few patients with moderate neurological disability reach this 20% improvement : 3 patients with EDSS 4-4,5 (2%) and 6 patients with EDSS 5-5,5. But when we compare improvement in T25FW with other mobility tests (TUG and step test) than 10% of patients with improvement in T25FW test between 10-19% reached improvement 20% improvement in TUG test or improvement more then 10 steps in step test. 9 % patients with moderate disability (EDSS 4-5,5) can reach 20% improvement in TUG but only 6% can reach the clinical meaningfull improvement (20%) in T25 FW. Patients with several disability EDSS 6-6,5 can reach clinical meaningfull change (more than 20%) in both tests. Conclusion: Quantification of the treatment effect of DF in MS patients with moderate versus severe disability requires different tests. In MS patients with moderate disability is TUG test better than T25FW test in quantifying treatment response. Both tests can easily be performed in MS office. While patients with severe mobility impairment are able to increase velocity by 20% and more, patients with moderate disability would reach the ceiling of the test and therefore do not reach 20% improvement. Yet the effect of the medication is confirmed on more challenging test, such as TUG test.

P2-M-61 Effect of a Forward Sloping Seat on the Strain Sustained by the Postural Chain

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Effect of a Forward Sloping Seat on the Strain Sustained by the Postural Chain Background and aim: Back pain complaints are widespread among people sitting for long periods [1], and awkward seated postures are associated with the risk of developing low back pain [2]. Hence, finding the best posture and seat to reduce the strain on the spine at its lowest level is an important public health issue. The aim of this study was to assess the effect of a forward sloping seat on posture and muscular activity of the trunk and lower limbs. Methods: Twelve asymptomatic subjects were tested in six conditions varying seat slope (0°, 15° forward) and height (high, medium, low). Angular position of head, trunk and pelvis was assessed by means of an inertial orientation system, and muscular activity of 11 superficial postural muscles located in the trunk and lower limbs was estimated using normalized EMG. Results: Results showed that a forward sloping seat, compared to a flat seat, induced a greater activity of the soleus ($p<0.01$), vastus lateralis ($p<0.05$) and vastus medialis ($p<0.05$), as well as a lower hip flexion ($p<0.01$). In contrast, no significant variation of head, trunk and pelvis angular position was observed according to seat slope. These results differ from previous studies supporting the use of forward sloping seats, and describing a more preserved lumbar lordosis and anterior pelvic tilt [3][4]. Conclusion: Forward sloping seats increase the load sustained by the lower limbs, without a systematic improvement of body posture. References: 1. Papageorgiou AC, Croft PR, Ferry S, Jayson MI, Silman AJ (1995) Estimating the prevalence of low back pain in the general population. Evidence from the South Manchester Back Pain Survey. Spine 20: 1889-1894. 2. Lis AM, Black KM, Korn H, Nordin M (2007) Association between sitting and occupational LBP. Eur Spine J 16: 283-298. 3. Bendix T, Biering-Sørensen F (1983) Posture of the trunk when sitting on forward inclining seats. Scand J Rehabil Med 15: 197-203. 4. Bridger RS (1988) Postural adaptations to a sloping chair and work surface. Hum Factors 30: 237-247.

P2-N-62 A virtual reality based dance training paradigm to increase physical activitylocomotor-balance control and physical activity in community dwelling chronic stroke survivors

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BACKGROUND AND AIM: Balance and gait related impairments contribute to decline in physical activity, community integration and increase in cardiovascular deconditioning. Recent research reveals that the interacting network of brain areas active during spatially patterned bipedal, rhythmic movements that are integrated in dance activate many brain centers that help in balance control and ambulation. Purpose To examine the effect of a virtual reality based dance training paradigm in improving gait and balance control along with physical activity levels, and to determine if these improvements would be carried over to home and community-based activity profiles. METHODS: Community dwelling individuals with hemiparetic stroke (N=9) received a virtual reality based dance paradigm for 6 weeks using the commercially available Kinect dance gaming "Just Dance 2014 for one hour thirty minutes. The change in balance control was evaluated by the Limits of Stability test (LOS) and Motor Control Test (MCT) (Neurocom Inc). The post-training changes in self-initiated center of pressure (COP) response time (RT), the movement velocity (MV), the maximum excursion (MXE) and reactive postural response weight symmetry (WS) were examined. Gait speed and cadence were recorded using an electronic walkway. Functional measures were used to assess balance control (BERG), endurance (six-minute walk test [6MWT]), risk of falls (Timed up and go test [TUG]), fear of falling (Fall efficacy scale [FES]) and community integration (community integration scale [CMI]). Changes in number of steps taken during dance training (first vs last session) and community ambulation (one week before and after intervention start) were assessed using Omran HJ-321 Tri-Axis Pedometer. Adherence to exercise was assessed by change on the Intrinsic Motivation Inventory (IMI) scores. RESULTS: Post-training the RT was significantly reduced (pre vs. post, $p < 0.05$). Similarly, post-training, MV, MXE and WS were significantly higher ($p<0.05$). Gait outcomes of speed and cadence and functional measures BERG, 6 MWT, TUG, FES and CMI increased significantly (pre vs. post, $p < 0.05$). Number of steps during dance training significantly increased from 1,882 ± 756 to 2718.4 ± 793 from the 1st to the last session ($p < 0.05$). Community physical activity showed a mean of 2898.1 ± 1312.3 steps per day pre intervention and 3876 ± 171 post intervention.($p = .24$). There was a significant increase in motivation, [IMI scores] (pre-vs post, $p<0.05$). CONCLUSIONS: Results validate the efficacy of this short duration high-intensity protocol for improving gait and balance control resulting in a change in falls efficacy, physical function and community ambulation in stroke. Future studies with larger sample sizes and longer duration are necessary to determine its efficacy on transitive retention of attained improvements in physical activity and determine its efficacy as a home based exercise program.

P2-N-63 Clustered Physical Activity Attenuates Expression of Motor Symptoms in Parkinson Disease Independent from Nigrostriatal Dopaminergic Degeneration

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Objective: To investigate the relationship between physical activity-related energy expenditure and motor symptom severity in Parkinson disease (PD) while accounting for the degree of nigrostriatal dopaminergic degeneration. Background: Physical activity programs are being promoted for patients with PD because motor impairments in PD incline many patients to a sedentary lifestyle. We investigated the relationship between duration of clustered weekly physical activity and motor symptoms severity using the CHAMPS questionnaire for physical activity in the elderly while accounting for the degree of nigrostriatal dopaminergic degeneration. Design/Methods: Cross-sectional study. PD patients, n=48 (40M); 69.4±7.4 years old; 8.4±4.2 years motor disease duration, mean UPDRS motor score 27.5 ± 10.3 underwent [11C]dihydrotetrabenazine (DTBZ) PET imaging to assess nigrostriatal dopaminergic denervation, and completed the CHAMPS physical activity questionnaire and motor assessment. Principal component analysis was performed on the CHAMPS physical activity to determine clusters of specific activities. Results: Principal component analysis of the CHAMPS questionnaire demonstrates several rotated factors with eigenvalue > 2. The factor with the highest eigenvalue (3.90) represented a combination of aerobic, strength, conditioning and flexibility activities. Regression analysis using UPDRS motor score as outcome variable demonstrated significant regressor effect for this specific set of clustered physical activities (F=5.13, P=0.029) while accounting for effects of nigrostriatal dopaminergic degeneration, age and duration of disease (total model (F=5.97, P=0.0008). Conclusions: A combination of aerobic, strength, conditioning and flexibility activities may attenuate motor symptom severity in PD independent from nigrostriatal dopaminergic degeneration.

P2-N-64 Older people who feel fatigue have restricted ability to accumulate physical activity

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Background & Aim Fatigue is an under-recognised and poorly managed geriatric syndrome. Fatigue has been associated with a 15-20% reduction in daily activity including total energy expenditure. Summary measures of daily physical activity provide limited understanding of how fatigue affects the accumulation of physical activity. Exploration of the temporal dynamical patterns of accumulation of physical activity may offer additional insights. This study examined the hour-by-hour accumulation of physical activity measured by accelerometry in order to provide insight into activity behaviours of older people experiencing fatigue. Methods Baseline data from the Generation 100 study was used. Physical activity was measured by ActiGraphTM GT3X activity monitors, and fatigue was measured using the 7-item Norwegian version of the Fatigue Severity Scale (FSS), with scores ≥ 28 considered indicative of fatigue. 'Fatigued' participants were matched to 'not fatigued' participants by age, gender and BMI. Average vertical axis counts per hour (CPH) were calculated for each participant for each hour. A phase space plot was constructed whereby CPH was plotted against the difference between CPH and the CPH for the following hour (d1CPH). The phase space plot shows the rate of change of CPH as a time series. Hourly activity levels for selected periods of the day were fitted to a regression line and the slopes compared. Results Each group consisted of 86 people with mean age 73.8 years (SD 2.0 years), BMI 26.5 (SD 3.9) and 61% female. Figure 1 shows the phase space plot and the regression plots for morning (06:00-12:00) and afternoon (13:00-20:00) periods. Slope for hourly accumulation of counts was significantly different (p=0.003) for the morning period, but not for the afternoon period (p=0.475). Conclusions Fatigue affects older people's rate of accumulation of activity during the morning. There is no difference in rate of accumulation of activity in the afternoon. Older people who feel fatigue have restricted ability to progressively increase their energy expenditure hour-by-hour which leads to lower overall levels of physical activity.

P2-N-65 What discharge factors predict ambulation activity outcomes in the first six months after stroke?

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BACKGROUND AND AIM: Ambulation activity is low after stroke [1]. Across the subacute phase of stroke recovery, some stroke survivors demonstrate improvements in ambulation activity [2, 3], whereas others show a decline in beneficial ambulation behaviours, such as high intensity walking [4]. It is not known if factors at hospital discharge could predict these outcomes. Therefore the aim of this study was to identify which factors at discharge predict ambulation activity outcomes across the first six months following discharge from hospital after stroke. METHODS: 36 stroke survivors (aged 71±10 years, 69% male) were assessed prior to hospital discharge and 1,3 and 6-months. At discharge, factors including: gait speed and endurance, fatigue, mood, executive function, pre-stroke physical activity, ambulatory self-confidence, perceived health status and stroke impact were collected. Measures of all ambulation activity including volume (total steps), frequency (total time spent in long ambulation bouts: > 300 steps), and intensity (total time spent in high intensity: >80 steps/minute) were collected over four days using the ActivPALTM accelerometer at 1,3 and 6-months. Based on Spearman's correlations, three to four strongest correlated variables were entered into a step-wise regression model for each activity outcome at each time point. RESULTS: Gait endurance alone predicted the volume ($R^2 = 0.29$, $F = 9.87$, $p = 0.004$), frequency ($R^2 = 0.29$, $F = 9.69$, $p = 0.005$) and intensity ($R^2 = 0.46$, $F = 20.28$, $p < 0.001$) of ambulation activity at one month. At three months, both discharge gait endurance and pre-stroke physical activity predicted volume ($R^2 = 0.46$, $F = 9.48$, $p = 0.001$) and intensity ($R^2 = 0.61$, $F = 17.5$, $p < 0.001$) of ambulation. Pre-stroke physical activity alone predicted frequency of ambulation activity per day ($R^2 = 0.31$, $F = 10.190$, $p = 0.004$). At six months, age alone predicted volume ($R^2 = 0.35$, $F = 11.78$, $p = 0.002$) and frequency ($R^2 = 0.34$, $F = 11.34$, $p = 0.003$) of walking, while the combination of pre-stroke activity, discharge gait endurance, and executive function predicted intensity of ambulation activity ($R^2 = 0.79$, $F = 25.32$, $p < 0.001$). CONCLUSIONS: Discharge gait endurance is the best predictor of ambulation activity at one month after discharge. It is also a good predictor of intensity of ambulation activity across the first six months after hospital discharge. After one month, other factors such as pre-stroke activity engagement, age and executive function contribute to ambulation activity outcomes over time. 1 English C et al. Phys Ther. 94(2):185-96. 2013. 2 Shaughnessy M et al. Stroke. 36(6):1305-7. 2005. 3 Askim T et al. J Rehabil Med. 45:423-8. 2013. 4 Manns PJ et al. Stroke. 40:864-67. 2009.

P2-N-66 Effectiveness of exergaming for improving balance in people with mild cognitive impairment: a randomized controlled trial

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BACKGROUND AND AIM: Besides cognitive deficits, people with mild cognitive impairment (MCI) experience a decline in motor performance, including postural balance. This study aimed to evaluate an Exergaming program designed for improving balance in people with MCI. METHODS: Memory clinic MCI patients (mean 78.2±8.7 years) were randomized to the intervention group (IG, n=12) or control group (CG, n=10). The IG underwent 4 weeks (twice a week) of Exergaming, including weight shifting and virtual obstacle crossing. Real time visual/audio lower-extremity feedback was provided using validated wearable sensors. The CG received no intervention. Outcome measures included changes in center of mass (CoM) sway, ankle and hip joint sway measured during eyes open (EO) and closed (EC) balance testing (feet together) at baseline and post-intervention. Gait (speed, variability), fear of falling, and user experience were also measured using validated assessment tools. RESULTS: Post-intervention sway of CoM, hip, and ankle were significantly reduced in IG compared to CG during EO balance testing (p= .015-.047). Effect sizes were moderately-large (eta squared= .213-.302). Previous fallers showed greatest improvement in balance. Fear of falling was significantly reduced in IG, compared to CG (p= .015). Change in EC balance (p= .178-.333) and gait (p= . 222-833) were non-significant. Users expressed a positive training experience including fun, safety, and helpfulness of sensor-feedback. CONCLUSIONS: This study shows that a tailored Exergaming approach can improve balance in people with clinically validated MCI. Study findings may help to inform interventions combining virtual reality environments and wearable sensors for rehabilitation of MCI-specific motor deficits.

P2-N-67 Neuromuscular and Physiological Variables Evolve Independently when Running Immediately After Cycling.

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NEUROMUSCULAR AND PHYSIOLOGICAL VARIABLES EVOLVE INDEPENDENTLY WHEN RUNNING IMMEDIATELY AFTER CYCLING. Background and Aim: Studies have investigated the effects of prior cycling on the neuromuscular and physiological characteristics of running. They have revealed that during the early period of running after cycling (<3mins), EMG patterns of the lower limb are modified in some highly trained triathletes (e.g., 36% of those tested, Chapman, 2008). These studies have however, analysed neuromuscular patterns during one period of predetermined length, rather than using individual physiological landmarks at which to characterise the EMG. Therefore, this study examined changes to the stereotypical patterns of lower limb EMG activity seen during isolated (non-cycling primed) running (IR) at physiologically determined times to more closely investigate if subtle neuromuscular adaptations exist. Methods: Six National level elite triathletes (25.6 ± 6.7 years) participated in this study. Each completed a 10-min IR followed by 60-min of rest, then a 20-min variable cadence cycling procedure, transitioning into a 10-min run (C-R). Whole body kinematics, 8 channels of lower limb EMG, oxygen (O2) and heart rate kinetics were collected. All kinematic and analog signals were sampled at 1000 Hz. Average EMG patterns for all 8 muscles were quantified for 10 gait cycles at four times, determined for each individual athlete: 1) 10th min steady-state (IR), 2) halftime after onset of running (t1/2), 3) "mean response time" (MRT) and, 4) 10th min steady-state (SS). Results: Heart rate and O2 uptake evolved independently of each other during the first 180s of running after cycling. Heart rate showed a significantly higher mean difference than O2 uptake in the C-R ($p<.001$). However, average (±1SD) EMG patterns, computed at the four time-points, showed a high level of reproducibility in each athlete. At t1/2, correlation coefficients calculated with IR EMG patterns, ranged from r=.66-.96 across all 8 muscles. At MRT these coefficients ranged from r=.59-.97, and at SS coefficients they were between r=.52-.97. All muscles at all physiological time points during C-R significantly correlated with the average activity during the IR ($p<.05$). Moreover, mean EMG amplitudes showed no significant differences at all physiological time points. Conclusions: These findings suggest that neuromuscular patterns were not affected by prior cycling when compared with isolated running in all triathletes. However, heart rate and O2 uptake evolved separately during the same period. This suggests that the central nervous system is capable of producing robust, well-trained patterns of muscular activity even when the cardiovascular system in under transient adaptive stress.

P2-O-68 Practicing without instructions- Dual-task learning among older adults:

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Background : Many situations in our life require us to divide attention between two tasks (i.e. dual-task). The most common situation is walking while talking on the phone. Dual- task abilities tend to deteriorate with aging, but are modifiable after training. This topic has been studied extensively; however, there is still lack of knowledge about the learning process of dual-tasking. The aim of this study is to explore the "natural" (i.e., without instruction) process of learning of dual-task while walking, among older adults. Method: 86 community-dwelling older adults (age 74.3± 5.9 years; 64% females) participated. All participants performed two sets of dual-tasks; five trials of walking with subtraction by three (set 1) or with a verbal fluency task (set 2). Each trial lasted for one minute. These sets were executed in a random order. In addition, participants were asked to walk for one minute without a cognitive task and to perform each cognitive task while sitting (i.e. single tasks). The participants were not instructed to focus on one task or the other during the practice. We calculated the distance walked and the cognitive performance during single and dual-tasks Dual-task costs (DTCs) were calculated using the formula: single task-dual task/ single task * 100). In addition, we measured cognitive abilities, executive skills and attention. Analyses included ANOVA Repeated Measures. Results: During the sets, the cognitive tasks significantly improved at the expense of the walking tasks ($p<.05$). Accordingly, the walking performance significantly decreased in each trial ($P<.05$). Significant correlations were found between Trail Making Tests A & B to DTCs of the walking tasks ($r=.30$, $r=.36$, respectively; $p<.05$). Conclusions: During the learning process, there was a negative correlation between the cognitive performance and walking tasks, such that the cognitive performance improved at the expense of the walking tasks. This pattern illuminates the need for specific instructions and feedback during the learning process in order to improve the ability to divide attention between the two tasks, rather than to prioritize one task.

P2-O-69 Effect of light touch on standing balance among individuals with incomplete spinal cord injury.

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BACKGROUND AND AIM: Someone with an incomplete spinal cord injury (iSCI) may have considerable balance challenges reflected in the high fall rate (up to 75%) in this population [1]. Standing balance among individuals with iSCI is usually affected due to motor and sensory impairments resulting from the injury [2]. Haptic input in form of light touch has shown to improve standing balance in able body individuals and individuals with other neurological impairments[3], and may also help improving stability in the iSCI population. The aim of this study was to investigate the effect of light touch on standing balance of individuals with iSCI. It is expected that light touch would improve standing balance among individuals with iSCI especially with eyes closed as individuals might rely more on additional sensory input to compensate for the loss of visual input. METHODS: Nine adults with iSCI (AIS D) participated in the study to date (7 males, 55.90 ± 17.53 years). Participants were instructed to stand on a force plate (AMTI OR6-7) for 60 seconds under 4 conditions in the following order- 1) eyes open without light touch , 2) eyes open with light touch, 3) eyes closed without light touch, 4) eyes closed with light touch. For haptic input, participants lightly touched a rail with their index finger of their dominant side or side with less affected sensation. Standing balance was measured by obtaining two centre of pressure parameters in the anterior-posterior (AP) and medial-lateral (ML) directions [3] - a) total excursion, and b) root mean square (RMS). Cutaneous pressure sensation scores (out of 36) of right index finger tip was also obtained. Data was checked for normality and analyzed using two by two repeated measures of ANOVA to test the main effects of, and interaction between, vision and touch at alpha of 0.05. Effect of cutaneous pressure impairments was analyzed descriptively. RESULTS: Preliminary analyses reveal interactions approaching significance for total excursion COPML ($p = 0.099$). Cutaneous pressure was partially impaired in all of the participants. With eyes closed all the participants improved their total excursion COPML scores except 2 participants who scored low on cutaneous pressure testing (scores of 8 & 21). With eyes open, only three participants improved their total excursion COPML scores: all of whom scored high on cutaneous pressure test (scores of 26, 30 & 34). CONCLUSIONS: Preliminary analysis suggests that light touch might improve balance among individuals with iSCI by decreasing the amount of sway and this improvement seems greater when vision is removed. Also, it appears impairments in cutaneous pressure sensation can lower the effect of haptic input on standing balance. Continuing analyses include comparisons to able-bodied individuals and a greater number of participants. 1Amatachaya et al. Spinal Cord 2011 2Lemay & Nadeau. Spinal Cord 2010 3Franzen et al. Neurorehabilitation and Neural Repair 2012

P2-O-70 Obesity increases stepping reaction and movement times

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Background and aim: Obesity reduces postural stability and may be an important risk factor for falling. To avoid a fall, taking a step to recover balance is a common strategy but proper reaction and response execution must be performed. The attentional load required for balance control increases with the complexity of the balance task and the additional requirement of stepping over an obstacle may be particularly challenging. To date, the influence of the complexity of a stepping movement in obese vs healthy weight participants has not been documented. In this light, we investigated obstacle avoidance during stepping by comparing the initiation (reaction time - RT) and execution phases (movement time - MT) of the step in obese and healthy controls. Methods: Ten obese (body mass index (BMI) between

31.4 and 36.6 kg/m2) and nine healthy weight participants (BMI between 20.2 and 24.5 kg/m2) completed a choice stepping reaction time task. The experimental setup consisted of a 110 by 110 cm platform that contained nine squares; a central one on which participants stood on and that recorded both feet independently and eight surrounding the central one that could be illuminated on a computer monitor in front of participants. Participants were asked to step as fast as possible onto one of the eight panels following its illumination (randomized) under two conditions in separate blocks: (i) no obstacle and (ii) over a 5 cm obstacle. Contact with the obstacle, RT and MT were measured for each condition. Results: No difference in the number of contacts made with the obstacle was observed across groups (p>.05). Reaction time was significantly higher in the obese group (517ms) than in the healthy weight group in absence of an obstacle (393ms, p<.001). Interestingly, the obstacle significantly increased RT in the obese group but not in the healthy weight group (+36ms and -7ms respectively, p<.05). Movement time was also higher in the obese group than in the healthy weight group in absence of an obstacle (340ms vs 407ms, p<.001). Adding an obstacle significantly increased MT in both groups, still, the increase was significantly larger in the obese compared to the healthy weight group (86ms vs. 46ms respectively, p<.05). Conclusions: The findings of this study indicate that during the generation of a quick, accurate step, obesity affects both central processing speed associated with initiating the movement as well as the speed of the actual movement. Compared with healthy weight people, obese people have an impaired ability to initiate and execute quick, accurate voluntary steps, especially when task complexity is increased. From a clinical perspective, obese individuals might be less efficient and more at risk of falling than healthy weight individuals in situations requiring fast stepping movements.

P2-O-71 Obstacle avoidance performance and foot placement accuracy are impaired among community-dwelling older adults with low executive function

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BACKGROUND AND AIM: Obstacle avoidance tasks demand a successful walking pattern adaptation which in turn requires integrity of motor and cognitive functions. There is evidence that impaired executive function (EF) is a critical risk factor for falls and is associated with decline in gait measures, particularly while negotiating obstacles. The aim of this study was to compare adaptive walking performance while negotiating an unexpected obstacle between older adults with high and low EF. METHODS: Fifty community-dwelling older-adults (74.3±6.8 years, Montreal Cognitive Assessment 26.3±2.6) walked 6 m at their self-selected speed. On the heel strike of the third step, a coloured light stimulus measuring 21.5 x 21.5 cm was projected on the walkway two steps ahead of the individual. Participants had to avoid the stimulus if pink or step onto it if green and then continue walking. The pink light stimulus was located such that the right foot would land in the middle of the light projection, should the participant continue walking at their self-selected speed. The green stimuli were projected in two locations - 3 cm before and 3 cm after the location of pink light stimulus, and thus required a short or a long step respectively. Three control (no stimulus) trials were followed by nine randomly presented target trials. Outcome measures were number of steps and mistakes during target trials, as well as temporal and spatial parameters of gait during target and control trials measured with a GAITRite mat. In addition, standard measures of sensorimotor functions (Physiological Profile Assessment- vision, hand reaction time, postural sway, leg proprioception and knee extension strength) and EF (Trail-Making Test-TMT) were assessed. Falls in the past year were also recorded. The sample was split in high and low EF based on TMT performance (Part B-Part A; cutpoint 70 s). RESULTS: Twelve older-adults (24%) were classified as having low EF. Measures of sensorimotor functions were similar between EF groups (p>0.05). Fall frequency in the past year was higher among older adults with low EF compared to those with high EF (58.3% vs 26.3%, p=.041). Analyses of covariance while controlling for age revealed that temporal and spatial measures of free walking trials were similar between EF groups but they differed during target trials. Compared to older adults with high EF, those with low EF took more steps (p=.001) and spent less time in the swing phase while approaching the target to avoid (p=.017). Older adults with low EF also showed less accurate foot placement onto the green target which required a short step adaptation strategy (p=.024). CONCLUSIONS: These results suggest that adaptive walking to negotiate an unexpected obstacle requires intact executive function to maintain stability and a safe and accurate stepping pattern. Such gait adaptability impairment may be one reason why older adults with low EF are at increased risk of falls.

P2-O-72 Instrumented Timed Up and Go test discriminates between community-dwelling fallers: the InCHIANTI-FARSEEING study

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Background and aim: The Timed-Up-and-Go test (TUGt) is widely used to assess functional status in elderly. An instrumented TUGt assessed by Smartphone technology could offer an opportunity to identify different motor characteristics in those who experienced a fall, retrospectively and prospectively, by an ad-hoc application for smarthphones (uTUG) which provides different biomechanical features of the performance. The main aim is to relate uTUG features with previous and future falls reported by participants into the InCHIANTI FU4 and to assess the predictivity power of biomechanical information. Methods: Data from 65ys and older participants, MMSE ≥24 and free of ADLs disability were used. Participants were asked during the home interview about falls occurred during the previous 12 months (12M) and then were interviewed monthly for 6 months (6M) by a telephonic interview to check for falls. TUGt was implemented into the physical assessment protocol and movement data were collected trough inertial sensors (gyroscope and accelerometer) built in a

Samsung Galaxy SII/III placed in a belt pocket on the back. uTUG assessed total and partial times to perform the test and derived al large number biomechanical features. Data reduction was performed by Factorial Analysis. The association between derived factors and falls were evaluated by multiple logistic regression models (MLRM). Model predictivity power was tested by ROC curves. Results: 340 older adults, age 80.1±6.5ys (range 65-92ys), 121 females, MMSE 27.2±1.8 were evaluated. 51 (21.2%) subjects reported at least a fall in the previous year whereas 20 (8.3%) experienced at least a fall during the 6M period. About 67.0% of features matrix variability was explained by six orthogonal indicators, labelled as: "global performance", "smoothness of sit to walk transition (StW)", "lateral weight shift control during the turn to sit transition (TtS)", "lateral weight shift control during StW", "forward weight shifting control during StW" and "smoothness of TtS". Implemented MLRM with factors and multiple confounders suggests an association between falls occurred in the previous 12M and "smoothness of TtS" (p=0.01). Considering the falls in the 6M period, the "smoothness of StW" was found significantly associated and predictive (p=0.01, AUC=0.74). Conclusions: Our findings underline the feasibility and the value of sensors derived parameters applied during the TUG Test, in quantify subtle differences in mobility function that are related to fall risk and than can not be captured by TUG duration. The sitting phase in a highly functioning elderly population is a distinctive marker of those the have experienced a previous fall while the attempt to start the walking phase from the sitting position has a meaningful for the subsequent risk for falling. uTUG can provide useful information relevant for the assessment of the fall risk and eventually for the fall risk prediction even in a robust older population

P2-O-73 Effect of planning time and practice on the obstacle avoidance strategies of older adults

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BACKGROUND AND AIM: Avoidance of obstacles (OBS) in the environment whether static or moving, is a major component of activities in daily life. Older adults are at a greater risk of falling for a variety of reasons [1], thus observations of their OBS avoidance strategies will contribute to our knowledge base and may lead to novel training/intervention studies which could reduce the occurrence of falls in this special population. The purpose of this study was to investigate the OBS avoidance strategies utilized by older adults during static and dynamic OBS crossing and whether reduced planning time and practice alter these strategies. METHODS: There were 8 older adults (aged 75 ± 5.2 years) recruited to participate in the study. Kinematic data was collected as the participant crossed over an OBS scaled to 30% of participant total leg length for the high position and 16.5 cm less for the low position. The protocol included trials that required a stepping strategy over a static high or low OBS and a dynamic OBS that moved in the approach phase to one of these final positions. OBS motion was triggered either immediately by the participant crossing through a laser gate (3 steps from the obstacle) or after a 333 ms delay. A total of 27 low OBS position and 27 high OBS position trials were collected with trials separated into 3 randomly presented blocks. RESULTS: Outcome measures included minimum foot clearance (MFC), landing distance, take-off distance, and approach/crossing velocity. Interestingly, neither the 333 ms OBS motion delay nor motion of the OBS resulted in differences for any of the calculated outcome measures. OBS crossing strategies however, did vary between the 8 subjects. There were 4 older adults that contacted the OBS at least once. This unsuccessful group (N=4) that contacted the OBS, had lead MFC values that increased in successive blocks, whereas the successful group (N=4) had a decreased lead MFC in successive blocks as well as significantly larger take-off distance and velocities ($p<0.05$). The unsuccessful group also had significantly lower lead MFC in the high OBS position than the low OBS position. CONCLUSIONS: The OBS delay did not impact the avoidance strategy; this was attributed to the participants having sufficient time of at least 2 steps before the OBS for feed-forward visual information to be integrated in order to plan an avoidance strategy [2]. Additionally, a learning effect appeared to be present for both groups, with older adults being able to modify their OBS avoidance strategy as they continued throughout the protocol. Understanding older adult obstacle avoidance strategies could lead the identification of unsafe movement patterns, the development of training interventions and the overall reduction of falls in older adults. [1] Public Health Agency of Canada Survey (PHAC) (2014) [2] Patla A, Vickers J (2003) Exp Brain Res 148:133-8

P2-O-74 The effect of a cholinesterase inhibitor on balance in Parkinson?s disease

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Abstract: BACKGROUND and AIM: Cholinesterase inhibitors have a positive impact on cognitive function in persons with PD and cognitive impairment or dementia.(Cochrane 2012) A small study also showed a reduction in falls in persons with PD without dementia.(Chung 2010) The primary aim of this study was to determine if donepezil (a centrally acting cholinesterase inhibitor) improves measures of balance in persons with Parkinson's disease (PD) compared to a placebo. METHODS: This was a double-blind placebo controlled crossover study. Participants received 6 weeks of treatment with either placebo or donepezil, then a month washout, then another 6 weeks of treatment opposite to the first. Inclusion criteria were an MMSE>27 and balance impairment on clinical and posturography assessments (SOT <70). RESULTS:Ten participants' data was used in the analysis. The mean age, UPDRS motor score, and PD disease duration were 69.6%2B5.9 years, 24%2B7, and 10.5%2B8 years at the initial visit. Mean scores on Stroop conflict time and trails B-A at baseline were 105%2B48s and 59%2B32s respectively. The mean composite SOT scores improved from 60%2B16 to 61%2B15 during the placebo phase and 59%2B11 to 62%2B14 during the donepezil phase. This change was not significant, p=0.7. However, in looking at the single conditions of the SOT, there was a statically significant change seen in condition 4

(Eyes Open, Sway referenced, p<0.03). Out of 10 participants, 4 improved more than 40%, 4 improved mildly (between 15% and 30%), and 2 didn't show improvements in C4 during the active phase of the study. In addition, there was a significant correlation between improvement in cognitive performance and balance, r=0.8, p=0.001. CONCLUSION: In this pilot study there was statistically significant improvement in one component of the SOT. A subset of patients appeared to have an improvement in balance. It appears that improvements in balance and executive functions are related.

P2-O-75 Physical activity and different concepts of fall risk estimation in older people - results of the ActiFE-Ulm study

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BACKGROUND AND AIM: The aim of this study was to investigate the relationship between physical activity and two measures of fall incidence in a population of community-dwelling older adults using total time under observation as well as falls per time doing objectively measured physical activity and to demonstrate the different perspectives of these two approaches when assessing rate of falls. METHODS: Between March 2009 and April 2010 physical activity of 1,214 German community-dwelling older people (≥65 years, 56.4% men) was recorded over one week using a thigh-worn uni-axial accelerometer (activPAL; PAL Technologies, Glasgow, Scotland). Average daily walking duration was extracted from these data and categorized in low (0-59 min), medium (60-119 min) and high (120 min and more) activity. Falls during one year were assessed prospectively by fall calendars. Poisson regression models were used to calculate fall rates and incidence rate ratios for each activity category each with (1) person-years and (2) hours walked as denominators stratified by gender, age group, fall history, and walking speed. All analyses were adjusted either for gender, age, or both. RESULTS: No statistically significant association was seen between falls per person-year and average daily walking duration. However, if falls per exposure time (daily walking duration) was considered, those who were low active sustained clearly more falls per hours walked. The highest incidence rates of falls were seen in low-active persons with slow walking speed (0.57 (95% confidence interval (95% CI): 0.33 to 0.98) falls per 100 hours walked) or history of falls (0.60 (95% CI: 0.36 to 0.99) falls per 100 hours walked). CONCLUSIONS: Falls per hours walked is a relevant and sensitive outcome measure. It complements the concept of incidence per person years, and gives a supplementary perspective on falls in community-dwelling older people.

P2-O-76 The association between excessive daytime sleepiness and gait parameters in community-dwelling elderly people

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BACKGROUND AND AIM: Sleep disturbances such as EDS are associated with declines in physical function, such as gait ability. A few studies have shown that the decline of gait speed may be related to sleep efficiency, but no consensus has yet been reached. This study examined the association between excessive daytime sleepiness (EDS) and gait parameters such as speed and variability in community-dwelling older adults. METHODS: The study included 3,901 individuals aged ≥65 years who were enrolled in the Obu Study of Health Promotion for the Elderly (OSHPE). Participants answered questions about EDS, sleep duration, and other sleep-related symptoms. EDS and other sleep-related symptoms was assessed using the question "How often do you have daytime sleepiness requiring a nap?" with the following options: "almost always," "sometimes," and "rarely or never." For analyses, EDS was deemed to be present when it was reported to occur "almost always." Gait speed, stride length, and the variability in stride length, were assessed by using a WalkWay device (WalkWay MW-1000, Anima Co., Tokyo, Japan). RESULTS: EDS was significantly associated with slower gait speed among younger old adults (<75 years, $p = 0.021$), while EDS was significantly associated with both slower gait speed ($p = 0.045$) and greater stride length coefficient of variation among older old adults (≥75 years, $p = 0.048$) in the multivariate analysis adjusted for age, sex, body mass index, medication, number of comorbidities, education, cognitive function, grip strength, physical activity, depressive symptoms, and other sleep-related problems. CONCLUSIONS: The results suggest that EDS is associated with gait ability in older adults, especially in older old adults. Further prospective studies are needed to determine the causal association between gait ability and sleep disturbances, including EDS.

P2-O-77 Relationship between gaze behavior and failure to cross a stationary, visible obstacle

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Background and Aim: Successful modification of gait while navigating cluttered environments is aided by vision. Participants tasked with crossing a stationary, visible obstacle occasionally fail and contact the obstacle (Heijnen et al., 2012). Participants who never contact the obstacle (successful participants) may have different gaze behaviors than those who made obstacle contact. This study determined if gaze behaviors were different between successful and unsuccessful participants. Methods: Thirty-four university aged adults (7 male, 21 ± 1.2 years of age, 1.68 ± 0.10 m) were recruited. Participants walked over a stationary obstacle that was positioned in the middle of a 6.7 m walkway for 150 trials. Obstacle height was 25% of leg length. Participants were categorized as a function of the number of obstacle contacts during the 150 trials: 0, 1, or 2 plus contacts, termed non-tripper, single-tripper, and frequent-tripper, respectively. Gaze behaviors (Mobile Eye-XG, ASL) were analyzed up to and including the participant's first contact trial, or to trial 150 if no contacts occurred. Fixation onset and offset were

defined as a gaze within a 3º variance with a minimal duration of 100 ms. Nine areas of interest (AOIs) were examined: the walkway was divided into 5 segments (including 60 cm in front of the obstacle where the trail foot is placed and 60 cm after the obstacle where the lead foot is placed), and the obstacle was divided into 3 segments (top, middle, bottom). The outside AOI was any area not previously designated but within the participant's field of vision. Measures included duration and frequency of fixations on each AOI, and also the total duration and frequency for all AOIs combined. Results: The participants were categorized as follows: 13 non-trippers (38%), 11 single-trippers (32%), and 10 frequent-trippers (29%). Durations of fixations: relative to frequent-trippers, non-trippers had longer fixations on the obstacle top (120 vs 42 ms, p=0.045) and shorter fixations outside of the walkway (930 vs 1,780 ms, p=0.044). Frequency of fixations: non-trippers had more frequent fixations on the following AOIs: obstacle top (0.6 vs 0.2, p=0.048), obstacle middle (0.5 vs 0.2, p=0.042), and area after the obstacle (1.3 vs 0.6, p=0.041). Non-trippers had less frequent fixations on the outside AOI (2.6 vs 5.2, p=0.008). Frequent-trippers had the same duration and frequency of fixations when all the AOIs were combined, but more fixations occurred in the area outside the walkway compared to non-trippers. Conclusion: More frequent and longer duration of visual fixations on key areas, such as the top of the obstacle and the walkway region just after the obstacle, may be a strategy to prevent obstacle contact. Documenting optimal gaze strategies may lead to the development of gaze interventions to prevent trips, similar to the 'quiet eye' technique that improves athletic performance (Vickers, 2009).

P2-O-78 Combining inhibition and choice reaction time in a step test as powerful predictor for falls in older people

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Background and aims: Falls in older people is a multifactorial problem with the combination of health-related factors as well as sensorimotor and cognitive abilities determining an individual's risk. Recently we have shown that the inhibitory choice stepping reaction time task (iCSRT) could predict falls in community-dwelling older adults. The iCSRT combines response selection and inhibition as measures of executive functioning with rapid stepping in a functional context. In this preplanned secondary analysis we aimed to determine whether the iCSRT remained as predictor in a multivariate model that included other known risk factors of falling and to identify their interrelationships. Methods: A cohort study with a 12-month prospective falls follow-up (monthly calendars) was conducted. Two-hundred-and-eleven older adults (mean age 80.5 ± 4.9 years, range 70-94; 62% women) without major cognitive impairment were included. Self-report measures of comorbidities (functional performance index) and concern about falling (icon-FES) were recorded. Sensorimotor functions were assessed with the Physiological Profile Assessment (PPA - contrast sensitivity, simple hand reaction time, postural sway, proprioception and isometric lower extremity strength) and the weighted z-transformed overall score was used for further analyses. Cognitive performance was assessed using the Attentional Network Test which determines the processing efficiency of three disparate anatomical and functional networks involved in attention (alerting, orienting, executive) using cued reaction times and Flanker tasks. In addition, the iCSRT, a combination of the choice stepping reaction time with a go/no-go task, was administered using a step mat connected to a computer display. We applied Classification and Regression Tree (CRT) analysis to identify subgroups of individuals with associated best test measures and cut points to discriminate fallers from non-fallers. Results: Ninety-two individuals (44%) experienced at least one fall during the follow-up period. CRT revealed that iCSRT was the best discriminating variable in this sample (node 1) with a cut point of 982ms. Overall, four subgroups were identified. In those with faster iCSRT times fall risk was partially explained by sensorimotor and cognitive performance. Absolute risks for falls ranged from 23.5% in individuals with good iCSRT and ANT-orienting scores to 72.4% in slow iCSRT performers. Conclusions: The results demonstrate the good predictive validity of the iCSRT task, a test combining rapid stepping with specific cognitive functions. It further shows the interrelationships of included variables in explaining the risk of falls. The findings help to develop interventions that target individuals according to their specific risk and suggest the inclusion of iCSRT into training programs.

P2-O-79 Anticipatory Postural Adjustment in Choice Reaction Step Initiation

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BACKGROUND AND AIM: The ability to step quickly in response to a perturbation has been shown to be critical for prevention of falls. The cognitive processing, weight shifting, and locomotion must be well timed to execute a successful step. The purpose of this study was to compare the response preparation and response execution processes between a simple (SRST) and a choice reaction stepping task (CRST). METHODS: Nine healthy young subjects were recruited to participate in this study. Subjects were required to stand on a forceplate and maintain their balance, and step forward on to a second forceplate with either the left or right foot after hearing an auditory tone (250 / 500 Hz) generated by a LABVIEW program. Twenty trials in the SRST and twenty trials in the CRST condition were collected from each participant. The Center of Pressure (COP) was analyzed to determine the types of anticipatory postural adjustment (APA) prior to a step. The reaction time (RT), APA phase, and stepping phase timing were calculated and analyzed using repeated measures ANOVA. RESULTS: RT, APA phase timing and overall stepping latency were slower for CRST than for SRST ($p < .001$). An intermediate type of APA response (Posterior Shift APA) in addition to the Correct and Error APAs was identified in the CRST trials. We found that RT was lengthened in trials with correct APAs ($p < .001$), while the APA phase in the error trials was significantly prolonged compared to the APA correct trials ($p < .001$). The Posterior Shift APA had a fast RT similar to the Error APA trials, while the APA phase duration was intermediate between Correct and Error APA trials. For the overall stepping latency, the Posterior Shift APAs were 100 ms shorter than the other 2 groups (p < .001). CONCLUSIONS: Our findings suggest that stimulus evaluation during choice reaction step initiation was not completed before movement execution. Instead, the evaluation process continued in the APA phase. Furthermore, the APA posterior shift pattern was identified and its overall step timing indicates a potential advantageous strategy to initiate a fast forward step which could lead to effective training for fall prevention.

P2-O-80 Daily-life trunk accelerometry aids prediction of recurrent falls in older adults

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Background and aim Falls are among the leading causes of disability in older adults and pose a growing burden on society. For more targeted fall prevention, those at risk of falls have to be identified. Trunk accelerometry obtained during daily life is a novel and upcoming method that is promising for this aim. We investigated the predictive value of the amount of daily activity and quality of daily-life gait estimated from trunk accelerometry for incidental and recurrent falls. Methods In this prospective cohort study, 313 community-dwelling older adults aged 65 and over participated. They were visited at home to assess risk factors for falls by questionnaires, grip strength and trail making tests. Subsequently, they wore a trunk accelerometer for one week from which we obtained the amount of daily activity and quality of daily-life gait. A six to twelve months follow-up with telephone calls every month was conducted to obtain prospective fall incidences. Principle component analysis was performed to reduce the number of variables and resolve high correlations between variables. Time to first and second fall were predicted using survival analysis with 10-fold cross validation. Results During follow-up, 44% of the participants reported experiencing a fall and 22% reported experiencing recurrent falls. Median time to first fall was 6 months and 8 months to second fall. Principle component analysis revealed that 17 independent components could be extracted. The fall risk model for time to first fall reached a cross-validated time-dependent AUC of 0.64-0.67 and revealed that the main determinants were components reflecting history of falls, fear of falling and depressive symptoms. When stratified by falls history, main determinants for time to first fall in non-fallers (i.e. incidental falls) were components reflecting variability, which reached a non-significant cross-validated time-dependent AUC of 0.49-0.62. Main determinants for time to first fall in fallers (i.e. recurrent falls) were components reflecting fear of falling and depressive symptoms, durations of lying and sitting, fitness and gait quality. This model reached a cross-validated time-dependent AUC of 0.67-0.75. A fall risk model for time to second fall reached a cross-validated time-dependent AUC of 0.69-0.78 and revealed that the main determinants were components reflecting fear of falling and depressive symptoms, history of falls and gait quality. Conclusion Overall, our results indicate that accelerometry chiefly supports the prediction of recurrent falls.

P2-P-81 Gait initiation of individuals with stroke before and after gait training with body weight support on treadmill and over the ground

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BACKGROUND and AIM: The use of body weight support (BWS) is a strategy commonly adopted for rehabilitation of individuals with gait impairment. Although this strategy is mostly used in conjunction with treadmill, we could ask if the type of surface these individuals walk with BWS influences a gait intervention program. In this study, we investigated if the type of surface (treadmill vs. over the ground) employed with a BWS system would influence the gait initiation of individuals with stroke. This task might be a big challenge for those individuals as it is the transition between upright quite stance and walking. METHODS: Ten individuals with stroke, between 53 and 67 years old took part of a gait training program with BWS. They were randomly assigned for gait training either on a treadmill (n=5) or over the ground (n=5), three times/week for six weeks. Before and right after the training sessions, they were requested to stand still with one foot on different force plates (Kistler) and start walking for approximately 3 m. Passive reflective markers were placed on main anatomical landmarks of both lower limbs and data from them were acquired with a motion analysis system (Vicon). All individuals initiated gait with the paretic limb at their preferred speed. Step length of paretic and non-paretic limbs and maximum displacement of center of pressure (CoP) in the medial-lateral (ML) and anterior-posterior (AP) directions were calculated. RESULTS: Overall, individuals that trained with BWS over the ground increased step length of non-paretic limb and CoP displacement in the ML direction compared to individuals that trained with BWS on treadmill, and no difference was found for the step length of paretic limb and the maximum displacement of CoP in the AP direction. CONCLUSIONS: The type of surface adopted for gait training with BWS influences gait initiation of individual with stroke. It seems that the possibility of changing body position over the space during gait training with BWS promotes improvement on lateral stability.

P2-P-82 Effect of ankle-foot orthosis on kinematics and ground reaction forces of level walking in healthy subjects

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BACKGROUND AND AIM: Ankle-foot orthosis is often prescribed in the rehabilitation of the patients with stroke, as it can prevent the foot from dropping towards the ground during walking. Many studies have investigated the gait characteristics of post-stroke hemiparetic patients to clarify the efficacy and biomechanical influence of the orthosis towards improvement of rehabilitation protocols. However,

clarifying the biomechanical effect of the orthosis solely based on gait analyses of patients is not trivial due to large interindividual variability of gait in hemiplegic patients. In the present study, therefore, we analyzed kinematics and ground reaction forces of walking with and without an ankle-foot orthosis in healthy subjects to clarify the biomechanical characteristics of bipedal walking with an orthosis. METHODS: Adult male participants were asked to walk across two force platforms set in a wooden walkway with and without an ankle-foot orthosis and three-dimensional body kinematics and ground reaction force profile were simultaneously recorded using a motion capture system and the force plates, respectively. Step lengths for the leg with the orthosis and the contralateral leg were calculated as the distance between the leading and trailing limb heel markers at the time of foot-ground contact of the orthosis and contralateral legs, respectively. The step length was normalized by the stride length. The duty factor, the ratio of stance phase with respect to the stride time, was also calculated for the both legs. RESULTS: We found that the stance phase (the duty factor) was significantly shortened and the step length was prolonged in the leg with an orthosis, and vice versa in the contralateral leg. Therefore, the gait pattern became essentially asymmetry due to the effect of the orthosis even in healthy subjects. The propulsive ground reaction force was found to be smaller in the leg with an orthosis than in the contralateral leg since plantarflexion of the ankle was actually restricted at the time of toe-off. When walking with an orthosis, the step length and the duty factor of the contralateral leg should probably be shortened and prolonged, respectively, to facilitate the forward movement of the leg with orthosis. CONCLUSIONS: Our study suggested that the prolongation of the stance phase and shortening of step length of the leg without an orthosis may facilitate walking with an unilateral orthosis. This finding may potentially be applied to rehabilitation of walking in hemiparetic patients.

P2-P-83 Feasibility of a Virtual Reality Remote Tele-Rehabilitation training for Parkinson's Disease- a case report

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BACKGROUND AND AIM: Physical training in Parkinson's disease (PD) improves motor performance, alleviates non-motor symptoms, and enhances cognitive function and quality of life. Despite this, adherence and attendance to exercise programs are low. Home training can help avoid the encumbrance associated with traveling to training and provide flexibility of training. We recently introduced a virtual reality (VR) system as a tool for motor-cognitive training. Mobility, balance and fall risk improved after training with the system in patients with PD. Here we describe a novel tele-rehabilitation training program using a Treadmill-VR system for motor-cognitive training of a patient with PD in his home setting. METHODS: The tele-rehabilitation system includes: a treadmill, screen, Kinect camera and a PC installed with the VR simulation. The Kinect measures the movement of the participant's feet while walking on the treadmill. These images are transferred into the VR simulation

and projected to the patient on the screen, providing feedback of performance. The virtual environment consists of obstacles, different pathways and distracters. This requires modulation of step amplitude coordinated with walking behavior while attending to cognitive tasks as attention, response selection and visual stimuli processing. Three video cameras provide a full size body depiction of the patient for remote monitoring. RESULTS: The system was installed in the home of a 44 year old patient with PD (disease duration: 15 years, UPDRS motor:29 H&Y:3; living in London). The patient is ambulatory with supervision and has difficulties in outdoor and complex environments. Remote monitoring software was installed on both the patient's and laboratory PCs, enabling visual and auditory connections. Weekly remote training sessions were conducted by an experienced clinician (in Tel Aviv) who manipulated parameters such as obstacle height and frequency, walking duration and distracters. Thirteen training sessions were conducted. The 1st session included 3 walking trials for a total of 21 minutes. The patient walked with hand support on the treadmill, at a speed of 2 [km/h] at the lowest level of difficulty. By session 7, the patient was able to walk with the support of only one hand and, by session 12, he achieved good balance and coordination and was able to walk with no hand support. Gait speed improved by 40% and endurance of walking improved by 200% amounting to 45 minutes of walking during a session. Difficulty level also increased and the amount of errors declined by 24%. The patient reports being able to walk outdoors for longer distances without support and feeling more confident in his gait. CONCLUSION: While future work involving more participants is needed to further evaluate efficacy, the present case study provides preliminary evidence on the feasibility and efficacy of a VR Remote Tele-Rehabilitation training system for patients with PD.

P2-P-84 Development of exergames for the training and evaluation of coordination and dynamic stability in cerebellar ataxia

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Background: Despite of the importance of the cerebellum for motor control and motor learning, recent studies have shown that training based on physiotherapy or exergames can lead to substantial motor improvements in degenerative cerebellar ataxia1. Specifically, we have shown that training based on commercial exergames can improve dynamic stability and joint coordination2. However, the use of commercial games presents several short comings, especially with respect to adaptations of training complexity. Here, we developed 2 exergames for individualized training and evaluation of ataxia-related control mechanisms in whole-body movements. Methods: The concept focuses on exercising ataxia-related control mechanisms like predictive control in joint coordination and dynamic stability in various tasks; e.g. predictive control is exercised on internal events like anticipatory body adjustments and on external events like anticipation of a ball trajectory. For the development of motor challenges with increasing complexity we integrate knowledge about the influence of gradual learning cueing of

sequences and feedback conditions which had been retrieved from motor learning studies with cerebellar patients1. Results: We have implemented 2 exergames based on the Kinect?v2 to train ataxia-specific control mechanisms in different environments. 1) a choice stepping reaction time task3. The player controls an avatar which has to step as fast as possible on highlighted target squares lightening up randomly around him. Game complexity is parameterized mainly by the amount and order of targets. At higher levels subjects perform specified target sequences and control a tetris-like game by target hitting. Exercise includes elements like dynamic stability and trunk-leg coordination which are known to be specifically dysfunctional in ataxia. 2) In air ball one has to keep a ball or other simulated objects in the air by hitting with all extremities. Complexity is parameterized by object characteristics (velocity), restrained work space and the amount of objects. At higher levels, targets have to be hit with the balls and a virtual partner joins the game. Pilot patient trials indicated that these games indeed addressed ataxia-related motor impairments. Moreover, they showed that game complexity can be adjusted to individual motor impairments and improvements, enabling training benefits over a longer period. The embedded analyses focus on predictive control, dynamic stability and joint coordination. Conclusions: Exergames are a novel method for a wide range of rehabilitation strategies and neurological conditions. We here show that customized exergames can be individually and continuously tailored according to each subjects' individual disease severity and training progress. 1. Ilg W, Bastian AJ, et al. Consensus paper: Cerebellum 2014;13(2):248-268. 2. Ilg W, et al . Neurology 2012;79(20):2056-2060. 3. Lord SR, Fitzpatrick RC. J of gerontology. 2001;56(10)

P2-P-85 Attentional requirements of postural control in people with spinal cord injury: the effect of dual task

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BACKGROUND AND AIM: The simultaneous performance of a postural and suprapostural task (dual tasking, DT) has been shown to result in the deterioration of the performance of one or both tasks, especially in people with disorders affecting balance. For people with spinal cord injury (SCI), whose standing balance is challenged, it is unknown the extent to which they rely on attentional resources to maintain quiet stance. The aim of this study was to use DT paradigms to investigate the attentional requirements for maintaining standing balance in people with SCI. METHODS: We recruited adults with SCI who could stand for at least 30 seconds without hand-held aids and age-matched able-bodied controls. Subjects were asked to perform two suprapostural tasks (a math task (counting backwards by 3s) and an auditory reaction time (RT) task) while standing, and asked to prioritize maintaining steady stance. Performance during the DT conditions were compared with their baseline, single-task (ST) performance. All trials lasted for 2 minutes (or the maximum standing time). The primary outcome measures were i) the change in maximum standing time and ii) the change in RT between DT and ST conditions. We also compared the error ratio (ER = incorrect responses/total responses) and total words uttered for the math task between DT and ST conditions. In subjects who could stand for at least 60 seconds, we analyzed center of pressure measures of sway using signals from the force plate. RESULTS: We have collected pilot data from 9 adults (8 males, 1 female) with SCI (mean age= 51±11 years; mean height=174±9 cm; years post-injury=12±11; level of injury: C1-L5; all motor-incomplete, ASIA C/D) and 8 matched controls (mean age=49±11years; mean height=178±10 cm). For the RT task, there was no significant difference between groups (SCI mean difference=13.1±57.5 ms; AB mean difference=14.4±26.0 ms; p=0.96). All SCI subjects could stand for at least 60 sec for force plate analysis. For the math task, the average difference between ST and DT conditions for CoP RMS AP=1.3±2.3mm, RMS ML=2.5±6.2mm, MPF AP=0±0.1Hz, MPF ML=-0.08±0.10Hz for the SCI group. For the control group, the average difference between ST and DT conditions for RMS AP=1.7±2.9mm, RMS ML=0.9±1.1mm, MPF AP=0.1±0.1Hz, MPF ML=0±0.2Hz. The SCI group appeared to show an increased change in RMS ML when comparing differences in ST and DT conditions than the control group. CONCLUSIONS: This pilot data indicate that the performance of a suprapostural task may affect sway measures in people with SCI. Further analysis of the counting task and movement reinvestment and data from more subjects is planned to confirm and extend the results of this study. We anticipate that the results of this study will demonstrate the importance of incorporating measures of dual-task performance in assessments of clinical outcomes in people with SCI.

P2-P-86 Cell phone telerehabilitation device for home-based balance training

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BACKGROUND AND AIM: Balance training reinforces the development of sensorimotor strategies to improve postural control and functional mobility, which is crucial for fall prevention in the older adult population. Rehabilitation programs typically consist of 1-2 sessions per week over 4-12 weeks. Although an increased number of sessions have been shown to lead to continued benefit, the number of sessions with expert instruction is limited due to practical considerations such as insurance reimbursement and patient load. The purpose of this research was to design and assess a cell phone telerehabilitation device capable of providing vibrotactile feedback to community dwelling older adults in their homes. METHODS: Design ethnography techniques including observations and interviews were used during a co-creative design process involving stakeholders to develop a second-generation cell phone-based telerehabilitation prototype. Non-clinical and pre-clinical tests were performed to characterize the prototype's performance, feasibility, and usability. Tilt estimates were compared with an off-the-shelf inertial measurement unit (IMU) and passive motion tracking system. Balance performance of four older adults was assessed with both the prototype and a high-fidelity laboratory-based vibrotactile feedback device. RESULTS: The prototype comprises two iPods/iPhones (one "sensing" and one "user interface" unit), custom software with an automated exercise progression routine (including static and dynamic standing, and gait-based exercises), a "tactor bud" accessory with four tactors that provide vibrotactile cues of body tilt, tactor controller board, and batteries. The sensing unit is worn around the torso while the user interface unit is worn on a lanyard around the neck. The four tactors are placed over the navel, spine, and right and left hand sides of the torso, and vibrate if the torso motion measured by the sensing unit exceeds a predefined threshold. Following the completion of each 30 s exercise, the data from the sensing unit are automatically saved and uploaded to a secured cloud server. The non-clinical sensing capability results demonstrated high correlation (>0.9) between the commercial IMU and the sensing unit during both static and dynamic tests. The pre-clinical results suggest that subjects can use the vibrotactile feedback cues to reduce their sway with root-mean-square tilt values comparable to those obtained using the high-fidelity device. CONCLUSIONS: Although a first-generation cell phone-based balance trainer was capable of providing real-time vibrotactile cues for informing corrective postural responses, it was difficult to operate and only provided directional cues along one axis. The new user interface unit has dramatically improved the usability of the telerehabilitation device. Given the preliminary results, the second-generation prototype has potential for supporting home-based balance training.

P2-P-87 Evaluating a conceptual progression framework by grouping balance exercises based on difficulty

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BACKGROUND AND AIM: Vestibular physical therapy (VPT) is an exercise-based program provided by physical therapists to improve the functional outcomes for patients with vestibular disorders. There is limited published experimental data to guide clinicians when determining VPT exercise progression. The aim of this study was to quantitatively characterize the degree of difficulty of VPT exercises performed on firm and foam surfaces while varying stance, vision, and head movement conditions. METHODS: A recently published VPT progression framework was used to guide the selection of VPT exercises used in this study, which included 25 exercises performed on a firm surface and 16 exercises performed on a foam surface by three subjects with documented unilateral and bilateral vestibular loss. Exercises were performed over 18 sessions and each exercise was repeated at least twice, with some exercises repeated 20 times. Root-mean-square (RMS) trunk tilt, 95% confidence interval elliptical fits to trunk tilt trajectory, and percentage time spent outside a circular zone defined by a 1° radius were computed for each 30-s exercise trial. Data were standardized and Principal Component Analysis (PCA) and hierarchical clustering methods were used to independently group the data for each subject and for each surface. RESULTS: PCA showed that the first two principal components explained at least 95% of the total variance. The exercise groupings based on visual inspection of PCA two-dimensional plots and

results from the hierarchical clustering method were similar. Three difficulty levels emerged from the analysis for each surface type. Exercises performed with feet apart on the firm surface were easiest, as well as feet together and semi-tandem Romberg stances performed with eyes open (with or without head movements). Exercises of moderate difficulty included those performed with feet together or semi-tandem Romberg stance with eyes closed and head movements. The most challenging exercises were those performed in tandem Romberg and single leg stances. Exercises that were considered easy on the firm surface were classified as moderately difficult when performed on the foam surface, especially during eyes closed and head movement conditions. Romberg and tandem Romberg exercises performed on foam during the eyes closed condition (with and without head movements) were classified as the most challenging. Single limb stance exercises were not performed on foam. CONCLUSION: These preliminary results suggest that altering the stance position, from a wide to narrow base of support, is the most important factor in determining the degree of exercise difficulty in persons with unilateral or bilateral vestibulopathy. Adding eyes closed or head movement conditions increases the exercise difficulty especially for narrow-based stance conditions or when standing on a compliant foam surface. The findings provide quantitative support for the development of exercise programs.

P2-Q-88 Interpersonal competition dynamics in a ballgame: Modeling of a 1-on-1 game and two opposing cognitive systems.

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BACKGROUND AND AIM: This study is aimed at understanding the interpersonal competition dynamics in a 1-on-1 subphase in a ballgame. We previously clarified the dynamics in actual motion measurement and demonstrated that a defender's better preparatory body state before the defensive step helps in preventing delaying the defensive step initiation and promotes effective guarding. However, we cannot fully explain the dynamics. In a 1-on-1 competition, the cognitive and motor processes of two opposing players complexly interact, and estimating these processes by measuring only the actual motion would be impossible. We therefore propose a new approach to model a 1-on-1 competitive game and the cognitive-motor systems of the defender and the dribbler. METHODS: In this model, the system consisted of two opposing players: the defender and the dribbler. If the two players have the same ability to move from a rest state, the defender can computationally guard against the dribbler because the defender moves shorter distances than the dribbler. To allow the dribbler to win, we then assumed that the dribbler could only observe the defender's preparatory body state in which the subsequent defender's movement acceleration randomly decreases (0: maximum decrease, 1: no decrease). For the cognitive models, we proposed the state feedback strategies (Fig. 1), which determine the desired acceleration according to the state spaces (Pdiff: difference in position, Vdiff: difference in velocity between them). The black areas indicate where the defender can be computationally penetrated. Thus, both players move at maximal speed. In the defender's white area, the defender moves according to the Vdiff. In the dribbler's gray area, if the defender's preparatory state is lower, the dribbler will move at maximal speed, but if not or in the white area, the dribbler moves at a relatively slower feinting speed. We assumed no delay except for the defender's first action from the dribbler's (termed tau). We investigated the effects of the defender's tau and the dribbler's decision threshold of the defender's preparatory state (0: always at feinting speed, 1: always at maximal speed) on the dribbler's winning probability (whether Pdiff exceeds a threshold or not). RESULTS: The results of the simulation demonstrated that as tau increased, the dribbler's winning probability increased. Similarly, as the dribbler's decision threshold was increased, the dribbler's winning probability increased. Although the former is supposed to be obvious, the latter does not necessarily apply to an actual 1-on-1 competition because in actual motion measurement, the dribbler does not always move at maximum speed. CONCLUSIONS: This study is the first step in understanding interpersonal competitive dynamics in a ballgame. These findings will provide greater insights into understanding performance improvement, impairment of motor function, and its recovery in rehabilitation, robotics, and sports.

P2-Q-89 An attempt to model postural sway as a relaxation oscillator.

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BACKGROUND AND AIM: Sagittal postural low-amplitude sway occurs continuously during quiet stance. It develops spontaneously in a pseudo-random way on both sides of the usual posture of the subject. The neuro- biomechanics of the sways could be defined by the realistic anthropometric implementation of a theoretical inverted pendulum. In usual cases when the intrinsic triceps surae musculotendinous stiffness (KAG) is lower than the gravitational equivalent stiffness (KG), the model triggers a repetitive activation of the ankle muscles around the antigravity tonus mean value. The sway analysis of real subjects confirms this inference. It particularly shows that both the Center of Pressure (COP) and the sway velocity evolve in between their higher and lower extreme values. We demonstrate by the implementation of plausible dynamic equilibrium equations of the inverted pendulum that a postural position controlled by repeated energy relaxation simulates fictive sways of COP and Center of Mass (COM) which are not statistically different from natural sways. The model is simple and robust. Neurophysiological correlations should be considered based on the current research literature. METHOD: The postural analysis of 5 young adult students has allowed to refine the parameters of our model. We gathered the following parameters: COP sways with a force platform; COM sways with an electromagnetic transducer (Flock of bird®) located on the back of the subject at the theoretical position of the gravity center (0.55 H); the soleus EMGs with skin electrodes. Our numerical simulation of the postural control is based on the relaxation process of non-linear oscillators according to the Van der Pol equation. This type of oscillator is usually characterized by transfers of energy beyond thresholds with

hysteresis. The modeled system variables (fig. 1) are: the height of the subject, their weight, KAG, viscous damping, the position and speed thresholds, the initial conditions, the time of analysis, etc. In the case of KAG < KG, an additional torque is created at one of the thresholds (internal soleus stretching of the Achilles tendon). The digital differential equations are solved using the Runge Kutta method with a suitable integration step. RESULTS: Observed simulations produce spontaneously random COP and COM profiles, within statistical limits without resorting to noise. Sustained oscillations and their pseudo-stochastic nature remained regardless of the sign of the KG -KAG inequality which proves the robustness of the model. The spatial, temporal and frequency signal characteristics are comparable to those obtained by experimentation. CONCLUSIONS: The relaxation oscillator model reflects the Human quiet stance by simulating alternating angular fall and uprighting of the COM. These episodes triggered by the string of thresholds can be programmed in anticipation on the sways that will be generated. The model is consistent with experimental observation.

P2-R-100 Upright standing after stroke: the non paretic leg pilots the postural stabilization

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BACKGROUND AND AIM- The erect stance is normally controlled by an ankle strategy on the anteroposterior (AP) axis and a hip strategy on the mediolateral (ML) axis. In hemiparetics the sensorimotor deficits are greater at the caudal than at the proximal parts of limbs. This might favor a predominant hip strategy for postural stabilization on the AP axis. Or alternatively a whole control from the non paretic lower limb. METHODS- We used a dual force platform to carried out posturographic assessments in 30 hemiparetics (60.1 ± 14.7 years, 22M/8F; 92.0 ± 48 days after a left [20] or a right [10] hemisphere stroke) and 30 matched healthy controls. To get similar weight-bearing asymmetries, hemiparetics were required to adopt a spontaneous and comfortable stance (63.0 ± 11.3% of body weight over the non paretic limb) whereas controls were required to stand asymmetrically (65.7 ± 3.0%). Original indices ranging from 0 to 1 were calculated to analyze ankle and hip contribution to the postural stabilization. Clinical deficits were precisely assessed. RESULTS- Along the ML axis, the hip contribution was very high and similar in Hemiparetics and in Controls (0.80 ± 0.07 vs 0.76 ± 0.09 a.u; $p>0.05$), indicating a predominant hip strategy. Along the AP axis, the ankle contribution was very close to 1 in controls (0.96 ± 0.03 a.u.; range 0.87-1.00) meaning an exclusive ankle strategy. Although a lower ankle involvement was found in Hemiparetics (0.88 ± 0.11 a.u.; $p<0.01$), the indices were surprisingly always above 0.5 (0.53-0.98), meaning that movements generated from the ankles remained predominant to control postural sways on the AP axis, in all patients even those with severe clinical deficits. However best ankle contribution were found in patients with no or light deficits of the motor command ($r=-0.513$; $p<0.01$) or pressure sensitivity ($r=-0.532$; $p<0.01$). CONCLUSIONS- Our study reveals that AP postural stabilization of standing hemiparetics remains controlled by an ankle strategy, even in patients combining poor distal motor command and deep sensory loss. An ankle strategy piloted by the non-paretic limb is preferred to a predominant hip control through lateral trunk motion. This should be considered when defining the objectives of the postural rehabilitation after stroke.

P2-R-101 Characterization and early detection of balance and gait deficits in Fragile X premutation carriers with and without fragile X-associated tremor/ataxia syndrome (FXTAS)

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BACKGROUND and AIM: FXTAS results from a "premutation" size 55-200 CGG repeat expansion in the fragile X mental retardation 1 (FMR1) gene. Core motor features include cerebellar gait ataxia and kinetic tremor, resulting in progressive disability. There are no studies describing gait deficits and only a few investigating balance in FXTAS patients. Our aims were to characterize balance and gait deficits in FXTAS and provide early identification of balance and gait markers in premutation (PM) carriers at risk for FXTAS. METHODS: Computerized dynamic posturography (CDP) was performed in 44 PM carriers, 21 with FXTAS (mean age 68.3 ± 2.1) and 23 without FXTAS (mean age 52.5 ± 2.6), to investigate balance in this population compared to 44 healthy controls (mean age 56.8 ± 2.0). CDP tests included the sensory organization test (SOT), the motor control test (MCT), and the limits of stability (LOS) test. Relationships between FMR1 molecular variables, age, sex, and CDP scores were explored. Gait and functional mobility analysis was performed using an inertial sensor based instrumented 7M Timed Up and Go (i-TUG) test across six trials. RESULTS: PM carriers with FXTAS demonstrated significantly greater postural sway on all SOT conditions, longer MCT response latencies on platform translations, and reduced distances to reach targets and directional control in the LOS test compared to controls, adjusted for age ($p = .03$ to $< .001$). PM carriers without FXTAS also demonstrated significantly delayed response latencies ($p < .005$) and disrupted sensory weighting for balance control ($p = .02$). Advancing age, male sex, increased CGG repeat size and reduced X activation of the normal allele in women predicted balance dysfunction in carriers. FXTAS patients (n=5) demonstrated significantly longer i-TUG durations, increased double support and stance time, reduced cadence, stride velocities and lengths, and slower leg swing velocities compared to controls ($p = .02$ to $< .0005$). They also demonstrated reduced turn and turn to sit velocities and increased turn to sit duration ($p < .016$). Gait variability was significantly greater in FXTAS patients than controls for stride lengths and velocities, cadence, percent swing time, swing velocities, and trunk ROM ($p= .014$ to $.001$). PM carriers without FXTAS (n= 7) had significantly longer i-TUG durations and increased stance and double support times ($p < .05$) compared to age matched controls. CONCLUSIONS: PM carriers with FXTAS and a subset of carriers without FXTAS demonstrated lower balance scores, reduced functional mobility and signs of gait instability compared to controls, and advancing age, male sex, and FMR1 genetic variables interacted to mediate the balance impairments. These findings suggest that CDP and the i-TUG may provide sensitive measures to detect preclinical

disease and to better characterize balance and gait impairments in FXTAS, advancing our understanding of risk factor profiles for FXTAS

P2-R-102 Does inconsistency in attentional control predict gait variability in Parkinson's disease?

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Background: Due to basal ganglia dysfunction, and consequently decreased movement automaticity, individuals with Parkinson's disease (PD) are highly susceptible to the effects of dual-tasking when walking. The increased variability in gait, identified when individuals with PD perform a dual task is often attributed to the inability to share attentional resources between gait and the secondary task. However, an alternative explanation may be that inconsistency in attentional control could result in greater gait variability in individuals with PD. Thus, it may be expected that attentional control might predict movement variability in PD. Aim: The aim of the present study was to investigate whether deficits in attentional control can predict variability in gait of individuals with PD during single and dual task walking. In order to achieve this goal, variability in simple and choice reaction time was used as a measure of attentional control. Methods: Sixty-eight individuals with PD walked a 10-meter long Zeno® carpet under single and dual task conditions (6 trials total). In the single task condition participants were instructed to walk at their normal pace, while in the dual task condition they were instructed to walk and count how many times they heard two pre-assigned digits (e.g. 4 and 2) from an audio track. Later, participants also performed a simple and a choice reaction time task. Intra-individual variability was calculated for reaction time as well as gait parameters thought to be sensitive to dual task interference (step length, step time, step width, and stride velocity). In order to control for movement slowness, coefficient of variation was used for all measures. Correlation analyses using stepwise linear regression reflected whether variability in reaction time was associated with variability in gait parameters during single and dual task conditions. In addition, age and disease severity (UDPRS III) were forced into the model, since these factors might contribute to variability in both gait and reaction time measures. Results: For the single task condition, variability in choice reaction time and disease severity were predictors of variability in step length ($R2=0.18$) and stride velocity ($R2=0.21$), while only variability in choice reaction time was a predictor of step time variability ($R2=0.16$). For the dual task condition, variability in choice reaction time was the sole predictor of variability in step length ($R2=0.14$), step time ($R2=0.17$), and stride velocity ($R2=0.22$). Variability in simple reaction time did not predict gait variability in either single task or dual task walking conditions. Conclusions: These results suggest that while the severity of motor symptoms and attention regulation play a role in gait variability during single task performance, gait variability during the dual task is mainly associated with inconsistency in attention control.

P2-R-103 The effect of dual task training in patients with Parkinson's disease: preliminary results of the DUALITY study

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BACKGROUND AND AIM: In people with Parkinson's disease (PD), gait and cognitive performance deteriorate during dual tasking. Aim of this study is to test the effect of two dual task (DT) training strategies on DT gait performance in PD. Because of tester blinding, pooled effects of both interventions are presented. By June, tests will be finished and unblinded results for the complete dataset (N=120) will be available. METHODS: Participants with PD (H&Y II-III) were included as part of the DUALITY study. Subjects were randomly allocated to a consecutive task training group in which tasks were trained separately or to an integrated task training group where tasks were trained simultaneously. Patients received six weeks of training, twice a week under supervision of a physiotherapist and twice a week without supervision. Both interventions comprised gait, cognitive and functional training. Testing took place at four time points: at baseline (T1), after 6 weeks control period (T2), 6 weeks of intervention (T3) and 12 weeks of follow-up (T4). Gait velocity, cadence and step length (GAITRite) were assessed in single task [ST] condition, with a trained secondary task (backwards Digit Span task [Digit]) and during untrained dual tasks (auditory Stroop task [Stroop], Mobile Phone task [MPT]). Falls were recorded weekly for the entire study period. Up till now, 98 participants finished the complete protocol and were included in the analyses using a linear mixed model with Bonferroni post-hoc testing. RESULTS: Gait performance remained largely stable between the first two tests before the intervention (T1vsT2). After DT training, gait velocity, cadence and step length improved for both ST and DT assessments. Significant improvements were found in ST and trained DT condition when comparing T1 versus T3 (ST velocity 6.71%, cadence 2.05%, step length 4.47%; DIGIT velocity 12.8%, cadence 6.46%, step length 5.85%). Most strikingly these results were replicated during untrained tasks (STROOP velocity 13.32%, cadence 5.66%, step length 7.33%; MPT velocity 11.39%, cadence 5.38%, step length 6.11%). Similar results were found when comparing T2 versus T3. Cadence however did not improve consistently in ST and MPT condition. Training effects were maintained at follow-up (T3vsT4). In the six weeks prior to intervention 125 falls were reported. Fall frequency decreased to 110 events during the intervention period. In the six weeks immediately after intervention fall rate decreased to 98. In the last six weeks of follow-up, fall rate increased again to 131 falls. CONCLUSIONS: DT training in people with PD has a positive and long-lasting effect on gait in ST and DT conditions and generalizes to untrained functional dual tasks. Furthermore, DT training does not increase fall risk and appears to be a safe intervention, contrary to common advice. At present, due to tester blinding, it is still unclear which training regime is most effective in achieving these outcomes.

P2-R-104 The effect of wearing sensors continuously over 12 weeks on health-related quality of life in patients with Parkinson?s disease

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BACKGROUND AND AIM: There is growing interest from patients, clinicians and scientists in objective and continuous assessment of health-related outcomes. Wearing body fixed sensors continuously 24/7 provides objective and unbiased movement data. However the impact of using these techniques on the perceived health-related quality of life (HRQoL) has, to the best of our knowledge, not yet been investigated. METHODS: We assessed 11 PD patients wearing a sensor system (S-PD; three sensors during the day - ankle, lower back, wrist - and one sensor at the lower back at night), and 11 PD patients without a sensor system (NS-PD), in a multi-center study (SENSE-PARK, www.sense-park.eu; Tübingen, Germany; Lisbon, Portugal; Tromsø, Norway). The sensors were continuously worn for 12 weeks, and users received feedback about specific movement patterns. HRQoL was assessed at baseline (V1), at the end of the assessment period (V2), and two weeks after (V3), using the Parkinson's Disease Questionnaire 39 (PDQ-39) summary index (PDQ-39 SI) and the individual sub scores (mobility, Activities of daily living - ADL, emotional wellbeing, stigma, social support, cognition, communication, and physical dysfunction). Paired t-test was used to test significance between visits, and unpaired t-test to test the delta values between the cohorts. RESULTS: Neither S-PD nor NS-PD patients showed significant changes of the PDQ-39 SI between V1, V2 and V3. However, the PDQ-39 mobility and ADL sub-scores showed specific changes in the S-PD cohort that were not observed in the NS-PD cohort. In S-PD, the PDQ-39 mobility sub-score showed a trend towards improvement from V1 to V2 (p=0.12) that reached significance at V3 (V1 vs. V3, p=0.046). This was not the case in NS-PD (p=0.69 and 0.32, resp.). Delta V1-V2 between S-PD and NS-PD approached significance (S-PD, 4.77 points; NS-PD, -5.00 points; p=0.08), Delta V1-V3 was significantly different (S-PD, 4.77 points; NS-PD, -2.92 points; p=0.04). In S-PD, the PDQ-39 ADL sub-score showed a trend towards improvement from V1 to V2 (p=0.08) and from V1 to V3 (p=0.06). This was not the case in NS-PD (p=0.92 and 0.51, resp.). Delta values of the PDQ-39 ADL subs-cores between cohorts were not significantly different. CONCLUSION: Our results argue for a positive influence of domestic-used wearable technique on HRQoL in PD patients. We hypothesize that collecting and seeing such movement data give people the feeling to have more control over the condition, which can, in turn, improve specific HRQoL aspects.

P2-R-105 Imaging of the cerebral orthostatic tremor network during stance

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BACKGROUND AND AIM: Primary orthostatic tremor (OT) is a rare neurological disease of unknown pathophysiology characterized by a high frequency tremor mainly of the legs when standing. The aim of the present study was to depict the cerebral tremor network in OT by during standing. METHODS: Ten patients (mean age 58±12y) with neuro-physiologically proven OT (EMG, posturography) and ten age-matched healthy controls were included in the study. All subjects underwent a [18F]-FDG-PET paradigm during real standing (i.e. injection of [18F]-FDG during upright stance for 10min, PET scan 30min p.i.). As a control condition in a second session a PET was acquired after injection of [18F]-FDG in lying position. PET images were processed by SPM8 software and compared between groups and conditions. RESULTS: All patients but no control subject showed a characteristic high-frequency peak at 12-16Hz in posturography. In healthy subjects the regional cerebral glucose metabolism (rCGM) during standing compared to lying was increased in the vermal cerebellum, thalamus and primary motor region. During standing, OT patients had a relatively increased rCGM in the cerebellum (including the dentate nucleus), the ventrointermediate nucleus of the thalamus and the primary and supplementary motor cortex bilaterally in comparison to the control group. A relatively decreased rCGM was found in the mesiofrontal cortical areas in OT patients during standing. CONCLUSIONS: In the present study a cerebello-thalamo-cortical tremor network is depicted in a group of OT patients using [18F]-FDG-PET during standing. The data strongly reinforce the idea that the ventrointermediate nucleus of the thalamus may be a therapeutic target for deep brain stimulation in OT.

P2-R-90 Longitudinal balance changes in patients with relapsing-remitting multiple sclerosis: Disease progression and confirming subjective assessments

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Background and aims: Balance impairment is one of the most prominent symptoms in multiple sclerosis (MS). Most MS patients accumulate central nervous system damage, thereby increasing their degree of disability. However, it is unknown to what extent balance impairment in MS changes over time and if these changes correlate with subjective feelings of vertigo and walking ability. Our primary objective was to track longitudinally changes in balance during stance and gait in order to determine whether these changes can serve as an objective marker of disability in MS trials. Our secondary objective was to determine if balance measures are related to patients' subjective impressions of their balance and gait capabilities. Methods: 16 Relapsing-Remitting MS (RRMS) patients (mean age 42 years, range 27-58; 10 female) have been recruited to date and tested once every 3 months (3x) over 6 months. Two patients, who had a relapse during this time and had significantly different balance measures, were analysed separately. To monitor disease progression, the Extended Disability Status Scale (EDSS) was used. Balance changes were determined by measuring peak-to-peak trunk sway angles and velocities (pitch and roll) with body-worn motion sensors during 6 stance tasks and 8 gait tasks. Subjective balance and gait deficits were assessed using the Dizziness Handicap Inventory (DHI) and the MS Walking Scale (MSWS-12). A linear mixed model and Spearman correlation analysis were used for analysis. Results: Over time patients showed no mean changes in EDSS, DHI and MSWS-12 scores with DHI scores showing the least stability. Likewise most balance measures were stable ($p>0.1$), particularly 2-legged eyes closed stance tasks. The exceptions were 1-legged stance tests eyes open on a normal surface and foam and walking 8m eyes closed which showed greater roll and pitch angles over time. In contrast, the tandem gait and walking on heels tests had reduced trunk sway over time ($p<0.05$). The balance measures of relapse patients showed a significantly greater trunk sway than the other MS patients. EDSS, DHI and MSWS-12 values were correlated with each other and best correlated with pitch angles for 1 and 2-legged stance tasks on foam support. Conclusions: The separation of balance values of relapse patients in comparison to stable RRMS patients, the slow worsening of balance for 1-legged stance tasks in stable patients, the strong correlations of balance measures with EDSS scores, and the correlations with subjective assessments in DHI and MSWS-12 questionnaires suggests that balance measures can serve as an objective and subjective marker of disability in MS trials for treatment protocols. The unexpected improvement in tandem gait with eyes open and walking 3m on heels which are commonly tested in the clinic suggests that practice may mask worsening balance for some tasks, and this needs to be taken into account in treatment protocols.

P2-R-91 Effects of disease severity and medication state on postural control asymmetry of challenging postural tasks in people with Parkinson's disease

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BACKGROUND AND AIM: People with Parkinson's disease (PD) are asymmetric on postural control during simple bipedal standing tasks [1-2]. In this condition, disease severity and medication does not seem to influence on postural control asymmetry in people with PD [1-2]. However, Boonstra et al. [3] indicated that depletion of levodopa increases postural control asymmetry in people with PD during postural tasks with perturbation in the sagittal plane. In our previous study, we found that challenging postural tasks increase asymmetry in people with PD [4], which makes us to question the effects of disease severity and medication state on postural control asymmetry in challenging tasks. Therefore, the aim of this study was to investigate the effects of disease severity and medication state on postural control asymmetry in challenging tasks of people with PD. METHODS: Nineteen people with PD and 11 neurological healthy individuals performed three 30s trials of standing tasks: bipedal standing, tandem adapted standing and unipedal standing. The people with PD performed the tasks in ON and OFF medication state. The people with PD were distributed in two groups according to disease severity:

unilateral group (n=8:H&Y 1 to 1.5) and bilateral group (n=11:H&Y 2 to 3). Two force plates (200Hz) were used to analyze postural control. The order of each block of trials was bipedal standing first (condition a), tandem adapted standing second (condition b) and unipedal standing last (condition c). The symmetric index [5] was calculated for following parameters of center of pressure: total displacement of sway, mean velocity, area and root mean square (RMS). Anova one-way (group) and two-way (PD groups x medication), with repeated measure for medication, were calculated. RESULTS: Bilateral group showed higher asymmetry of area in tandem adapted standing and RMS in both directions (AP and ML) in unipedal standing than control group (Table 1). There were PD groups x medication interaction. Under effects from medication, unilateral group showed lower asymmetry of AP RMS and area than bilateral group in unipedal standing. In addition, unilateral group showed lower asymmetry of mean velocity, AP RMS and area in unipodal standing and of area in tandem adapted standing after medication dose. CONCLUSIONS: Postural control asymmetry on challenging postural tasks was dependent of disease severity and medication state in people with PD. Bilateral group showed higher postural control asymmetry than control group and unilateral group in challenging postural tasks. Finally, the medication dose was able to reduce postural control asymmetry of unilateral group in challenging postural tasks. REFERENCES 1-Beretta, V.S. et al. (2014) Plos One, Submitted. 2-Boonstra, T.A. et al. (2014) Plos One, 9: 1-12. 3-Geurts, A.C.H. et al. (2011) Gait Post, 24: 83-90. 4-Rocchi, L. et al. (2002) J Neurol Neurosurg Psychiatry, 73: 267-274. 5-Sadeghi, H. (2003) Gait Post, 17: 197-204.

P2-R-92 Freezing of gait in Parkinson's disease and the role of postural control impairments

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Background and aim: Patients with Parkinson's disease (PD) increasingly show postural control impairments with disease progression. Moreover, up to 80% of patients develops freezing of gait (FOG). Despite the fact that freezing is a predictor of falling, the relationship between a specific postural control deficit and FOG is unknown. Therefore, we investigated a number of postural control measures that could potentially discriminate between freezers and non-freezers in PD. Methods: 46 PD patients (H&Y 2-3) and 20 healthy controls were included. 14 patients were identified as freezer (FR) and 32 as non-freezer (NFR) based on the nFOGQ and verified by observations during examination. All groups were matched for age and PD subgroups for MDS-UPDRS III (OFF) scores and disease duration. The clinical Mini-BESTest (total and subscores) was used to assess static and dynamic balance. In addition, static balance was investigated by single leg stance (SLS) duration and sway parameters during SLS and double support tasks using the VICON 3D-motion analysis system and force plates. Double leg stance was captured for 20 seconds on a firm and foam surface and with eyes open and closed. Sway parameters of the center of pressure (COP) in both medio-lateral (ML) and anterior-posterior (AP) directions were investigated. Non-parametric statistics were used to compare Mini-BESTest scores and SLS durations.

One-way ANOVA was used to investigate postural sway parameters during single and double support conditions. Results: The total score on the Mini-BESTest tended to be (p=.061) lower in FRs compared to NFRs. More specifically, FRs showed worse scores in the domain of dynamic gait (p=.017) during; change in gait speed (p=.010), walking with pivot turns (p=.020) and the timed get up and go task (p=.048). Also, SLS duration was shorter in FRs for both disease-dominant and non-dominant legs (p=.046 & .019). Interestingly, AP-velocity of COP was decreased in FRs during SLS (p=.012 & .044) and during the foam-eyes-closed condition (p=.004), which implies less postural sway in FRs. Moreover, a similar trend for reduced sway parameters during the other double support conditions was apparent. In ML direction, no differences in postural sway were found between FRs and NFRs. Conclusion: These results indicate that the Mini-BESTest and SLS-duration are potential clinical instruments to discriminate between FRs and NFRs's postural capacity. Postural sway parameters revealed no clear relationship between postural instability and FOG. Though, the decreased AP-velocity of the COP could be interpreted as a reduced flexibility of FRs to respond to sudden changes in forward progression and explain why freezing may lead to falling. Whereas differences in postural sway between PD and HC are mostly found in ML direction, postural control impairments in the AP direction seem to be specific to FOG. However, tasks and outcome parameters should be refined to confirm this hypothesis.

P2-R-93 Locomotor deficits and their relation to balance confidence and perceived motor functioning in people with Parkinson's Disease

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BACKGROUND AND AIM. Gait and balance disturbances are common and important manifestations of idiopathic Parkinson's disease (PD). The aim of this study is to investigate the relationship between objective balance and gait deficits and the perceived balance confidence and motor functioning in everyday situations. METHODS. We tested 104 subjects with a diagnosis of idiopathic PDin their OFF (> 12h after last dose of levodopa) and ON states (1h after taking 1.25x of regular dose of levodopa). Subjects performed three trials of the instrumented stand and walk (ISAW) test, consisting of 30 quiet standing, gait initiation with the most affected leg, 7-m walk and 180° turn. The subjects wore 6 inertial sensors (MTX Xsens or Opals, APDM) on the wrists, ankles, sternum and lumbar area. Gait and balance measures were automatically computed using APDM Mobility Lab. Clinical assessment in the OFF state included UPDRS III (motor) and the 4-item subscore, PIGD (arising from a chair, standing posture, gait, and postural stability/pull test.). Subjects also completed the Activity-specific Balance Confidence (ABC) scale and the mobility domain of the Parkinson's Disease Questionnaire (PDQ-39, mobility). Spearman correlations were used to assess the absolute strength of association between measures. RESULTS. The participants self-reported balance confidence (ABC scale) and mobility (PDQ-39 Mobility) were significantly associated with pace-related gait measures and turning measures (Figure 1). Overall, the self-reported ratings were more strongly associated with participant's balance and gait in the OFF than in the ON state. Performance of turns was most strongly related to motor UPDRS and PIGD (turning peak velocity, duration, and number of steps: $|\rho|>0.44$). CONCLUSIONS. Turning measurements were the strongest predictors of motor functioning, as assessed with the UPDRS motor and PIGD sub-score, in people with PD. In addition to turning, gait speed and APA size were related to balance confidence and perceived motor functioning. The OFF state motor signs were the stronger predictors of balance confidence and perceived motor functioning. ACKNOWLEDGEMENTS. Supported by NIH grants: # 1 RC1 NS068678 and # UL1 RR0 Figure 1. Association of (A) ABC score, and (B) PDQ-39 mobility and mobility metrics in the OFF and ON states.

P2-R-94 Continuous Monitoring of Mobility in Huntington Disease Patients Using Inertial Sensors

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BACKGROUND: Current practice for motor symptoms assessment is a brief clinical evaluation performed by a neurologist every 3-6 months. Clinicians use momentary clinical rating scales. The value of these scales is limited because each patient's motor state varies throughout the day and can be altered by diet, activity, quality of sleep, or stress. The objective of this study is to explore the use of inertial sensors to provide objective measures of gait in individuals with Huntington disease (HD). We aim to evaluate the feasibility of using the sensors in the home with HD patients. METHODS: We conducted a single blind pilot study with 5 ambulatory HD subjects and 5 age and gender matched, healthy controls (CT). Subjects came to the clinic for a brief examination and completion of the Total Functional Capacity (TFC) sub-scale of the UHDRS. They performed a 2-minute walk with Opal monitors (APDM Inc.) attached to each foot. Following the clinical visit, subjects wore the monitors at home for 7 days during daily activities. Blinded investigators used the Opals' gyroscope and accelerometer data to characterize subjects' mobility. Periods of walking were identified and used to calculate gait metrics including: stride length (% of height) and velocity (%/s), step duration (s), double support time (% gait cycle), pitch at toe off and heel strike (deg), cadence (steps/m), and their daily variability. We used descriptive statistics and independent samples t-tests to compare gait metrics of he HD and CT subjects. RESULTS: Subjects were able to wear the sensors for a daily average of 10 hours. Blinded gait analysis correctly identified the HD and CT subjects for 4/5 pairs. Compared to CT, HD subjects displayed grater variability and decreased stride length (68.1±13.5, 53.0±15.3), reduced stride velocity (57.4±5.6, 45.1±6.3), shorter step duration (0.67±0.06, 0.65±0.10), and larger cadence (47.5±2.7, 50.0±5.1); all with $p < 0.05$. Compared to the short walk in the clinic, subjects walked slower in the home with increased double support time. Lower TFC scores correlated with greater variability in stride length ($\rho=-0.82$), pitch at toe off ($\rho=-0.80$), and increased double support time ($\rho=-0.75$). Higher chorea scores correlated significantly with lower stride

length (ρ=-0.76). Figure 1 shows HD Subjects (group B) have reduced stride length compared to their age-matched pairs (group A). CONCLUSIONS: It is feasible for HD patients to use movement monitors at home to collect objective gait data. Objective metrics distinguished gait characteristics in people with HD from the CT subjects. Compared to gait metrics in the home, gait in the clinic does not adequately reflect mobility in daily life. Objective gait metrics are closely related to subjects' clinical scores.

P2-R-95 Accelerometer Cut Points for Physical Activity Assessment of Older Adults with Parkinson's Disease

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BACKGROUND AND AIM: For cross-sectional or longitudinal measurement of PA, an objective measure such as accelerometry is preferred over more subjective measures. To approximate intensity from accelerometry data in specific populations, the accelerometer must be calibrated, e.g. by deriving cut-points for the population at hand. Symptoms of Parkinson's disease (PD) alter gait patterns, with the consequence that intensity cut points derived from a healthy population may not be valid for older adults with PD. According to our knowledge, so far no accelerometer has been calibrated for older adults with PD. Hence, the aim of this study was to define accelerometer cut points for different walking speeds in older adults with mild to moderate PD. METHODS: A volunteer sample of 30 older adults (mean age 73; SD 5.4 years) with mild to moderate PD was recruited via advertisement through patient organizations and local clinics. The participants walked at self-defined brisk, normal, and slow speeds for three minutes in a circular indoor hallway, each wearing an accelerometer around the waist. Walking speed was calculated and used as a reference measure. Participants were randomly separated into a calibration (two-thirds) and cross-validation sample (one-third). Through ROC analysis, accelerometer cut points in counts per 15 seconds in the vertical axis and vector magnitude for different levels of walking speed were generated in the calibration sample, and the level of agreement between true and cut point-predicted walking speeds in the cross-validation sample was tested using a quadratic weighted Cohen's Kappa. RESULTS: Optimal cut points for walking speeds ≤ 1.0 m/s were ≤ 396 and ≤ 425 counts/15 sec; for speeds > 1.3 m/s, they were ≥ 681 and ≥ 839 counts/15 sec for the vertical axis and vector magnitude, respectively. Sensitivity and specificity were 61%-100% for the developed cut points. Significant differences ($p < 0.05$) were found between counts for all walking speeds. The quadratic weighted Kappa showed substantial agreement: $\kappa = 0.74$ (95% CI 0.53-0.95). CONCLUSIONS: This study provides accelerometer cut points based on walking speed for physical activity measurement in older adults with PD for use in intervention evaluations and when investigating links between physical activity and health.

P2-R-96 Effect of Deep Brain Stimulation on Gait in Parkinson's Disease

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Background and Aim: Gait impairments are a hallmark symptom of PD often contributing to patient falls and reducing quality of life. Specifically, it remains unclear whether PD gait improves or worsens with DBS intervention over a long-term. Currently gait changes are monitored using the Unified Parkinsons Disease Rating Scale, which is subjective and qualitative in nature. An objective and quantitative assessment of gait, using kinematic technology, will allow the clinician to more effectively determine whether gait is affected by DBS. Kinematic sensor technologies that are targeted to specifically studying gait are a new avenue being explored to monitor the gait changes with DBS. The goal of the present study is to assess the progression of gait changes, following DBS intervention, over a year long period using kinematically based gait measures. Methods: PD patients undergoing bilateral STN-DBS alongside healthy age-matched controls will be used in the study. The patients will be recruited from the Movement Disorder Clinic at the University Hospital in London, Ontario. Patients are assessed one week pre-operatively and then up to one year post-operatively. During each programming visit the patient is monitored by a clinician, and their device is adjusted if required (Changing: voltage, frequency, pulse width). The patients gait is captured using the PKMAS gait analysis carpet. The carpet assesses various aspects of gait, including: stride length, stride width, gait cycle, center of mass/pressure and single/double support time. The study has been approved by the university ethics committee and each participant has signed informed consent. Results: 3 bilateral STN-DBS patients have completed the one year study and there are 11 active patients in the study. 7 of the total patients have completed the 6 month session. Preliminary data has shown an improvement in important areas of gait performance up to 6 months post-operatively. Stride length (Pre-op: M=94.56 cm, 6 months: M=113.32 cm) and step length (Pre-op: M=47.53 cm, 6 months: M=59.89 cm) both increased from pre-operative baseline. Gait cycle is a measure of time from when one foot touches the ground to when the same foot touches the ground again. Gait cycle improved from PD pre-operative baseline (Pre-op: M=1.11 sec, 6 months: M=1.04 sec). Double support time decreased from Pd pre-operative baseline (Pre-op: M=.30 sec, 6 months: .26 sec), which better represents control data (M=.28 sec). Conclusions: Preliminary data analysis suggests DBS intervention may improve gait over a 6 month period post-operatively. Further analysis, up to 1 year post-operation, will better elucidate the long-term efficacy of DBS intervention on gait. Our method provides the first objective and quantitative measure of long-term gait variances in PD patients undergoing DBS treatment.

P2-R-97 Static sway in prodromal Parkinson´s Disease: Longitudinal data from seven converters

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BACKGROUND AND AIM: Quantitative assessment of prodromal signs of Parkinson's disease (PD) may be the key to eventually enable diagnosis earlier as it is currently possible. Recent observations show that postural deficits may occur even before clinical diagnosis of PD can be made. Therefore, we hypothesized that PD converters show an altered sway pattern prior to diagnosis. METHODS: In the frame of the TREND study (Tübinger evaluation of Risk factors for Early detection of NeuroDegeneration, www.trend-studie.de), 1100 older adults with and without risk factors for PD are assessed biannually. During the first four years of observation, seven participants developed PD. All of them underwent a static sway assessment 0.5 to 2 years prior to diagnosis. Two of them underwent an additional assessment 3.5 years prior to diagnosis. Static sway was assessed for 30 seconds on a foam in semitandem stance under eyes closed condition. During the task, participants wore the Dynaport sensor (McRoberts) at the lower back. Area of sway, velocity, acceleration, JERK and mean power frequency (MPF) of sway were extracted, and compared to controls (N=322) and PD patients without any clinical evidence for postural deficits (N=35). Due to the currently available number of PD converters, data will be reported descriptively. RESULTS: The investigated quantitative sway parameters did not show a uniform "development" from prodromal PD to PD. Some parameters of the PD converters were between the mean values of the control cohort and the PD cohort (e.g. area of sway and acceleration), some were comparable between all three cohorts (e.g. velocity), some showed a U-shaped behavior (e.g. MPF and JERK, with higher values in PD converters, and an increase into direction of clinical diagnosis). Differences of of JERK, acceleration and area of sway were more pronounced in the anterioposterior than in the mediolateral direction. CONCLUSION: This - to the best of our knowledge, first - longitudinal quantitative analysis of static sway in prodromal PD suggests that the sway measures do not show uniform changes over time but "behave" differently in this preclinical phase. Some changes seem to be linear, some U-shaped, and some measures may not relevantly change during this period. The aim of future analyses should therefore be to identify specific patterns of changes of the sway parameters in this preclinical phase, to potentially add to a marker panel for the definition of prodromal PD.

P2-R-98 Establishing Disease Severity of Cervical Spondylotic Myelopathy through Novel Sensitive Gait Assessments

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INTRODUCTION: Disrupted locomotion plays a significant role in the disability of individuals with cervical spondylotic myelopathy (CSM), more so as the disease progresses. Current gait assessments fail to demonstrate sensitivity of subtle gait changes in CSM. The purpose of this study is to define the significance of using spatio-temporal gait parameters in the assessment of the CSM population, to define severity of disease particularly in the earliest stages and to measure change in the natural history of the disease and most importantly assess change secondary to intervention. Objectives: To characterize disrupted locomotion using spatio-temporal parameters by defining the parameters of gait that differentiate degrees of severity, most useful in early detection of CSM and subtle changes in gait impairment. METHODS: A prospective observational cross sectional study (n=90) was conducted; including patients with a diagnosis of CSM (positive MRI for spinal cord compression, 1 clinical symptom and 1 neurological sign). GAITRite walkway analysis, Modified Japanese Orthopaedic Association Assessment (mJOA) and the Berg Balance Scale were administered. Analysis: Paired T-tests were used to compare the study sub-groups to a control group and discriminant functional analysis was used to define the most significant parameters in creating a general gait profile for CSM. RESULTS: Velocity, stride length, base of support and double support, instability ratio, stride length SD, single stance time SD and double stance time SD are spatio-temporal parameters that detect very early changes in disruption of the gait pattern ($p<0.05$), prior to any other detectable gait impairment. As severity increases to moderate or severe, cadence, single and double stance time, and variability in stepping show significant ($p<0.05$) differences from normative values. CONCLUSIONS: Gait impairment in mild CSM is not obvious from observation alone. With gait analysis certain spatio-temporal parameters are useful in detecting differences that can applied longitudinally while others are more discriminant among a cross sectional sample. Velocity, stride length, base of support and double stance time are more useful as parameters for measurement longitudinally as the values of mild patients remain in the normative range. Whereas the instability ratio, stride length SD and single stance time SD are useful for discrimination among groups when detecting even the most subtle differences, the values are not within normative range. Current clinical tests of gait do not detect or quantify early signs of CSM. This work identifies the spatio-temporal parameters that are sensitive to gait impairment specific to CSM. Gait analysis shows utility in detecting subtle differences, thus useful when measuring efficacy of new therapeutics and early detection of disease. This measurement capability provides insights for clinical-decision making.

P2-R-99 Insights into freezing of gait mechanisms from walking through a doorway and turning

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Background. Freezing of Gait (FoG) in people with Parkinson's disease (PD) is an environmentally sensitive, intermittent problem that occurs most often during turning, gait initiation, and passing through doorways. Due to its intermittent nature, this phenomenon has been difficult to study in the laboratory, and its pathophysiology is still controversial. Aim. To characterize the muscle activations and movements prior to, and during, FoG to gain a better understanding of the neural control mechanisms responsible. Methods. Five subjects with idiopathic PD who have a clinical history of FoG (FoG+, UPDRS III: 51±13) and 5 idiopathic PD without FoG (FoG-, UPDRS III: 40±16) walked an assessment course with gait initiation, passes through a doorway, and 180° turns while wearing 3 Opal inertial sensors (APDM) mounted on the posterior trunk and on each ankle, and wireless EMG (Cometa) bilaterally on the tibialis anterior (TA), gastrocnemius medialis (GM) and at the hip on the tensor fasciae latae (TFL). Heel-strike (Hs) and toe-off (To) events for each right and left steps were extracted from the shank angular velocities. EMG signals were collected at 2000 Hz, then rectified and low-pass filtered (20 Hz) to obtain the linear envelope, and expressed as a percentage of gait cycle. The following variables were computed for the overall course: FoG ratio (power spectral density ratio between high and low frequencies of shank acceleration) and gait speed. Onset of activity from Hs for the TA, GM, and contralateral TFL, offset of activity for the ipsilateral TFL from Hs and successive onset; as well as duration of activities in stance/swing were calculated for the 5 steps preceding a turn. Results. All the FoG+ showed freezing of gait during the assessment course. The FoG ratio was significantly higher in FoG+ compared to FoG- (1.25±0.3 vs 0.5±0.3, p=0.007) while gait speed, excluding turns, was similar (0.67m/s±0.23 vs 0.88m/s±0.13, p=0.11). In the steps before a turn with or without FoG, we observed that: i) the ipsilateral TFL offset and the controlateral TFL onset were similar across groups, whereas the subsequent ipsilateral TFL onset was later in the FoG+ for the step prior to a freezing episode; ii) the ipsilateral TFL activity was reduced during stance but increased during swing in FoG+; iii) the controlateral TFL activity was higher during stance and reduced during swing in FoG+. The medio-lateral acceleration traces were similar in amplitude, but less variable in FoG+. Conclusions. We observed increased ipsilateral TFL activity and reduced contralateral TFL activity in FoG+ compared to FoG-, suggesting a lack of release of APA inhibition and inadequate postural preparation for a step. These novel, preliminary findings suggest that abnormal temporal muscle activation patterns during FoG episodes are due to abnormal coupling of anticipatory postural adjustments with stepping rather than a disruption of central pattern generators.

P2-S-106 Factors affecting patient's ambulatory ability at discharge from an acute hospital in Japan following hip fracture surgery.

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1) Background and aim: It is known that the length of stay (LOS) in Japanese hospitals is much longer than that in hospitals in other countries. However, the increase in medical care costs due to an aging society has become a major social issue in recent years. The Japanese government has thus attempted to reduce LOS. Patients who need longer rehabilitations are moved to rehabilitation facilities; consequently, LOS in acute hospitals is reduced. Therefore, it is important to predict whether patients can be discharged directly to homes from an acute hospital. One of the discharge criteria is regained

ambulatory ability. The aim of this study was to identify factors associated with the ambulatory ability of hip fracture patients at discharge from an acute hospital. 2) Methods: Forty-seven consecutive patients aged 65 years and older admitted to a single general hospital in Japan between January and November 2014 with a hip fracture were prospectively assessed. Patient demographics, presence of complications, method of operation, nutritional status, presence of a certification of need, number of days from surgery to start of rehabilitation, preoperative mobility, cognitive function, lower-limb strength, and postoperative basic mobility were investigated. Differences between patients who regained ambulatory ability and those who did not at discharge from an acute hospital were examined by chi-square or independent t-tests. Statistically significant factors were entered into a logistic regression analysis. Significance was set at $P < 0.05$. All participants provided written informed consent. The relevant ethics committees of Tokyo Metropolitan University approved this study. 3) Results: There were 41 female and six male patients with a mean age of 82.9 ± 7.2 years (mean ± SD). The mean LOS was 37.2 ± 10.7 days. Age, with or without a certification of need, number of days from surgery to start of rehabilitation, preoperative mobility, cognitive function, lower-limb strength, and postoperative basic mobility were significantly different between the two groups ($P < 0.05$). Young age (OR = 0.6), good cognitive function (OR = 1.64), and early rehabilitation (OR = 0.41) were significant predictors for regaining ambulatory ability by discharge from an acute hospital. The accuracy rate was 95.7%. 4) Conclusion: This study shows that by evaluating three factors (age, cognitive function, and number of days from surgery to start of rehabilitation), ambulatory ability at discharge can be predicted with high accuracy. This highlights the importance of preventive rehabilitation and early rehabilitation. For patients who are not predicted to have regained ambulatory ability at discharge, LOS could be reduced through advanced preparation to move to a rehabilitation facility. Future research is needed to validate this model's generalizability and to determine effective interventions for patients who are not predicted to regain ambulatory ability by discharge.

P2-T-107 The influence of cutaneous afferent input from the foot sole and foot dorsum on ankle proprioception

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BACKGROUND AND AIM: In the upper limb, it has been shown that cutaneous input from fast adapting (FA) type II afferents can inhibit the transmission of sensory information from nearby regions (Bystrzycka et al 1977; Ferrington et al 1977). FAII input has also been found to interfere with proprioception at the index finger (Weerakkody et al 2007; 2009). It is unknown whether similar sensory interactions occur in the lower limb. The purpose of this study was to determine if cutaneous afferent input from different regions of the foot (heel, metatarsals, and dorsum) influences ankle proprioception. METHODS: Eleven subjects completed a passive joint matching task to assess ankle proprioception. Subjects were seated with eyes closed and feet strapped into two foot pedals. Each foot pedal could rotate into dorsiflexion (DF) and plantarflexion (PF) about an axis aligned with the malleoli. Using a servomotor, the left (target) ankle was passively rotated to one of 3 target angles (17° PF, 7° PF, and 7° DF) and held. The right (matching) ankle was then passively rotated until the subject perceived both ankles were aligned. To activate cutaneous afferents, vibration was applied to different regions of the target foot (heel, metatarsals, and dorsum) during the ramp up and hold phases. Two frequencies of vibration were used to target the activation of different cutaneous afferent populations at amplitudes approximately 3dB above perceptual threshold (FAI; 45 Hz, 80µm, FAII; 260 Hz, 10µm). Vibration was applied using custom-made vibration pads that were molded to the skin surface with silicone rubber. Background muscle activity was monitored and angular position was recorded using electrogoniometers attached across each ankle and potentiometers in each foot pedal. Outcome measures assessed were directional, absolute, and variable error. RESULTS: Preliminary results show vibration had no effect on directional, absolute, or variable error at any skin regions for all 3 target angles. Matching accuracy was lowest for the larger target angle (17° PF), shown by increased directional, absolute, and variable error. CONCLUSIONS: Unlike the upper limb, these results suggest low levels of cutaneous afferent input from the foot sole or dorsum do not interfere with proprioception at the ankle joint. These findings may be due to functional differences between the upper and lower limbs. Tactile sensation in the hand is necessary for fine manipulation of tools, whereas ankle proprioception is critical for locomotion and posture. It is possible that sensory interactions among proprioceptive inputs in the lower limb manifest with a greater cutaneous input relative to those found in the hand.

P2-T-108 Influence of cutaneous input of sole foot and visual information in dyslexic children to maintain postural stability.

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Background/aim: Dyslexic children show a deficit in postural stability. The aim of our study is to test the influence of the sole foot and of the visual information in dyslexic children. Methods: Postural stability was evaluated with TechnoConcept® platform in twenty-five dyslexic children (mean age: 9.3 ± 0.29 years) in two postural conditions (with and without foam: 4 mm under the feet) and two visual conditions (eyes open and eyes closed). We measured the surface, the length and the mean velocity of the center of pressure (CoP) and the Romberg Quotient. Results: All postural parameters (surface, length and mean velocity of CoP) with foam under the feet were significantly greater than without foam. Furthermore, with eyes closed, the length of the CoP was significantly longer with respect to eyes open condition. Finally, the Romberg Quotient was significantly greater without foam that with foam. Conclusions: All these findings suggested that both sensory inputs (sole foot and visual information) are involved in postural control. Dyslexic children, when inputs are less informative by the foam, are not able to compensate with other available inputs the maintaining of their postural stability efficiently. Interestingly, the change of the Romberg Quotient between the two conditions suggests a relationship between the cutaneous inputs of sole foot and the visual inputs. We suggest that a lacking of cerebellar integrations could be responsible of the postural deficits observed in dyslexic children.

P2-U-109 Dual tasking increases the risk of collisions during obstacle avoidance in individuals with post-stroke visuospatial neglect

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Walking in the community often involves performing concurrent tasks like planning, making lists or talking i.e. dual tasking. Such dual tasking is known to be challenging for post-stroke individuals. Whether visuospatial neglect (VSN), an attentional-perceptual deficit commonly observed after stroke, further alters walking abilities under dual task conditions remains unknown. In this study, we assessed the influence of a cognitive task on a locomotor task involving the avoidance of moving objects in persons with and without VSN.Methods: Twelve individuals with VSN (VSN%2B, n=6) and without VSN (VSN-, n=6) after a right cerebrovascular accident (RCVA) were tested in a virtual environment that included 3 obstacles, one of which approached head-on (HO), contralesionally (CL) or ipsilesionally (IL). The following conditions were tested:(1) walking towards a target while avoiding the obstacle (single task, ST-Walk), (2) obstacle avoidance while walking and performing an auditory pitch-discrimination task (dual task, DT-Walk) and (3) performing an auditory pitch-discrimination task while seated (ST-Cog). We compared performances under single and dual task conditions using locomotor measures (collision rate, walking speed) and cognitive measures (number of errors in discrimination task). Results: Compared to the ST-Walk condition, DT-Walk condition led to reduced walking speeds (10-13% reduction) for all obstacle approaches in VSN%2B individuals, as opposed to increased walking speeds (7-10% increase) in VSN- individuals. During ST-Walk, both VSN%2B and VSN- individuals collided with CL obstacles (n=3 in each group, 25-26% of trials) and HO obstacles (n=4 in each group, 31%-39% of trials). Number of colliders and collision rates increased during DT-Walk for VSN%2B individuals for the CL (n=6, 52±4% of trials) and HO obstacles (n=5, 33±13% of trials), while for the VSN- group the number of colliders and collision rate decreased for CL obstacle (n=0) and were maintained for HO obstacle (n=4, 31±13% of trials).Both groups made no errors in ST-Cog task. During DT-Walk, VSN%2B individuals made errors in the cognitive task for all obstacle approaches (39-47% of trials) while VSN- individuals only made errors during the CL condition (24% of trials). Conclusion: In VSN%2B individuals, alterations of both locomotor (increased collision rates) and cognitive task performances (more errors) when dual tasking suggests the presence of a cognitive-motor interference. Their slower walking speeds in DT-Walk could result from increased attentional load caused by the cognitive task, rather than representing a

collision avoidance strategy. VSN- individuals sped up and generally made fewer collisions in DT-Walk compared to ST-Walk, suggesting a prioritization of the locomotor task. Cognitive errors during the CL condition and collisions with CL and HO obstacles in the ST-Walk condition are suggestive of contralesional visuospatial inattention that is consistently observed after RCVA.

P2-U-110 Dual-task and task demand effects on sensorimotor coupling during postural control of young adults

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BACKGROUND AND AIM: Postural control involves the integration of sensory cues coming from several systems into appropriate motor activity. Several studies have showed that sensorimotor coupling in postural tasks has to be flexible to accommodate all the environmental changes, especially in more demanding tasks. Despite all the available recent knowledge, the attention requirements to perform postural tasks still need to be further understood. Therefore, the aim of this study was to examine the effects of a dual-task in the relationship between sensory information and body sway during postural control with different demands. METHODS: Thirty healthy young adults stood upright, as still as possible, inside of a moving room. Fifteen participants stood with parallel feet on a regular floor surface (easy-task group) and 15 participants stood with parallel feet on a wood surface (8 cm width), narrowing the support basis (hard-task group). All participants performed 8 trials, each with 60 seconds, with the room oscillating back and forth (sinusoidal movement), with amplitude of 0.6 cm and peak-to-peak velocity of 0.6 cm/s. In the first four trials, participants were not informed that the room was moving and in two of these trials, they had to count backwards from 100, with decrements of 3 (dual-task). In the last four trials, participants were informed about the movement of the room and that they had to resist to any visual effect on body sway. Once more, in two of these trials they had to perform the dual-task mentioned before. Body sway and moving room position were obtained through IREDs (OPTOTRAK, 3020) placed on the participant's back and on the moving room. Mean sway amplitude, coherence, gain, and phase variables were used to examine the performance of the postural control and the coupling between visual information and body sway. RESULTS: Body sway was larger for the hard-task group in all conditions, but it was reduced when participants were requested to resist to the moving room effect. Participants from both groups swayed coherently with the movement of the room in the first trials when they had no knowledge about the room movement. Coherence values for the hard-task group did not change after the request to resist to the room and when performing the dual-task. Differently, coherence values for the easy-task group were reduced after the request to resist to the room effect, but it increased when the dual-task was performed. Finally, the easy-task group swayed behind the movement of the room and the hard-task group swayed ahead of the room. CONCLUSIONS: These results suggest that task demand affects the coupling between visual information and body sway.

Information about the sensory manipulation can change the coupling between visual information and body sway, but only in less demanding tasks, and yet such change demands attention resources.

P2-U-111 Prior Athletic Training has No Effect on Alternate Foot placement During Planar Obstacle Avoidance

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BACKGROUND AND AIM: When undesirable landing areas (i.e. planar obstacles) present along the travel path during ambulation, modifications are made to the locomotor pattern to enable avoidance. These adjustments are based upon environmental demands and the capabilities of the individual. It was suggested by Gerin-Lajoie et al. (2007) that athletes process visuo-spatial information faster than the non-athletes, allowing them to perform better on a navigational task through a cluttered environment. Ballet is a form of specific training that develops strong perception-action coupling in addition to; fluid movement of joints, good coordination, and muscle tone (Federici et al., 2005). The current study assessed non-athletes and those with varying types of training to investigate whether training influences the maintenance of forward progression to stability in relation to alternate foot placement during planar obstacle avoidance. METHODS: The current study included; 1) Field Athletes having recent/current participation in a field sport (n=11, 22± 2.68 years), 2) individuals with previous/current ballet dance training (n=10, 21.1± 1.1 years), and 3) Non-Athletes had no previous participation in competitive organized sport in the past 5 years (n=12, 21.75± 1.54 years). The path was unconfined but defined by the start position of the participant and the goal (13m by 6m) to which they walked to at a comfortable pace. Planar obstacles (15cm wide x 70cm long rectangles) were projected ~8m from the start position. There was 48 randomized trials, 50% straight walk through and an even random distribution of: 1) Double obstacle at steady state (DSS) where both obstacles appeared after participants reached steady state (i.e. 3-4 steps from start); 2) Double obstacle appearance was delayed (DDEL) until participants were 2 steps away from the first obstacle (N-2); and 3) Single obstacle appearance (SIN) where the obstacle (at N) solely appeared when the participant was at N-2. RESULTS: All participants, regardless of training, stepped medially during SIN. Most participants (n=23) selected medial-medial avoidance during double obstacle avoidance and the rest were variable in behaviour. The variability of behaviour (computed as a coefficient of unalikeability (CV)) had significant moderate positive correlations with the minimum Dynamic Stability Margin at N-1 for DSS and DDEL ($r = 0.36$; $r = 0.44$, respectively, $p<0.001$). There was a significant weak positive relationship between CV and ML COM variability ($r = 0.28$, $p<0.05$) during DDEL. CONCLUSIONS: Greater ML COM variability leads to avoidance behaviour that weighs forward progression and stability with relative equity, as stepping medially perturbs the COM the least from its forward momentum but narrows the BOS creating instability that must be offset in the

following step. Avoidance of planar obstacles at a walk lacked context specificity, to dance or field sport training, to elicit any behavioural differences.

P2-U-112 Visual feedback from the foot is not important for determining foot placement accuracy when stepping in to a floor-based target

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BACKGROUND & AIM: Lower visual field information is used in an online manner to update foot placement and clearance when negotiating obstacles or descending a kerb [1,2], suggesting visual feedback of the lower limbs and/or the obstacle or kerb edge is important to such adaptive gait tasks. Here we explore the relative importance of visual feedback from the foot versus feedback from the environment being walked through. This was achieved by participants placing their lead foot into a floor-based target in darkness when either their leading or trailing foot or both feet were illuminated by LED strips. METHODS: Seventeen young adults were instructed to place their lead-limb foot in the centre of a floor-based rectangular target (length normalised to 150% of foot length) during overground gait. All trials were completed in darkness, with the target permanently illuminated by low illuminance red LED strips. LED strips were also attached to the external profile of the front portion of each shoe. Participants completed the trials with either; 1) the foot of the targeting limb illuminated, 2) the non-targeting limb illuminated; 3) both feet illuminated; 4) neither foot illuminated. Each condition was completed 10 times and repeated with both the dominant (D) and non-dominant (ND) limb as the targeting limb. ML and AP foot placement accuracy, foot reach kinematics and walking speed were determined across limb and vision conditions. Data were analysed using random effects modelling. RESULTS: Preliminary results suggest there were no significant main effects of vision condition for any variable measured ($p>0.28$). In contrast limb dominance had a significant effect on several parameters; ML foot placement was greater ($p=0.003$), terminal foot reach duration was reduced ($p=0.002$), and foot height at the instant immediately prior to making its final deliberate vertical trajectory deviation onto the target was lower ($p<0.001$) for the ND limb compared to the D limb. CONCLUSIONS: Findings suggest visual feedback of the foot was unimportant to foot placement accuracy and instead, that exproprioceptive information about the body (head) relative to the target was important [3], with a body schema used to guide the targeting limb's spatial orientation relative to the head [4]. The limb dominance effects suggest that the schema's spatial properties were expressed differently in the D and ND limbs. These findings appear to contradict previous research highlighting the importance of visual feedback of the lower limb in the control of adaptive gait. Perhaps the incomplete visual feedback regarding floor level meant exproprioception could not be contextualised in its customary global perspective and hence limb proprioception became more important. REFS: [1] Buckley et al. PLOS one.

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P2-U-113 Associations between measures of structural morphometry and the sit-to-stand-to-sit performance in individuals with non-specific low back pain and healthy controls

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BACKGROUND AND AIM So far, the majority of the structural brain imaging studies in non-specific low back pain (NSLBP) evaluated volumetric gray matter changes. Together, the majority of these alterations in NSLBP, either reduced or increased, are observed in areas related to sensorimotor control. These alterations are indicative of impaired sensorimotor performance. Individuals with NSLBP show an impaired sensorimotor control. They need significantly more time to perform five consecutive sit-to-stand-to-sit (STSTS) movements compared to healthy controls. This STSTS task necessitates optimal sensorimotor control, which requires an efficient processing of sensory and motor information across the brain. Although, it is suggested that specific measures such as cortical surface area and cortical thickness reflect a different underlying neural architecture, the literature regarding these measures in NSLBP is limited. The current study was designed to investigate the association between sensorimotor control, as measured by the STSTS performance, and cortical surface area and cortical thickness in individuals with NSLBP and healthy controls. METHODS Seventeen individuals with NSLBP and 17 healthy controls were instructed to perform five consecutive STSTS movements as fast as possible. Based on the center of pressure displacement, the total duration of the STSTS task was determined. In addition, T1-weighted anatomical scans of the brain (voxel size of 0.98x0.98x1.2 mm^3, repetition time of 9.6 ms, echo time of 4.6 ms, a flip angle of 8o, 182 coronal slices, field of view of 250x250x218 mm^3 and a matrix of 256x256 mm^2) were acquired and analyzed with the Freesurfer analysis suite. RESULTS Compared to healthy controls, individuals with NSLBP showed an impaired sensorimotor control, as inferred from an increased duration to perform five STSTS movements ($p= 0.002$). Furthermore, worse sensorimotor performance on unstable support surface was associated with decreased cortical surface area of the superior parietal cortex ($r= -0.52$, $p= 0.003$) and the frontal pole ($r= -0.48$, $p= 0.005$) in individuals with NSLBP and healthy controls. Moreover, worse performance of the STSTS task on stable support surface was correlated with cortical thinning of the rostral anterior cingulate cortex ($r= -0.54$, $p= 0.002$). Finally, increased measures of cortical thickness were associated with increased levels of pain intensity in the individuals with NSLBP ($p< 0.005$). CONCLUSIONS The current findings suggest that cortical surface area and cortical thickness show a distinct association with sensorimotor control in individuals with NSLBP and healthy controls. Furthermore, only measures of cortical thickness were associated with the parameters of pain intensity in the individuals with NSLBP. These findings emphasize the importance of evaluating these non-volumetric parameters next to cortical volume to provide a more complete understanding of sensorimotor control and NSLBP.

P2-U-114 The effect of self-induced head rotations on path trajectory in the absence of vision.

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BACKGROUND: Steering (i.e. walking towards a goal) is a common daily activity. Previous studies have found that when individuals steer they do so in a systematic sequential fashion. This behaviour has been referred to as the steering synergy in which the individual's head and eyes initiate the turn followed by the trunk and then the feet. Cinelli and Warren (2012) found that voluntary head turns in response to verbal commands resulted in deviations of only 1-2° in the direction opposite of the head turn, and concluded that head rotations are not an essential component of steering control. The purpose of this study was to remove visual input during a steering task to examine the affects of a head turn on path trajectory in order to determine the vestibular and somatosensory systems' ability to accurately steer towards a previously observed goal. METHODS: Participants (n=10, all female non-athletes, 18-25 years) were recruited for the study. Prior to the experimental conditions, 10 trials were performed in which the participants walked along a 9-metre pathway toward a visible pole-like goal placed at the end. Vision was occluded in three experimental conditions using opaque LCD goggles that allowed visibility of the goal prior to the trial, then removed during locomotion. Experimental conditions were presented in a randomized order and included: 1) straight walking; 2) walking with right head turn; and 3) walking with left head turn. Head turns were initiated after 4m of walking, during which the participant was verbally instructed to turn their head approximately 45 degrees and continue walking straight towards the remembered goal. Kinematic data was collected at 60 Hz using an NDI OptoTrak motion tracking system. Participants were instrumented with IRED markers on the head, trunk and heels to calculate COM path trajectory in space and body segment behaviours. RESULTS: Results revealed a significant difference in magnitude of heading error between the four conditions ($F(3,9) = 85.8$, $p<.001$), such that the eyes open condition (0.89deg) was significantly different from all three experimental conditions (2.65, 3.48, 3.59deg for straight, right turn, and left turn respectively). Although the direction of deviation was inconsistent within each condition, all experimental conditions resulted in twice as many leftward deviations as rightward. CONCLUSIONS: Even though the removal of vision with or without head rotations led to slight (7%) but significant path deviations, the direction of deviation was inconsistent. This outcome was most likely due to the inherent error built into the vestibular and somatosensory systems' abilities to achieve goal-directed locomotion in the absence of vision and misalignment of head on trunk. These findings demonstrate that head rotations even in the absence of vision are not an essential component of steering control.

P2-U-115 Does effective Adapted Tango rehabilitation improve postural response scaling across stance widths in individuals with Parkinson disease?

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BACKGROUND & AIM: Rehabilitation has successfully ameliorated balance deficits in individuals with Parkinson's disease (PD), but the neural mechanisms underlying these improvements remain unclear. In postural responses to support-surface perturbations, individuals with PD demonstrate impaired scaling of muscle response magnitudes across different biomechanical contexts. While individuals without PD use lower muscle response magnitudes when standing at a wide stance compared to a narrow stance, individuals with PD use similar muscle response magnitudes at both stance widths. We hypothesize that impaired modulation of central set, or sensitivity to perturbations, across biomechanical contexts may be a cause of postural instability in individuals with PD. Here, we predicted that central set modulation would be improved after successful dance-based balance rehabilitation, as reflected by larger differences in leg muscle response magnitude between wide and narrow stances. METHODS: We tracked 9 individuals with PD (Unified Parkinson's Disease Rating Scale mean ± SD: 30 ± 4.7; Hoehn & Yahr range: 2-3, ON medications) before and after a high-volume adapted Argentine tango rehabilitation program (90 minute sessions, 5 days/week for 3 weeks). Surface electromyography (EMG) was recorded from 16 leg and torso muscles. Lateral support surface perturbations were administered while participants stood at either narrow stance (10 cm) or wide stance (30 cm). EMG in each trial was demeaned and magnitudes were calculated by averaging over a window 100-450 ms after perturbation onset, to capture the medium and long-latency postural responses. RESULTS: Participants improved on the Berg Balance Scale and Fullerton Advanced Balance Scale ($p<0.05$). Before Adapted Tango, Participants scaled their postural responses across stance widths (significant effect of stance width on EMG magnitude across participants and muscles, $p<0.001$). At baseline, the magnitude of scaling in this cohort (ranging from 11%-129% across muscles) was larger than that observed in a previous study conducted in the practically-defined OFF state (≈30%-70%), suggesting that this cohort was less impaired. Postural response scaling did not change significantly after Adapted Tango (from 11%-129%, pretest, to 14%-138%, posttest; interaction effect between stance width and observation on EMG magnitude across participants and muscles $p=0.14$). However, background activity (EMG magnitude during the 50 ms before perturbation onset) scaling increased significantly after Adapted Tango ($p=0.002$). CONCLUSIONS: These results suggest that postural response magnitude scaling is not necessarily affected by dance-based balance rehabilitation; however, antiparkinsonian medications may be masking an underlying effect. Effective dance-based balance rehabilitation may improve muscle activity scaling during quiet standing, possibly by ameliorating basal ganglia deficits in modulation of central set.

P2-U-116 Corticovestibular interactions underlying balance control in healthy subjects

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BACKGROUDN AND AIM: Balance deficits following lesions of the central nervous system are a leading cause of decreased autonomy and impaired function. Many studies have demonstrated the importance of brainstem structures for balance control and individuals can be trained to improve their balance, such as high level athletes, or to regain balance abilities through balance training. All these suggest that interactions exist between cortex -which has been linked to motor learning- and brainstem systems, notably vestibular system. Evidence of convergence between corticospinal tract (CST) and brainstem pathways on interneurons were observed in the cervical spinal cord and at supraspinal levels in monkeys. Imaging studies showed that several cortical areas are activated by vestibular structures, and individuals that sustained a stroke at a cortical level were shown to have impairment to the vestibulospinal tract and have balance deficits. This suggests a role of corticovestibular interactions for balance control. Thus the goal of this study is to characterize interactions between motor cortex and vestibular system in healthy subjects during standing, more specifically by looking at modulation of corticospinal excitability by vestibular afferents. METHODS: Six healthy subjects stood on a force platform, head facing forward, eyes closed. EMG activity of right Soleus (SOL) was recorded during standing. Transcranial magnetic stimulation (TMS; intensity: 1.2 x motor threshold) was used to asses the excitability of the CST and Galvanic vestibular stimulation (GVS; intensity: 3,5 mA) was used to activate the vestibular afferents with cathode behind the right ear or behind the left ear. Interstimulus interval (ISI) between TMS and GVS ranged from 0 to 130 ms and for each ISI, four conditions were tested: no stimulation, GVS alone, TMS alone, GVS and TMS. Ten trials were applied for each condition. Comparison of the amplitude of the evoked motor potentiel (MEP) with and without GVS conditionnig was done to measure the modulation of the vestibular afferents on the CST output. To control for the effect of the GVS directly on the motoneuronal pool, the effect of GVS on EMG and on H-reflex of the SOL - which reflects the spinal excitability- was also done. RESULTS: With cathode right, inhibition of MEP was observed for an ISI of 70 (91±6%), 90 (85±5%), 110 (85±6%) and 130 (91±9) while no effects was found on the EMG (range from 106±7% at 70 ms to 95±5% at 130 ms) and on the H-reflex (from 104±3% at 70 ms to 108±9% at 130 ms). With cathode left, facilitation of MEP was observed at 40 ms (122±6%), while no changes were observed on the EMG (100±4%) or the H-reflex (102±4%). CONCLUSIONS: Preliminary results suggest that the the vestibular system can selectively modulate the CST output and gives further insights into balance mechanisms. Supported by NERSC.

P2-U-117 The effects of constraining vision and eye movements on whole-body coordination during standing turns

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BACKGROUND AND AIM: Whole body turns are usually characterized by a sequential 'top down' coordinated reorientation of the body beginning with anticipatory eye and head rotation towards the turn direction followed by the axial body segments and ending with the feet. However, the neural mechanisms underlying this stereotyped behaviour remain undefined. Various hypotheses have been proposed to account for anticipatory eye and head rotations which include: 1) a vision-centric CNS control mechanism whereby non-specific visual information is used to guide the turn; 2) a gaze-centric control mechanism where visual fixation of environmental features is used to guide the turn; or 3) a head-centric control mechanism whereby sensory input derived from head posture is used to control and align body and lower limb position. The aim of the present study was to systematically manipulate the availability of vision of individuals making large standing turns and observe the effects on turning kinematics. We postulated that a) if we were to remove all vision and anticipatory eye and head movements were still observed then this would be supportive of hypothesis 3; b) that if we were to leave vision intact but remove the possibility to fixate environmental features and anticipatory eye and head movements were still observed then this would support hypothesis 1; c) abolishment or attenuation of anticipatory eye and head movements resulting from both experimental conditions would support hypothesis 2. METHODS: Seventeen young adults (mean age 25.10 ± 2.45) completed 5 trials of 180° standing turns to either the right or left under each of the following vision conditions: full vision, no vision and gaze fixation on a head-mounted target suspended at eye level (60 trials total). Full body kinematic data (Vicon Bonita 200Hz) and horizontal eye rotations (Bluegain EOG 1000Hz) were recorded. RESULTS: RM ANOVA showed a main effect of visual condition on peak head yaw velocity (F (2, 32) = 18.105, P<.001) with peak head velocity fastest in the full vision condition (mean 96.63 ± 22.38°s-1), followed by the no vision condition (mean 84.31 ± 16.01°s-1) and slowest in the fixation condition (mean 78.59 ± 15.97°s-1). RM ANCOVA with peak head velocity as a covariate showed a main effect of visual condition on maximum separation between the head and pelvis (F (1.186, 17.784 = 4.351, P<.05). The maximum separation between the head and the pelvis during no vision (right: 5.73 ± 3.94°; left: 5.15 ± 2.40°) and fixation (right: 4.67 ± 3.43°; left: 4.58 ± 3.10°) conditions was considerably reduced compared to the full vision (right: 9.24 ± 9.59°; left: 8.56 ± 5.12°) condition. CONCLUSION: Our preliminary results are supportive of the second hypothesis which proposes that eye and head movements lead the turning sequence to provide intermittent visual anchoring on environmental features throughout the course of the turn. We are currently analysing measures of dynamic

P2-U-118 Task dependency of vestibular evoked arm movement

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Background & Aim: Previous research has demonstrated electrical vestibular stimulation evokes arm responses when reaching. Postural responses to vestibular stimulation only occur when whole-body motion is perceived, and are dependent on the task requiring the subject to compensate for this perturbation. It is unclear if this is the case with arm responses. Our aim is to investigate whether vestibular evoked arm responses are dependant on the task requiring arm movement in compensation for perceived whole-body motion. Methods: We used galvanic vestibular stimulation (GVS) to artificially stimulate the vestibular afferents of 8 subjects during whole-body rotation (30deg and 60deg amplitudes). This produces an illusory perception of rotation, greater, or less than actual, depending on stimulation polarity. During rotation and GVS, subjects completed one of two pointing tasks. The tasks were designed to manipulate the need for compensatory arm movements for perceived whole-body rotation. Subjects either had to keep a stationary pointing position fixed to their body (body-fixed task), or maintain pointing at a memorized earth-fixed target throughout rotation (earth-fixed task). No visual feedback was available. Hand position in space was recorded with a motion tracking system. Results: In the earth-fixed task, subjects made compensatory arm movements in the opposite direction to body rotation, to maintain pointing accuracy. When GVS was applied during rotation, such that subjects perceived they had been rotated further than actual, the arm compensation was even greater than when no GVS was applied. An equal and opposite effect occurred when the GVS polarity was reversed, with the arm compensating less, as body rotation was perceived as less. In contrast, during the body-fixed task, the arm position closely followed that of the body rotation, with no GVS effect on arm positioning at all. These results were confirmed by a significant interaction between pointing task and GVS ($P<0.05$), and occurred in both amplitudes of rotation. Conclusions: In agreement with previous research we have found GVS evokes arm responses. Furthermore, our results demonstrate that vestibular evoked arm movement only occurs when the task requires maintaining arm position relative to an earth-fixed target, during body motion. The vestibular system provides information on body motion, allowing the arm to make a compensatory response, necessary to maintain an accurate arm position. We conclude vestibular evoked arm responses are task dependant, and not the result of a direct link between the vestibular system and arm.

P2-U-119 Effect of hand loads carried on gait of patients with Parkinson's disease in the approach phase to climb stairs

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BACKGROUND AND AIM: In complex environments gait impairments of people with Parkinson's disease (PD) may be aggravated. For locomotion in stairs, the record of environmental information and the planning of task still occur in the approach phase. The sensory integration deficits associated with cognitive requirements for the planning of motor action in the approach phase can interfere with walking pattern of PD patients increasing instability and the risk of falls. In addition, in public and home environments people often up and down stairs carrying hand loads. The transportation of loads, changes the postural balance. However, little is known about the effect of hand loads carried on the gait, especially in patients with PD. The aim of this study was to investigate the spatial and temporal changes of gait and the effect of hand loads carried on gait of patients with Parkinson's disease in the approach phase to climb stairs. METHODS: twenty-eight idiopathic PD patients (mild and moderate levels in the Hoehn and Yahr Rating Scale) and 28 neurologically healthy people, match in age, height and sex, participated in this study. The spatial and temporal data were recorded using a GAITRite® System 6m long, placed in front of a four-step stairs. The participant began the walk at 6m from the stairs and up the stairs in 3 conditions: free walk, no-load approach phase and with load in the approach phase. The load has been customized for 10% of body weight and the participants performed 3 trials in each condition. The spatiotemporal variables were: step length, base of support, single support time, double support time and stride velocity. We used an unpaired Student t test analysis to compare the means age, height, weight, sex and cognitive functions (Mini Mental State Examination) data between patients with PD and control subjects. The dependent variables were statistically treated by Two-Way ANOVA (2 groups; 3 conditions), with repeated measures in the second factor (P-value <0.05). RESULTS: Interaction between factors was observed on single support time in no-load approach phase step (p=0.043). Patients with PD have shorter duration of single support time on no-load approach phase than the control group. Independently of the group the participants decreased the base of support (p=0.018) and the single support time (p<0.001) with load in the approach phase condition. Regardless of the condition the PD group showed lower step length than the control group (p=0.003). CONCLUSIONS: Apparently the load carrying led to adjustments in variables of stability in both PD group and control group. However, in the approach phase PD group showed more conservative strategies than the control group, decreasing the single support time.

P2-U-120 The effect of a gait synchronization task on dynamic characteristics of cardiac and gait rhythms

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BACKGROUND AND AIM: Gait patterns alter with aging, illness, and injury. Stride time, step width, and step length tends to become more random, possibly due to changes in neural control or connectivity, which reflects a less functional (i.e., maladaptive) gait behavior. To restore more patterned behavior in gait, visual and auditory cues that exhibit specific patterns (i.e., fractal scaling characteristics) have been used as stimuli to guide the re-emergence of adaptive gait. However, before use in rehabilitation, it is important to consider how altering gait patterns may influence patterns in other systems, such as cardiac dynamics. This project concurrently examined gait and cardiac dynamics during a treadmill walking task while synchronizing to a fractal visual cue. METHODS: Healthy adults (N=8, 24.5±3.8 yrs) walked for 45 total minutes (three consecutive 15-minute phases) on a treadmill at their preferred speed. During the pre- and post-synchronization phases, participants walked with no stimulus presented to them. During the synchronization phase, participants matched their step timing to blinking left and right footprints projected on a screen in front of them. Stride time, step length, step width, and cardiac R-R interval (time between heart beats) time series were constructed from the continuous motion and electrocardiogram data of each 15-minute phase. Mean, standard deviation, coefficient of variation, and detrended fluctuation analysis scaling exponent alpha (DFA α) were calculated for each time series. Separate repeated measures ANOVAs were conducted for each metric of the dependent variables. Alpha was set to .05 a priori. RESULTS: A significant main effect (PHASE) was identified for all gait measurements (all $p < .05$) except DFA α of step width. Only mean R-R interval exhibited a significant main effect. Examination of the individual contrasts for variability (SD, CV, and DFA) of gait patterns revealed that stride time and step length were only significantly different during the synchronization task. Step width SD increased during the synchronization phase and continued to increase post-synchronization; and DFA α of step width only increased during the post-synchronization phase. CONCLUSIONS: A visual cue can be used to systematically alter stride time, step length, and step width characteristics during treadmill walking. The visual cue used in this study requires focus on timing patterns during gait, and thus the dynamics of step length and stride time were directly manipulated. However, characteristics of step width are also altered during the synchronization task. Additionally, this task altered cardiac dynamics by increasing the heart rate during the synchronization phase. This was likely caused by changes in autonomic control of the heart associated with exercise. Combined, these findings suggest that interventions aimed to alter gait timing patterns may indirectly alter spatial characteristics of gait and card

P2-V-121 Effect of position on precision within the recording field of a markerless motion capture system

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BACKGROUD AND AIM: Markerless motion capture systems are relatively new devices that can significantly speed up capturing full body motion. They have the potential to be used in a clinical setting for movement analysis, as well as for large cohort research. However, the precision of such system needs to be characterized. The objective of this study is to assess the precision within the recording field of the markerless motion capture system Openstage (Organic Motion, NY). METHODS: We used a 16-cameras Openstage 2 system with the Backstage version 2.4. In a first condition (static), a mannequin

was used to assess the static noise of the system at 13 different locations in the recording field (4x3 meters). Ten trials were recorded at each location. Positions in the global coordinated system of every limb were recorded by the system. Root mean square error (RMSE) was used to calculate the noise of each segment, in each position. Analysis of variance (ANOVA) was used to compare level of noise between limbs. In a second condition (dynamic), we wanted to determine the smallest oscillation amplitude the Openstage system can detect. To do so, we induced an oscillation to the mannequin and recorded motion until it stopped. Movement of the head was also captured with a gold standard active marker system (Visualeyez VZ4000 - PTI, BC). A threshold of disagreement of r=0.8 was used to determine when the signals detected by both systems were no longer correlated. RESULTS: Noise amplitude (static condition) for all limbs and positions ranged from 0.79mm to 10.49mm, with a mean of 2.38±1.01mm. However, when we excluded positions that have higher noise amplitude, the mean RMSE fell to 2.30±0.80mm, with a maximum of 4.62mm. Higher noise of the excluded positions was clearly induced by the proximity of the recording field edges. Furthermore, we identified a 3.1 square meters spot located in the center of the recording field where average noise for all limbs was 1.80±0.65mm, ranging from 0.79 to 4.60mm. Still, we found significant difference between noise levels between limbs when compared with an ANOVA. During oscillation detection (dynamic condition), the smallest oscillation detected varied from 3.17mm to 13.23mm, depending of the recording position, with an average of 5.75±2.78mm. CONCLUSIONS: Precision of the Openstage system varied within the recording field. This should be considered when planning the tasks to be captured. For instance, tasks that do not involved gait should be performed in the centre of the recording field. Furthermore, recording should be avoid along the edges of the recording field, unless movements are large in amplitude and have a large signal-to-noise ratio. The results also showed that precision is not constant between limb segments. These findings should be considered in the interpretation of results, especially whether considering such system for clinical evaluation of mobility.

P2-V-123 Test-retest reliability of centre of foot pressure measuring to assess postural control during anterior-posterior balancing on seesaw

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BACKGROUND AND AIM: Although standing on a seesaw represents a postural task usually employed for both research and clinical purposes, its test-retest reliability remains to be established. This study was specifically designed to address this issue by assessing the test-retest reliability of this test and by determining the optimum number of trial recordings required to ensure reliable measurements. METHODS: Eleven young healthy adults volunteered. Participants stood barefoot on a force platform with their eyes closed. This force platform was placed on a moving support (seesaw) made of a square

plate mounted above two circular ridges, capable of producing translational-rotational movement rolling in the sagittal direction. Participants' task was to stand as still as possible during anterior-posterior balance on the seesaw. Prior to the experiment, all participants practiced this postural task for one trial. Ten 25.6s-trials were then performed to achieve session 1. This entire experimental procedure (session 1) was repeated by the same operater after a 1 hour-interval (session 2) to evaluate test-retest reliability. Spatio-temporal descriptors of displacements of the centre of foot pressure were used to describe the participants' postural behavior. Intraclass correlation coefficient (ICC(2,1)) and Bland and Altman graphs with limits of agreement were used as statistical methods for assessing test-retest reliability. RESULTS: Results showed that (1) the test-retest reliability of this postural test increases as the number of trials used to establish individual's postural performance increases and (2) using the mean of 3 trials is sufficient to ensure fair to excellent reliability of the CoP-based measurements. CONCLUSIONS: The trial-to-trial analysis demonstrated that the number of trial recordings has an effect on the reliability of the CoP displacement measurements used to assess postural control during anterior-posterior balance on the seesaw. Our analysis further suggested that three 25.6s trial recordings are sufficient to ensure fair to excellent test-retest reliability of the CoP-based measurements. Taken together, our results evidenced that particular care should be provided to number of trials performed by participants to reach reliable CoP measures to assess postural control during anterior-posterior balance on the seesaw. Along these lines, we believe that the present findings could have implications in scientific, clinical and rehabilitative areas. At this point, however, it is relevant to mention that this reliability experiment involved healthy young adults only. Thus it remains possible that, in clinical populations for whom fatigue and attention may become an important issue (e.g., balance-impaired persons or older adults), increasing the number of trials could decrease the reliability of the CoP measures. An experiment is currently being carried out to address this issue.

P2-V-124 Effects of training with a new Smartphone-based biofeedback system (CuPiD) on mobility in people with Parkinson's disease: iTUG outcomes

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INTRODUCTION: The Cupid Smartphone-based auditory bio-feedback (ABF) system was developed to improve the gait of patients with Parkinson's disease (PD). In this study, we evaluated whether training with the CuPiD system was more effective than traditional training in improving mobility as assessed using the 3 meters iTUG (instrumented Timed Up and Go). METHODS: The CuPiD system consists of three wireless inertial measurement sensors and a Smartphone used as a wearable processing unit. The system measures the subject's gait and provides real-time feedback to improve the walking pattern.

Subjects participated in a 6 week at-home program in which they were encouraged to train for 30 minutes at least 3 times a week, with or without the CuPiD system. iTUG was assessed before and after training using a body fixed sensor placed on the lower back (Opal, APDM Inc.). The sensor included 3 linear accelerometers (vertical, anterior-posterior, medio-lateral) and 3 gyroscopes for quantifying angular velocity (yaw, pitch, and roll). Measures were derived from the walking, sit-to-stand, stand-to-sit, and turn components of the TUG. Repeated Measures Analysis of Variance (RM ANOVA) tested changes between pre and post assessments and group. Post hoc analysis was used to assess changes between groups. RESULTS: 11 subjects (mean age: 69.72±18.18 yrs, disease duration: 10.12±4.67 yrs; 2 women) used the CuPiD system and 8 controls (64.87±9.87 yrs, disease duration: 10.40±5.98 yrs; 2 women) received conventional training. The duration of the usual TUG decreased in the CuPiD group (pre: 11.85±2.38 sec, post: 10.53±2.38 sec, p=0.017). These changes were not significant in the control group (p=0.063). A significant between group interaction effect (p=0.027) was observed in stand-to-sit pitch duration, with a trend for improvement in the CuPiD group (p=0.086) but not in the control group (p=0.790). Both groups significantly increased their 2nd turn to sit trunk rotation (CuPiD: p=0.004, Controls: p=0.04) with a significant interaction effect between groups (p<0.033). DISCUSSION AND CONCLUSION: Training with the CuPiD system resulted in lower TUG duration, increased trunk rotation, and decreased stand-to-sit duration. These initial findings suggest that the CuPiD Smartphone app has beneficial effects on the mobility of patients with PD, beyond that seen using conventional training, and that this intervention may be an effective tool for home-based rehabilitation of mobility.

P2-V-125 Describing Neurological Disorders as changes in Gait Domains

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Background: Conventional gait analysis records temporal and spatial characteristics of the gait cycle and usually generates large volumes of data. The most common method for data reduction in view of their high intrinsic correlations is Principal Component Analysis (PCA). PCA leads to the emergence of macro parameters/ domains/ factors (combination of existing parameters), which describe a certain property of gait. Five domains namely Rhythm (cadence, stride time), Pace (speed, stride length), Variability, Phase and Support (base of support) have been described. We study the changes in these gait domains during different walking conditions as well as in patients with various (oto-) neurological gait by projecting new data onto well-defined gait domains. Methods: 17 discreet measurements using a GAITRite® sensor carpet were obtained from healthy subjects (N=30) during preferred walking speed and PCA was performed to establish the existence of gait domains and extract principal component scores and the transformation matrix. Similar measurements were obtained from the subjects during slow speed, maximal speed, dual task (serial subtraction, verbal, tray carrying) and eyes closed gait. The experiment was repeated using clinically confirmed cases of postural phobic vertigo (N=30), bilateral vestibulopathy (N=30), cerebellar ataxia (N=30) and progressive supranuclear palsy (N=30). All measurements were then projected onto the principal component space to determine their scores in the identified gait domains and compared using Students T test. Results: PCA on healthy subjects during preferred speed gait revealed the existence of five components that explained 88.1% of the variance of the data, with the first explaining 41.1%. Dual task gait was characterized by an increase in Phase and Variability and a decrease in Rhythm. Postural phobic vertigo patients had similar domain scores as that of healthy subjects. Bilateral vestibulopathy patients had significant decrease in Phase, Rhythm and Pace and increase in Variability domains. Patients with cerebellar ataxia and progressive supranuclear palsy had changes in all domains. Conclusions: Gait domain analysis is a powerful tool, and can be used to express large spatio-temporal data sets in a few domains. Gait domains are easily identifiable and reproducible in healthy adults during preferred speed. Distinct gait patterns are observable during different gait tasks as well as in (oto-) neurological gait disorders. Projecting new data onto an existing domain space can be utilized provided a standardized domain space can be described. This method can be used to provide domain based descriptions to various clinical groups without loss of domain data.

P2-V-126 Concurrent Validity of a Wearable Smartphone-Enabled Camera-Based System for Assessment of Postural Sway

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BACKGROUND AND AIM: Spatiotemporal characteristics of postural sway are used to quantify balance for multiple populations: concussion, Parkinson's disease, etc. However, quantifying sway with a force plate or 3D motion analysis system requires expensive equipment, and can be inconvenient. Accelerometer assessments may not accurately capture the small movements associated with postural sway. The best approach to measure displacement is an optical device, so we developed a wearable system that uses the camera from a smartphone to assess postural sway, called SwayWatch. The smartphone is worn at the waist, and the camera records a marker placed on the ground; displacement of the marker will correspond to trunk movement. In this abstract, we assess the concurrent validity of SwayWatch with a criterion reference motion analysis system. METHODS: SwayWatch measures antero-posterior (AP) and medio-lateral (ML) sway with the Smartphone camera (Apple, iPhone 5s, iOS8), and a 90-degree wide-angle lens. The Smartphone is attached to a belt and a circular marker (d=9cm) is placed on the floor. Customized application software processes the video image, isolates and locates the floor marker and provides a time series which quantifies trunk motion. Calibration is based on a known diameter of a marker. Ten young, healthy adults (24.6±3.4yrs) stood quietly for 1 minute in the following conditions: two feet eyes open (2FEO), two feet eyes closed (2FEC), one foot eyes open (1FEO), and tandem standing eyes open (TEO). Trunk motion was simultaneously measured with an optical motion analysis system (Optotrak 3020, NDI) and SwayWatch. Spatial and temporal parameters were assessed:

root mean square (RMS) and mean power frequency (MPF). Agreement between SwayWatch and Optotrak was evaluated with absolute error and Intra-Class Correlation (ICC (2,1)). RESULTS: The absolute RMS error was less than 1 mm in AP/ML: 0.3±0.3mm / 0.2±0.2mm (2FEO), 0.5±0.4mm / 0.5±0.5mm (2FEC), 0.6±0.3mm / 0.6±0.3mm (1FEO), and 0.5±0.4mm / 0.5±0.4mm (TEO). The ICCs for RMS in AP/ML were: 0.92/0.93 (2FEO), 0.78/0.82 (2FEC), 0.86/0.75 (1FEO), and 0.74/0.86 (TEO), demonstrating an excellent level of agreements. The mean absolute MPF error was less than 0.4Hz in AP/ML: 0.12±0.14 Hz / 0.30±0.38Hz (2FEO), 0.33±0.20 Hz / 0.19±0.20Hz (2FEC), 0.04±0.09 Hz / 0.07±0.13Hz (1FEO), and 0.30±0.28 Hz / 0.08±0.13Hz (TEO) for anterio-posterior/medio-lateral sways, respectively. Accordant ICCs in AP/ML planes were: 0.79/0.70, 0.62/0.68, 0.72/0.85, and 0.80/0.72. CONCLUSIONS: SwayWatch demonstrated excellent concurrent agreement for RMS, and moderate agreement for MPF in young adults. SwayWatch provides significant advantages for assessing postural sway, including convenience and wide availability due to the smartphone platform.

P2-V-127 Reliability of wearable motion capture system with inertial and pressure sensors for gait analysis to predict joint forces and moments in whole body

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BACKGROUND AND AIM: Motion capture technology is the main tool for clinical and biomechanical gait analysis to assess postural pattern and gait biomechanics. The optical motion capture system with force plate has been conventionally used in gait analysis due to its accuracy. This system also has some drawbacks such as restricted capturing area, limited foot placement and tied to the laboratory. The wearable motion capture system consisted of inertial and magnetic measurement system and insole pressure system can be good alternative of the conventional motion capture system to solve the aforementioned restrictions. The objective of this study is to evaluate the prediction of joint kinetics in whole body with a wearable sensor system by comparing to that with the conventional system in terms of joint forces and moments. METHODS: Walking motions were captured from 5 healthy male subjects (age, 27±1 yrs; height, 171.4±3.9 cm; weight, 73.3±12.1 kg) using wearable and conventional systems simultaneously. The wearable system consisted of MVN® inertial motion capture system (Xsens Technologies, Enschede, Nederlands) with 17 inertial and magnetic sensors and Pedar-X® (Novel gmbh, Munich, Germany) insole pressure system. The conventional system composed of Hawk® digital system (Motion Analysis, Santa Rosa, CA, USA) with 10 cameras and 4 MP4060® force plates (Bertec Corporation, Columbus, OH, USA). In the wearable system, the orientations of each body segment, vertical component of ground reaction force (GRF) and center of pressure (CoP) data were recorded. The positions of 37 anatomical landmarks were then calculated from the orientations of body segments using the implemented software MVN®. The 3D GRF was analyzed from insole pressure data based on zero moment point (ZMP) method. Inverse dynamic analyses were conducted using Matlab® with a dynamics model of the human whole body. RESULTS: Joint forces strongly correlated between the wearable system and the conventional system (Figure 1) with small normalized root mean squared error (NRMSE)s in all joints (r=0.71-0.99; NRMSE=5.5%-6.2%). The lower extremity showed significantly higher correlation (r=0.99) than the trunk (r=0.80-0.81) and the upper extremity (r=0.71-0.79). Joint moments showed good agreement with strong correlation (r=0.70-0.98) in all joints except the shoulder (r=0.49). The NRMSEs of joint moments were acceptable (8.0%-16.9%) in all joints except the shoulder (24.1%) and elbow (35.2%). CONCLUSION: The wearable motion capture system proposed in this study revealed reliable joint force and moment in comparison to the conventional system, especially in lower extremity. Due to its wearable and portable characteristic and without restrictions in capturing volume and foot placement, the wearable system can be a useful tool for both inside clinical and outside field posture and gait analysis.

P2-V-128 Construct validity of the Mini-BESTest in mild to moderate Parkinson's disease

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Background and aim: The Mini-BESTest, originating from the Balance Evaluations Systems Test (BESTest), was developed as a multi-item test for the unidimensional construct of dynamic balance. Consisting of four subcomponents (anticipatory postural adjustments, reactive postural control, sensory orientation and dynamic gait), the Mini-BESTest has previously been found reliable in elderly with mild to moderate Parkinson's Disease (PD). Construct validity ("the degree to which scores of a measurement instrument are consistent with hypotheses") can be investigated by comparing hypothesized differences between groups with known abilities of the construct to be measured (i.e. known groups validity). Our overarching aim was to use a known-groups validity approach to investigate if the Mini-BESTest could detect differences between groups of elderly with known balance abilities. We hypothesized that the Mini-BESTest would produce significantly lower scores in, respectively, elderly with mild to moderate PD compared to healthy elderly; and in elderly with moderate disease severity of PD compared to those with mild disease severity. Methods: For this study, a group of elderly with PD (n=105, 45 females, 60-88 years, mean age 71) and a group of healthy controls (n=47, 20 females, 60-88 years, mean age 71) was included. People with PD were divided into two subgroups with regard to their disease severity, mild (H&Y=2, n= 48, 22 females, 63-87 years, mean age 72, 0.5-17 years since diagnosis) and moderate (H&Y=3, n=57, 23 females, 61-87 years, mean age 73, 0.5-25 years since diagnosis). Independent T-tests were used to investigate between-group differences regarding the total score of the Mini-BESTest. Due to lack of normal distribution, the Mann- Whitney U Test was used to investigate between-group differences regarding the subcomponents of the Mini-BESTest. Level of significance was set to p=0.05. Results: In accordance with our hypotheses, the group of elderly with mild to moderate PD produced lower scores on the Mini-BESTest than did the age-matched controls. This was the case with regards to the total score ($p<0.001$) as well as for all subcomponents ($p<0.001$). Moreover, the group of elderly with mild PD achieved higher scores on the Mini-BESTest than did the group with moderate PD with regards to the total score ($p<0.001$) and all subcategories (p¡Ü0.033) except for postural orientation ($p=0.086$). Conclusion: These results show that the Mini-BESTest was able to adequately detect differences in balance abilities between elderly with and without PD, regarding the total score as well as for all subcomponents. The Mini-BESTest was also able to detect differences between elderly with mild and moderate disease severity of PD. The lack of difference for subcomponent sensory orientation was likely due to its limited sensitivity for this population. Overall, these results support the construct validity of the Mini-BESTest in mild to moderate PD.

P2-V-129 Association between the Outcomes of a Smartphone-based Instrumented Timed Up and Go and Traditional Clinical Assessment Tools in Community-Dwelling Older People

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BACKGROUND AND AIM: Within the framework of the FARSEEING project (farseeingresearch.eu), Smartphones (SPs) are used to instrument clinical tests for functional assessment; recent studies showed the potential of using inertial sensors to boost the quantitative information about motor performance measured by means of functional tests commonly used in clinical practice like the Timed Up and Go (TUG) test. The use of a SP as a clinical tool is assessed within the InChianti study (inchiantistudy.net), a cohort study of factors contributing to loss of mobility in late life. In this study we aimed to investigate the association between features derived from an instrumented Timed Up and Go test and well-established clinical assessment tools for quantifying motor and cognitive impairments. METHODS: The study included 170 elderly subjects (80±6.5 years old, 96 females) wearing a SP on the lower back by means of an elastic belt. An Android application was used for instrumenting the TUG (Mellone et al, 2012). A rich set of sensor-based features were extracted from the raw signals; in order to reduce the large number of measures a factor analysis was applied. The following clinical data were collected from the elderly subjects: depression (CES-D score), cognitive impairments (MMSE), essential elements of self-care (ADL), independent living in the community (IADL), physical performance (SPPB), number of medications, number of comorbidities, and fear of falling. Multiple Linear Regression models confounded by age, gender, and BMI were used for investigating the association between instrumental measures and the clinical assessment tools. RESULTS: Seven factors were identified from TUG features explaining 70% of the variance: "Global Fitness (GF)", "Smoothness of the Sit to Walk (StW) Transition", "Forward/Vertical Weight Shift of the StW Transition", "Lateral Weight Shift (LWS) of the StW Transition", "Smoothness of the Turn to Sit (TtS) transition", "LWS of the TtS Transition", and the "Dynamics of Antero-Posterior Acceleration during postural transitions". High SPPB scores were associated with higher GF, and higher smoothness of the StW and TtS transitions. High MMSE were also

associated with a higher GF. Loss of independence was associated with a lower GF and a lower smoothness of the StW transition. A high number of drugs was associated with a reduced LWS during StW transition. No significant associations were found with the number of comorbidities and the fear of falling. CONCLUSIONS: : Sensor-based measures are coherent with clinical assessments performed in institutions supporting the hypothesis that SP-based functional assessment can be an effective solution for quantitative movement analysis with a clear clinical value for community-dwelling older persons. ACKNOWLEDGEMENTS: The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement FARSEEING n° 288940

P2-V-130 Supplementing clinical gait tests with body-worn sensors in incomplete spinal cord injury

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BACKGROUND AND AIM: Walking is an important goal for those with incomplete spinal cord injury (iSCI).[1] Walking is often measured with clinical, time-based tests, such as the 10-meter walk test (10mWT) and the Timed-up and Go (TUG). Timed tests show a ceiling effect in iSCI[2]; those who are high functioning achieve scores within the normal range. Yet, most ambulatory individuals with iSCI experience a fall[3], highlighting the need for sensitive measures of gait. The aim of this study was to determine if measuring spatiotemporal and kinematic variables during the 10mWT and TUG would improve the discriminative validity of these tests. We hypothesized that variables reflecting stability (e.g. trunk range of motion (ROM)), would differ between high-functioning individuals with iSCI and their able-bodied (AB) peers. METHODS: Adults with iSCI were included if they were >1 year post-injury, scored D on the ASIA Impairment Scale, and walked without gait aids. Age- and gender-matched AB participants were recruited. Participants performed the 10mWT and TUG while wearing a wireless, inertial measurement system (Mobility Lab, APDM Inc.). Sensors were worn on bilateral wrists, bilateral ankles, the waist, and chest. During both tests, variables reflecting gait stability were studied: double support (expressed as a percentage of the gait cycle), and trunk ROM and velocity in transverse, frontal, and sagittal directions. For the TUG, additional analyses focused on the turn and transfers (sit to stand, turn to sit). For the turn, the duration, number of steps, and peak velocity were considered. For the transfers, the duration, and trunk ROM and peak velocity were studied. Data are reported as the mean ± 1 SD. Normality was assessed with the Shapiro-Wilk test. Independent t-tests or Mann-Whitney U tests were used to compare groups. Alpha was 0.01 due to the large number of tests. RESULTS: Ten individuals with iSCI (8 males, 57.1±17.7 years old) and 10 AB people participated. All but one participant with iSCI fell in the past year. The groups did not differ in self-selected gait speed (10mWT). However, those with iSCI spent more of the gait cycle in double support (28±6% vs 21±2%, $p<0.01$), and showed greater transverse trunk ROM (8.4±2.4° vs 4.3±0.7°, $p<0.001$). There was a trend for the group with iSCI to take longer to complete the TUG (19.7±5.5s vs 14.4±1.3s, p=0.02). Measures of the TUG transfers and turn did not differ between groups (p>0.02), but as seen during the 10mWT, participants with iSCI showed greater transverse trunk ROM when walking during the TUG (9.4±2.4° vs 5.5±1.0°, p<0.001). CONCLUSIONS: Despite having similar gait speeds to AB people, high functioning individuals with iSCI show greater trunk ROM and double support when walking. Measuring these variables during the 10mWT and TUG improves the discriminative validity of these tests in iSCI. [1]Andersen J Neurotrauma 2004 [2]Musselman & Yang Phys Ther 2014 [3]Brotherton et al. Spinal Cord 2007

P2-V-131 A preliminary study of quantitative analysis for body sway using electromagnetic tracker

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Background and aim: Many proposals for parameters describing some aspect of body sway have been made in the past few decades. Most of the parameters are obtained in the standing subject with devices that measure movements of the body or its center of pressure (CoP). CoP co-ordinates are derived from ground reaction forces registered with the aid of a force platform. However, complicated movement patterns of body sway is difficult to be measured only by force platform. We have developed a method of measuring body sway by using a 3-dimensional electromagnetic tracker. This methodological study aims at comparison of the conventional force plate in order to achieve practical useful parameters of movement at different part of the body. Method: Young (n = 21, average age of 23.3 y.o.) and old healthy participantsand (n = 16, average age of 71.8 y.o.) were recruited for body sway analyses using force plate and 3-dimension electromagnetic tracker (MoCap) respectively. Magnetic sensors were put on the head, shoulders, waist and both knees respectively for MoCap recordings. Subjects were asked to stand quietly, barefoot with their feet closed together on the force plate (FP) under eyes-opened and -closed conditions. CoP registration was performed for 60 s. Romberg ratios and mean area of outermost displacement (MAP) were used as parameters for analysis. Comparison of means were made using the two-tails t-test, with p<0.05 as the criterion for statistical significant. Result: The Romberg ratio is lower in MoCap compared to that of force plate in the young group but no significant difference in elder group. On the other hand, the MAP, is higher in MoCap compared to that of FP in elder group under eyes-closed condition, but insignificant in young group. In the aspect of age influence, the Romberg ratios are higher in both FP and MoCap in elder group, and also MAP is higher under eyes-closed condition only in MoCap. These results implied that not only the vestibular input, but somatic input in elder group also depleted that caused difficulty in maintaining posture. Since MoCap is capable to measure changes in different point of the body, it may serve as a better test tool in recording and detecting central and peripheral disorders of individuals. The head sway degree relative to the waist of the MoCap recordings, showed no significant change in either group. It is unable to identify the different of the head swaying degree when the bilateral vestibular functions are normal. Conclusion: We have developed a method that is capable to measure each different part of the body and also CoP by using a 3-dimensional electromagnetic tracker. Even though visual inputs and spatial cognition are intact, depletion of vestibular and somatic inputs in elderly people may affect the ability of maintaining a proper upright standing, due to the head movement more dominant relative to the waist.

P2-V-132 Evaluation of Estimating Plantar Pressure Distribution Based on Plantar Images by Image Processing

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BACKGROUND&AIM: Plantar distribution is one of the well-known parameters that many researchers and therapists have been measured for gait evaluation. However a resolution of commercialized pressure distribution sensors is not enough to evaluate the small part of the pressure such as the one of small toes. Therefore we paid attention to information delivered from the captured plantar image that has higher resolution than the pressure distribution sensor. Based on the above, we proposed the new method to estimate pressure based on the plantar image captured by high speed camera. METHODS: The proposed method can calculate the plantar pressure distribution based on the brightness distribution of the plantar image captured by high speed camera (Point Grey Research Inc., 2048×2048 pixel, 150 fps) located under a transparent acrylic resin plate. To evaluate the proposed method, the comparison experiments with human foot model are conducted. It is difficult to confirm the reproducibility of comparing the plantar pressure because the plantar pressure changes during a walk. To evaluate the relation between the brightness of the image and pressure, a hemisphere made of soft urethane reign of stiffness same with human heel are used for measurement instead of human foot. 3 types of pressure distribution calculated by 1) the proposed method, 2) pressure distribution sensor (LL sensor, Xiroku, 3600 detectors in 600 mm×600 mm, 100 fps), and 3) numerical simulation by FEM are compared. The hemisphere is pressed to the transparent acrylic resin plate from above. The pressed image was captured by the camera located under the plate in the same way as the pressure distribution sensors. SULTS: The comparison results show that the pressure distribution calculated by 1) the proposed method is qualitatively similar to the distribution calculated by 2) the sensor and 3) FEM. The image provided higher resolution data (approximately 4900 pixels per square centimeter) than pressure distribution sensor (1 detector sensor per square centimeter). CONCLUSIONS: The comparison results suggested the possibility of estimation of the plantar pressure from the plantar image. We have been developed a "CAterpillar Type TrAnsParent treadmill (CaTTaP)" that captures the continuous plantar image during a walk. With CaTTaP, many gait parameters such as grounding position, plantar contact area, plantar skin deformation and so on can be measured by image processing on the continuous plantar image. For future work, we will improve CaTTaP and our system to evaluate human gait by estimating plantar pressure during a walk based on the high resolution data.

P2-V-133 ROMBERG RATIO IN QUIET STANCE POSTUROGRAPHY ? TEST TO RETEST RELIABILITY

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We investigated test to retest reliability and intraindividual variability of Romberg ratios in quiet stance posturography. Thirty-six healthy young adults (17 M, 19 F aged 15-38 years) were divided into 3 groups with different time-intervals between consecutive trials (20 minutes, 3 hours and 24 hours respectively). Each group performed 5 posturography recordings in a randomized order of eyes open (EO) or closed (EC) %2B once after 3 months. We measured the torque variance in posturography and calculated Romberg ratios. Total postural sway as well as sway above and below 0.1 Hz was analyzed Test to retest reliability was found to be poor for Romberg ratios (intraclass correlation coefficients (ICC) <0.4) despite that the individual EO and EC posturography recordings were consistent. For sway >0.1Hz the Romberg ratios were found to be more consistent (fair to good, ICC 0.49-0.71). The variation between 2 consecutive tests (absolute difference (%)) was high when using the traditional Romberg ratio (EC/EO), but became less varied if an alternate formula that includes the total postural sway was used ((EC-EO)/(EC%2BEO)*100). Conclusion: In healthy young adults the evaluation of ratios from repeated quiet stance posturography show great intraindividual inconsistency. This questions the Romberg ratio as being a reliable tool for evaluation of postural performance and determination of sensory preference in postural control, at least in healthy controls. Whether test-retest reliability is acceptable in patient cohorts needs to be evaluated for proper validity of intervention and outcome studies and for detection of clinical relevance.

P2-V-134 The hip joint extension during a gait stance phase is simultaneous with the extension of the knee

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[Background & aim]Correctly measuring knee joint angle during gait is difficult due to the knee being a moving axis and looseness of the soft tissues. We devised a method of measurement that solves those problems, and demonstrated it is effective. Our method can also be used to clarify the relationship between the timing of maximum flexion of knee joint angle and the start of hip joint extension during the stance phase of walking. [Method] Subjects, comprising 20 healthy women (21.5±0.4 years), gave their informed consent. Joint angle measurement involved imaging markers and calculating the angle from digitized coordinates. Markers were placed at the greater trochanter and lateral epicondyle of the femur, and at two points between the greater trochanter and lateral epicondyle when trisected (markers 1, 2, 3 and 4 in order from most proximal site). Similarly, we also placed markers at the head of the fibula, lateral malleolus and at two points between the head of the fibula and lateral malleolus when trisected (markers 5, 6, 7 and 8 in order from most proximal site). Knee joint angle was calculated with a conventional method using the angle formed by markers 1, 4 and 8, and with our newly devised method using the angle formed by the straight line passing through markers 2 and 3 and the straight line passing through markers 6 and 7. Hip joint angle was calculated with a conventional method using the angle formed by a perpendicular line and a straight line passing through markers 1 and 4, and with our method using the angle formed by a perpendicular line and the straight line passing through markers 2 and 3. The paired Student's t-test was used to compare differences in angles measured with the two methods. The level of significance was set at $p < 0.05$. [Results] The knee joint reached maximum flexion during the stance phase at 16.3% of gait cycle 1 when measured with the conventional method and at 14.3% with our method. Hip joint extension started at 7.9% of the cycle according to the conventional method, and at 10.7% according to our method. Thus, with the conventional method, the femur started to extend at 48.2% of the period of maximum knee joint flexion, but started to extend at 75.1% according to our method ($p<0.05$). Furthermore, it was demonstrated, using our method that in 12 of the 20 subjects' maximum knee flexion and the start of hip extension occurred simultaneously. [Conclusions] After heel strike, the leg progresses into a forward inclination. However, if hip joint extension begins simultaneously, the knee will extend during mid stance. This makes it necessary for the hip joint to maintain flexion during forward inclination of the leg in order for the knee to flex during mid stance. Accordingly, it is theoretically impossible for the knee to start flexing immediately after heel strike. We believe that the method we devised can be used to clarify the relationship between the timing of hip joint extension and knee flexion during gait.

P2-W-135 Sensory and reflexive hypersensitivity in mal de debarquement syndrome

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Background and aims. Mal de Debarquement (MdD) is a syndrome of imbalance classically after a sea voyage. MdD presents as abnormal non-vertiginous motion sensations, typically rocking and bobbing. Most people experience transient symptoms but a definition of persistent MdD is symptoms ≥1 month after a journey of ≥4 hours1. There is no consensus on pathogenesis and aetiology other than it is probably not a primary vestibular disorder as clinical vestibular function tests are normal and it is unresponsive to vestibular treatments. This study aimed to determine if persistent MdD patients are hypersensitive to vestibular signals of rotation with the hypothesis that they would show perceptual but not reflex hypersensitivity. Methods. Patients (N=8, 7F, 27-60yrs) and matched controls were studied.

All had normal vestibulo-ocular (VOR) head impulse and caloric tests. Perceptual sensitivity to whole-body yaw and lateral rocking stimulation were determined by psychophysical tests. In dark, seated subjects were rotated 30-180° over 5s before pointing to their start positions (Fig A). Illusory motion evoked by galvanic vestibular stimulation (GVS: 1.5mA, 10s) was used to assess pure vestibular perception. Sensory thresholds for detecting the direction of yaw were determined by forced-choice tracking and fitting a psychometric function to identify the amplitude that produced 50% correct responses. Rocking sensitivity was determined sitting on a motorised swing with a roll axis aligned with the head (B). Subjects reported perceptions of rocking (1-4° amplitude, 0.3Hz) using a visual scale. Rocking sensitivity was similarly determined using sinusoidal GVS (0.25-4mA amplitude) while stationary. Balance during standing was assessed by forceplate (Kistler) posturography with eyes open and shut, and standing on a rigid floor and foam (B). Vestibulospinal reflexes were assessed by binaural bipolar GVS (≤1mA) measuring medium-latency lateral shear forces. Results. Posturographic measures from MdD patients were not different to those of control subjects (Fig D). MdD patients showed exaggerated senses of self-motion during real yaw (P=0.02 by ANOVA) or virtual yaw (E: P<0.001). However, MdD thresholds for detecting yaw direction were increased (P=0.007). MdD patients showed exaggerated senses of roll self-motion during real rocking (FO: P=0.02) and virtual rocking (FΠ: P<0.001). Against our hypothesis, MdD showed markedly increased and delayed medium-latency GVS responses during standing (G: P<0.001). Conclusions. MdD is characterised by perceptual motion hypersensitivity and vestibulospinal hyper-reflexia, but normal VOR responses. The results indicate separation of perceptual, balance and ocular processing of vestibular afference. MdD could reflect disordered autoregulation of vestibular sensitivity or integration with somatosensory and visual afference as occurs in normal subjects. 1. Hain TC et al (1999) Mal de debarquement. Arch otolaryngol. 125, 615-620.

P2-W-136 The vestibular function in patients with type 2 diabetes mellitus and a history of falls.

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Aim: To assess the vestibular function in patients with type 2 diabetes mellitus with a history of falls. Methods: A total of 106 patients accepted to participate in the study. They were 34 to 84 years old. According to the report of falling during the previous year, they were classified in 2 groups, with falls (n=26) and with no falls (n=80). After a clinical evaluation and the report of symptoms of postural instability (using a standardized questionnaire), sinusoidal rotation (at 0.16 Hz & 1.28 Hz), static visual vertical and unilateral centrifugation (300°/s at 3.5 cm) were performed. Results: The two groups had a similar age and body mass index, as well as a similar frequency of peripheral neuropathy. Compared to patients with no falls, patients with falls had a higher female/male ratio and a higher score on the questionnaire of symptoms, but similar gain to sinusoidal rotation at high and low frequencies. The

frequency of patients with static visual vertical >2° was also similar in the two groups. Although, during unilateral centrifugation, there was a trend for a higher frequency of right/ left asymmetry in patients with falls, it was not significant. There was no relationship between the score of the questionnaire and the evidence of asymmetry of the utricular function. In the two groups, the frequency of asymmetry of the utricular function was larger during rotation. either with the head centered or during unilateral centrifugation, than the frequency of a static visual vertical >2°. In conclusion, the occurrence of falls in patients with type 2 diabetes mellitus, receiving primary health care, is not independently related to the vestibular responses to angular acceleration in the yaw plane or to the evidence of asymmetry of the utricular function, without evidence of vestibular disease.

P2-W-137 Postural threat modulates vestibulo-spinal and vestibulo-ocular reflexes during stance

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BACKGROUND AND AIM: The vestibular system may contribute to anxiety-related effects on balance control during stance and gait, particularly through increases in vestibulo-spinal reflex (VSR) gain [1,2]. While increased gain of vestibulo-ocular reflexes (VOR) involved in gaze stabilization has been associated with chronic anxiety [3], it is unclear whether VOR are also sensitive to threat-related changes in fear, anxiety and arousal. Vestibular Evoked Myogenic Potentials (VEMPs) and Head Impulse Tests (HIT) can be incorporated to measure changes in the gain of VSR and VOR pathways. The primary aim of the study was to investigate how threat-related changes in arousal, anxiety and fear influence VEMP and HIT outcomes measured during upright stance. Since the VOR depends also on visual pathways receiving signals relating to visual field motion and eye movements we also examined the independent effect of postural threat on the control of voluntary eye movements using saccades and smooth pursuit (SP) tasks. METHODS: Forty-five healthy young adults stood quietly at low (0.8m from the ground) and high (3.2m) surface height conditions in two experiments. For experiment 1 (25 subjects) VEMPs were recorded with surface EMG from inferior oblique (IO), sternocleidomastoid (SCM), trapezius (TRP) and soleus (SOL) muscles in response to 256 air-conducted short tone bursts (125 dB SPL; 500Hz; 4 ms) delivered via headphones. A sub-set of subjects (n=19) also received horizontal and vertical head thrusts (approx. 150 °/s) at each height. Eye rotations and head accelerations were recorded using a video HIT system and used to calculate VOR gains. For experiment 2 (20 subjects) electro-oculography (EOG) recordings of saccades (range 8-45°) and SP (15, 20 and 30 °/s) were used to calculate peak velocities and gains, respectively, at each height. All dependent measures were compared across height using paired t-tests and correlated with changes in electrodermal activity (EDA), fear and anxiety. RESULTS: VEMP amplitudes (IO, TRP, SOL) and horizontal and vertical VOR gains all increased with height ($p<0.05$). Changes in IO and SCM VEMP amplitudes, as well as horizontal VOR gains were correlated with changes in EDA ($r=0.44$ to 0.59, $p<0.05$). IO VEMP amplitude also positively correlated with fear ($r=0.43$, $p=0.03$). Eye saccade peak velocity ($p=0.03$) and SP velocity gain ($p=0.01$) increased with height. CONCLUSIONS: This is the first study to show a significant relationship between arousal and fear and changes in VSR and VOR gains. These results suggest that the relationship between fear, anxiety and balance may be mediated by changes in VSR. The novel observations of threat-related changes in oculomotor function suggest that changes in VOR gain may involve vestibular as well as non-vestibular mechanisms. ACKNOWLEDGEMENTS: Funded by NSERC and BC BADD Society. REFERENCES: [1] Horslen et al, J Physiol 2014; [2] Naranjo et al, ISPGR 2014; [3] Furman et al, J Vestib Res 2006.

P2-W-138 Vertigo induced by downhill mountain biking

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BACKGROUND AND AIM Competitive cyclists complain of vertigo. In a previous study we studied downhill mountain bikers (DMB) and road cyclists (RC) and found that older downhill cyclists and younger road cyclists showed an increased incidence of vertigo in everyday life compared to age-matched controls. It was thought that this might relate to effort related metabolic disturbances in RC's but perhaps brain dysfunction or microtrauma of the ear in DMB. DMB riders (but not RCs) undergo very large decelerations of the head during races and during falls (common in this race group). We wondered if these acceleration/deceleration events might cause otolith disfunction (as it has been shown that more than 50% of patients suffering acute head trauma have otolithic disfunction, and such head trauma includes rapid accelerations and decelerations of the head and also the otolith organs). We hypothesized that such damage in our cyclists would occur immediately following an event or a training session. Our aim in this study was to look at the incidence of vertigo immediately post event to see if there was a statistical difference between the DMB group and the RC group. METHODS We studied 191 elite French cyclists; 111 downhill cyclists and 80 road cyclists. All subjects filled in details of their training and also completed a questionnaire on the occurrence of vertigo immediately following competitions or after a training session. The questionnaire was specifically designed to elicit symptoms of otolithic origin (e.g. feelings of being on a boat, walking on a water mattress, etc) We used a chi squared statistical analysis and a Student's T-test to compare the occurrence of vertigo in the two groups. RESULTS Vertigo was reported in 48 of our DMB group (43%) but only in 20 of the RC's (25%). In the DMB group with vertigo, 72% had falls that they felt was a vertigo determinant. CONCLUSIONS Our two groups of elite cyclists reported a significant difference in the incidence of post event vertigo. Based on our questionnaire design, we hypothesized that our DMB group had a significantly higher incidence of otolithic damage. We did not feel that our fallers had suffered a head injury as such, as these athletes were helmeted and suffered the same biomechanical deceleration whether or not they struck their heads. CONCLUSIONS The sport of downhill mountain biking can induce vertigo and the mechanism of this pathology is suggested to be vestibular (particularly otolithic) damage, which could possibly result in ongoing problems to these athletes later in life.

P2-W-139 Influence of visual contrast and prominence of task-relevant stimuli on obstacle negotiation in fallers with and without Parkinson's disease.

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BACKGROUND AND AIM: Successful obstacle negotiation is a complex motor task which relies on adequate vision to distinguish the obstacle from the ground. Reduced visual acuity and contrast sensitivity are common in ageing[1] and people with Parkinson's disease (PD)[2] which may impede safe negotiation of cluttered environments and contribute to increased falls risk. The aim of this study was to investigate the effect of visual contrast on obstacle negotiation in people who fall with and without PD. METHODS: Gait was measured in 9 people with PD (Mean[SD]age: 68.9[7.1]y, H&Y stage II-III) and 12 older adults (Age:75.5[7.6]y) with a history of recurrent falls. Participants negotiated a small (2x60x2cm), long (2x60x15cm), and high (15x60x2cm) obstacle under high and low contrast (hue (colour) manipulation) conditions. Gait characteristics (speed, step length, duration and width) were measured using an instrumented walkway (GAITRite). A general linear model evaluated the effects of obstacle type (small/long/high); step (penultimate (A2) and final (A1) approach steps, and the lead (Ld) and trail (Tr) crossing steps); and obstacle contrast (high/low) on gait in PD and older adult fallers. Ophthalmologic assessments were obtained binocularly. RESULTS: The visual acuity of older adult fallers was considerably worse than PD fallers (p=.066) but contrast sensitivity was similar (p=.703). PD fallers widened their step when crossing the small and long obstacles more than older adult fallers when obstacle contrast was high (11% and 14% increase, respectively). When contrast was low, PD fallers widened their step as a function of obstacle type (small-long-high, p=.038). Participants crossed the high obstacle (high contrast) more slowly and slowed down earlier in the approach for the high obstacle under low contrast conditions irrespective of group (p=.035, Figure 1). Increased step length was observed for the long obstacle (low contrast) condition, particularly for the lead step compared to the small and high obstacles (p=.003, Figure 1). CONCLUSIONS: Obstacle negotiation is altered when contrast is reduced. PD fallers widened their step when negotiating high obstacles under low contrast, suggesting that when task-relevant stimuli are less visually prominent additional motor alterations are required to compensate. The increased lead step length observed for the long obstacle (low contrast) was likely an adaptation in response to reduced obstacle edge definition and therefore both groups exaggerated their step to safely clear the obstacle. Improving the contrast of potential hazards in the home and community is important to reduce trip hazards particularly when object edge definition is reduced (minimal environmental contrast) and environmental hazards are less protrusive within the field of view (relative orientation of long vs. high obstacle). REFERENCES: [1] Lord (2001) JAGS 508-515 [2] Davidsdottir (2005) Vision Research 1285-1296

P3-A-1 Characterization and quantification of mobility and activity outcomes in community living older adults using wearable global positioning technology

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Background & Aim: The objective of this study was to characterize and compare across variables in different domains of the International Classification of Functioning, Disability and Health (ICF), the mobility and activity profiles of community living older adults measured using ambulatory activity and mobility monitoring based on wearable sensors. Methods: 88 older adults living independently in the community in Montreal (Canada) were recruited and wore for 12 days during the day (average of 13 hours) a data logging platform incorporating a GPS receiver. LOCATION (time spent at the home - number of trips outside of the home) ACTIVITY (number of destination per trip outside of home) and TRAVEL (total transit distance, total transit distance in vehicle, total transit distance on foot) outcomes were extracted and reported per day of recordings. GEOSPATIAL DISTRIBUTION outcomes for the sphere of mobility of the participants were computed using modeling statistics (area and maximal distance of minimum span ellipse of GPS data clusters). A COMPOSITE INDEX score from these 9 outcomes variables was computed using a PCA. Body structures and function (cognitive status, depressive symptoms, body composition, pain), personal (age, gender, education, revenue) and environmental (social participation, living situation, walking access to shop and services, access to a car) outcomes were measured using questionnaires. Mobility outcomes were compared across participants using grouping criteria on body structures and function, personal and environmental outcomes. Results: 70/88 participants (80%) were kept for the analyses (33 men, 37 women aged between 55-85). 8 participants were lost for technical reasons and 10 participants were lost for lack of compliance. Participants spent per day on average 66% of the recording time in their home, with 2.41 trips outside of the home, 2.84 destination per trip, 34,11 minutes spent at destination. They travelled on average 28.66 km per day (26.66 km in a vehicle, 2,00 km). Their sphere of mobility and their composite score varied greatly between individuals. No significant differences in mobility outcomes were found when segmenting individuals according to body structures and function outcomes. Revenue (below poverty line) was the only personal outcomes that showed significant differences in 6 out of the 9 mobility outcomes. Environmental outcomes (frequency of social participation less then once per month, living alone, walking access to shop and services more then 15 min, no car access) affected mobility outcomes the most. Conclusions: Results suggest that mobility outcomes derived from recording of multiple days of body worn GPS can be sensitive to different domains of the ICF with environmental variables contributing significantly to variation in mobility of community dwelling older adults. On-going studies are looking at how aging and disease affect these mobility outcomes.

P3-A-2 Hesitation before walking is a measurable characteristic of free living mobility in stroke survivors

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BACKGROUND:Movement transitions (e.g. sitting to standing or walking to running), place greater demands on the motor control system than those imposed during steady state conditions such as standing and walking[1,2]. Therefore studying gait transitions of individuals with neuropathology may provide new insight into their motor control problems. Hesitation during the sit to stand (STS) to walk movement sequence can indicate underlying motor/balance impairments [3]. The extent to which this hesitation occurs in stroke survivors (SS) during free living is unknown and may be a useful metric of motor function. The aim of this study was to compare the STS -Walk transition time in stroke and healthy populations during everyday life. METHODS:Participants were healthy older adults (n= 30, 12 males, mean±SD age 66.8 ± 10.5 yrs) and stroke survivors (n=34, <1 month since stroke, mean±SD age 68.5 ± 11.2 yrs). A triaxial accelerometer (PalTechnologies, UK) was mounted on participants' thigh for 48 hours while at home. Raw data were categorised into movement states and transitions using proprietal algorithms. The transition time between a STS event and subsequent walking bout was extracted and categorised into uninterrupted (<=2s) and interrupted (>2s) movements based on previous studies of STS movements [4]. This was then expressed as a percentage of all transitions and compared with age-matched healthy controls. RESULTS: 47% of the transitions between STS and walking were UNinterrupted for the control group compared to 20.7% for stroke survivors (p< 0.001). Furthermore, there was a significant, positive, correlation between mobility (Modified Rivermead Mobility Index) and percentage of uninterrupted transitions (R=0.478, P = 0.004). CONCLUSIONS: These results indicate moving from sitting to walking is typically more interrupted in people living with stroke at home than for healthy age-match counterparts. Activity monitoring opens up the possibility of gaining greater understanding of movement transitions in free living stroke survivors with the capacity to inform rehabilitation programmes. Sit to stand to walk movements are more often hesitant in free living stroke survivors indicating impairments during movement transitions which are frequently necessary in independent living and are important targets for rehabilitation and measurement.

P3-A-3 Sit-to-stand transition time estimation based on wrist and hip acceleration sensors

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BACKGROUND AND AIM: Difficulties in safely performing mobility-related activities in daily life, such as sit-to-stand transitions (STST), can lead to deterioration in independent functioning (Tiedemann, 2008) and higher risk of falling (Rapp, 2012). Thus, the aim of this pilot study is to investigate the performance of a novel method for estimation of the STST-time based on hip and wrist acceleration data. METHODS: Data acquisition was performed with 36 older adults (65-95 years, 23 females) with a wide range of physical performance (median habitual gait speed 0.88 m/s; range 0.25 m/s to 1.76 m/s). Two sensor nodes based on 3-axial acceleration sensors were attached at the wrist of the dominant arm and ipsilateral hip. The measurement protocol included 8 types of STST performed under different conditions. Measurements were video-recorded and labeled to be used as the reference criterion. The beginning of the STST in videos was defined as the start of the flexion phase characterized by leaning forward, while the end was defined as the body extended in full height (Zijlstra, 2012). A sample-based method for the detection of the local extremes of the signal vector magnitude computed on the acceleration signal was proposed for both, wrist and hip sensor data. Empirical evidence shows that a local maximum depicts the seat-off moment and local minimum depicts the moment when the center of mass reaches the highest point. Assuming plausibility between detected STST interval and its residual, STST time was estimated as a double span between respective local extremes. Pearson's linear coefficient of correlation was calculated to describe the association between video and sensor timing. RESULTS: In total 321 STST recorded with both, hip and wrist sensors were evaluated (sensitivity: 97% and 93%). Video timing was moderately associated with hip sensor ($r=0.65$, $p<0.01$) and wrist sensor time estimates ($r=0.55$, $p<0.01$). Considerably better relation is shown for short STST (between minimum and mean transition duration), $r=0.81$, $p<0.01$ and $r=0.76$, $p<0.01$ for hip and wrist, respectively. CONCLUSIONS: The proposed method causes a trade off between elimination of the movement artifacts prior and directly after the STST, particularly for the wrist sensor, and the loss of information for STST parts outside local extremes interval. Estimation of the long STST duration shows moderate results due to the increasing transition parts outside extremes interval, while short STST are approximated good for both sensors. The hip sensor has shown slightly better results than the wrist sensor for all STST since it is closer to the center of mass where most of the transition movement can be caught. Furthermore, method enables time estimation of various types of STST, characteristic for the daily life activities. Further research should investigate additional events during STST in order to increase algorithm performance, particularly for long transitions.

P3-B-4 Lower Limb Adaptations and Compensation to Altered Kinematic Properties in Human Gait

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BACKGROUND & AIM: When limb dynamics are altered, channels of communication exist between the affected limb and the controller, the central nervous system, this allows for an optimal feedback control to modify sensory feedback and produce a motor command that fulfills the aspects of the movement task [1]. Upper limb movements, subjected to the Coriolis Effect, adapted to a new optimal movement pattern to meet the altered state of their environment [2]. In other instances, the human limb was able to quickly adapt to a perceived increase of limb weight [3] and adapted to a new limb trajectory. In both situations, when original parameters were restored, movements had the ability to return to their original state but had to readapt to this new state. The aim of this study is to explore the lower limb adaptation process by examining the compensatory reaction to restricted knee motion and to determine how quickly adaptations deviate and return to original walking patterns. METHODS: Testing includes one 15 minute treadmill walking protocol (at 1.38m/s) divided into 3 conditions. The three conditions were treadmill walking with an unlocked brace (PRE LOCK), brace locked at 30 degrees from full extension (LOCK), and return to an unlocked brace (POST LOCK). Individual strides were averaged into bins of 5 strides each. Toe clearance was calculated as the minimum vertical distance between mid-swing and stance phases, ±2 SD bars from steady state mean. Toe clearance values were considered statistically different if they were outside the ±2 SD. Two-way analysis of variance was conducted to determine the significant difference between steady state mean values. RESULTS: PRE LOCK and LOCK toe clearance values were within the ±2 SD for all bins of data. POST LOCK toe clearance values had an initial increase in toe clearance (0.062 m) after mechanical restraints were removed. During continuous walking the toe clearance values returned to steady state walking after 10 bins (~50 strides). Steady state walking patterns were statistically difference between walking conditions ($p > 0.05$). CONCLUSION: When the lower limb had restricted flexion, motor patterns exhibited tight control over toe clearance. Under these properties, the body is able to quickly compensate and adapt to produce safe trajectory of the limb through space and avoid tripping. Additionally when the restriction was removed the limb exhibited large initial toe clearance values and returned to near original toe clearance values.
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P3-B-5 Dizziness increases precautionary locomotor behaviour in patients with unilateral vestibular disorder

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BACKGROUND AND AIMS: Chronic dizziness is associated with gait unsteadiness in challenging motor tasks or environments with multiple intense visual stimuli. We specifically probed the question, "does dizziness interact with locomotor adaptation?". METHODS: Twelve patients with compensated vestibular neuritis (VN), twelve with unilateral active Meniere's disease (MD) and twelve older normal controls were recruited. MD and VN patients were matched for canal paresis. Locomotor adaptation was assessed with the "broken escalator paradigm": 5 trials stepping onto a stationary sled (BEFORE), 5 with the sled moving (MOVING) followed by 5 trials on a stationary sled (AFTER trials) which typically elicits the "broken escalator" locomotor aftereffect (LAE) in the first trial. RESULTS: Dizziness scores were four times higher in MD compared to VN. During MOVING trials, MD patients demonstrated significantly larger trunk sway compared to both VN and control groups. All groups produced a LAE, demonstrated by increased trunk sway in AFTER trial 1 compared to BEFORE trials. MD patients had significantly larger LAE compared to both VN and control groups. Higher dizziness scores translated to a larger LAE size. CONCLUSIONS: We suggest that dizziness interacts with locomotor networks to trigger increased precautionary behaviour.

P3-B-6 Does instruction type affect motor learning of a bilateral lower extremity motor task after stroke?

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BACKGROUND AND AIM: Motor learning is a set of processes associated with practice leading to relatively permanent changes in capability for skilled movement1. Motor re-learning is also the basis for motor recovery during rehabilitation after stroke. The appropriate application of motor learning principles to rehabilitation interventions may help overcome the recovery plateau2. For example, it has been suggested that instruction by visual demonstration may facilitate motor learning3,4 but it is not known if this applies to learning a reciprocal lower extremity (LE) motor task after stroke. The aim of this study was to determine which type of motor skill instruction (visual, verbal or manual) was most effective at facilitating motor learning of a bilateral LE motor task post-stroke. METHODS: Fifteen participants with sub-acute stroke were randomly assigned to manual (N=5), verbal (N=4) or visual (N=6) type of instruction for a seated, alternating foot tapping task to a target on two force platforms. Participants were instructed to tap as fast and as accurately as possible. Participants performed up to 50 trials (20 seconds each) during an acquisition session. Motor learning was assessed at a retention session 24-48hrs later where participants performed 10 trials (20 seconds each) of the same task. Motor performance was quantified by the number and accuracy of taps. RESULTS: Participants in all 3 groups were similar in age, time post-stroke, stroke severity, cognition and motor impairment. Repeated measures ANOVA revealed a within-subject main effect for trial ($p<0.001$) and a significant interaction of trial with instruction type ($p=0.04$) for number of taps. There were no between or within subject main

effects of interactions for tap accuracy from acquisition to retention. CONCLUSIONS: The results suggest all participants demonstrated motor learning of the motor task with respect to the number of taps but not the accuracy of taps. Visual instruction appears to be superior in influencing motor learning. The final results of this ongoing study may inform how to optimize the delivery of instructions during therapy to promote motor re-learning of bilateral lower extremity motor tasks like gait. REFERENCES: [1] Schmidt RA, Lee TD. Motor control and learning. 2011. [2] Page SJ et al. Arch Phys Med Rehabil. 2004. [3] Williams JG. Journal of human movement studies. 1993. [4] Ertelt D et al. Neuroimage. 2007.

P3-B-7 What is the role of augmented feedback in learning reactive balance control?

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Introduction: Concurrent augmented visual feedback of the centre of pressure (COP) or vertical standing forces can improve quiet standing balance control [1]; however, it is unknown if such feedback is useful for improving reactive balance control. Additionally, augmented feedback that provides an external focus of attention has been shown to be more effective than that providing an internal focus [2], although only when the goal of the task is also external [3]. It can be argued that balance control involves an internal focus of attention: maintaining control of the centre of gravity (COG). This study aimed: 1) to determine if concurrent augmented feedback can be used to improve reactive balance control; and 2) if feedback of the COP (external focus) or COG (internal focus) is more effective. Methods: 36 healthy older adults (60-75yrs) were recruited. Participants were randomly allocated to one of 3 groups depending on type of feedback received: feedback of the COP (COPf), feedback of the COG (COGf), or no feedback. The goal was to maintain standing balance without stepping while experiencing 30sec of continuous, pseudo-random waveform perturbations on a moving platform. Participants completed 25 perturbation trials with feedback (acquisition period), directly followed by 5 trials with no feedback (immediate transfer). After 24hrs, another 5 trials with no feedback (delayed transfer) were completed. A force plate and custom LabVIEW program were used to provide concurrent visual feedback of the COP or estimated COG location in the anterior-posterior direction (COPf and COGf groups). Participants were instructed to minimize the excursion of displayed COP/COG while maintaining balance on the moving platform. The root mean square (RMS) of the COP and COG, and RMS error (RMSE; i.e. COP minus COG), were compared between the groups and over time using a two-way ANOVA with group-by-time interaction. Results: There were no significant group-by-time interaction effects from the start to end of the acquisition ($p>0.0744$); from the end of acquisition to the immediate transfer ($p>0.0758$); or from the end of acquisition to delayed transfer ($p>0.3001$). All three groups

showed significant improvement during the acquisition period (reduction of RMS COP by 10.4%, RMS COG by 7.5% and RMSE by 21.8%: $p<0.0069$), and between the acquisition period and delayed transfer (reduction of RMS COP by 6.9%, RMS COG by 5.3% and RMSE by 5.4%: $p<0.037$). Conclusions: All groups improved ability to control balance during the continuous perturbations, with no group improving more than the others. These results suggest that concurrent augmented visual feedback is not beneficial for improving reactive balance control. Funding: This study was supported by The Drummond Foundation.
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P3-B-8 How do young adults improve their recovery performance following large backward balance perturbations?

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BACKGROUND AND AIM: Following a loss of balance, taking a step is a key saving strategy. Perturbation-based training specifically aimed at improving balance recovery steps may thus be a promising approach for preventing falls. For designing such training interventions, more insight is needed into how people learn improving their balance recovery performance. The aim of this study was to identify how healthy young participants improve their step quality with repeated exposure to perturbations, whether providing feedback on performance helps them improve more rapidly, and whether these gains are retained between testing sessions. METHODS: Three groups of 10 healthy young individuals were subjected to two sessions of large translational perturbations inducing a backward loss of balance. Each session consisted of 35 perturbations at an intensity of 4.5 m/s^2 (300 ms); sessions were one week apart. No practice trials were allowed. The primary outcome was the angle of the stepping leg relative to the vertical at the instant of foot contact, as this is highly representative of step quality[1]. All participants were instructed to recover balance with only one step. In addition, group 1 received numerical feedback on their performance. Group 2 only received qualitative visual feedback. Both types of feedback were projected on a screen in front of the participants following each trial. Group 3 received no further feedback. RESULTS: Across all participants, the leg angle in the very first trial was 2.8±7.7° and only four subjects succeeded recovering with one step. In subsequent trials, the leg angles improved very rapidly to 9.1±7.1° in trial 2, 12.4±7.6° in trial 5 and 16.4±5.7° in trial 31-35 (all $p<0.005$). First-trial leg angles in session 2 (13.9±6.2°) were substantially greater than in session 1 ($p<0.001$), and only slightly smaller than those at the end of session 1 ($p=0.018$). The leg angle in the second trial of session 2 (17.0±5.3°) was no longer different from that at the end of session 1. We did not observe any main or interaction effects of Group. CONCLUSIONS: A key finding of this study is the major first-trial effect on recovery performance, as indicated by the poor leg angles and the common need to take multiple steps. Step quality quickly improved over repeated trials and interestingly, after one week these improvements were largely retained even in the first trial. These findings are promising regarding the potential of perturbation-based balance training. Somewhat surprisingly, we did not find any additional benefit of providing feedback on performance. This may have been due to the instruction to recover using only one step, as succeeding or failing to do so also provided the subjects with feedback. It remains for future research to investigate whether feedback (and which modality of feedback) may aid balance-impaired people improve their balance recovery steps. REFERENCE [1]Weerdesteyn et al. Gait Posture, 2012;35:462-6.

P3-B-9 Investigation of postural motor learning in people with Multiple Sclerosis

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Multiple sclerosis (MS) is frequently associated with impaired balance resulting in falls and impaired mobility. Although rehabilitation has been recommended to improve balance in patients with MS, the extent to which people with MS can improve and retain improvements in postural responses to external perturbations is unknown. The aim of this study was to determine the extent to which MS affects the postural motor learning. 24 subjects with mild to moderate MS and 14 age-matched healthy control subjects underwent postural motor training with 5 sets of continuous sinusoidal surface translations provided by a servocontrolled, hydraulic force platform. Subjects were also tested the next day for retention and the ability to generalize the learned pattern to a naïve perturbation pattern. Primary outcome measure was the relative phase between the body center of mass and the platform motion. Despite deficits in postural motor performance in subjects with MS, they demonstrated a similar ability to improve postural control with training as the healthy control subjects. Both MS and control groups learned to anticipate the pattern of forward-backward perturbations so body CoM changed from a phase-lag to a phase lead relationship with the surface oscillations. Although deficits in motor performance were related to somatosensory deficits, the extent of improvement in postural control was independent of somatosensory deficits. People with MS have the capacity to improve postural responses with practice and, retain the learned behavior. Thus, despite the significant sensorimotor impairments, people with MS can improve their postural responses with practice by relying more on a feedforward strategy.

P3-C-10 The association between the impact of dizziness on quality of life and the postural fractality in elderly dizzy patients.

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Background and aim: Spontaneous fluctuation during static standing shows a functioning system of the postural control and it denotes underlying postural control system. The stationary and linear analysis using the displacement of the center of pressure (COP) during static standing have been reported to be uncorrelated with the function of postural control system and the subjective severeity of patients with dizziness and disequilibrium. The mainstay of postural analysis has been therefore a measurement of the dynamic characteristics of the COP and the fractality in order to provide a quantitative analysis of the postural control system. Furthermore, the COP trace has been reported to be a correlated process with different scaling regions, suggesting the presence of a multifractal structure. In this study, we investigate the multifractal nature of the COP traces based on the wavelet transform in order to link the classical notion of the multifractal spectrum in an analysis of the postural control system. In this study, we evaluated the association between the impact of dizziness on quality of life and the postural fractality in the elderly dizzy patients by multifractal analysis. Methods: The COP series signal for static standing of 60 seconds under eyes open and eyes closed condition was collected from 50 dizzy patients aged > 70 years old and 50 dizzy patients aged < 50 years old. The wavelet-based multifractal methodology was employed to estimate the fractal dimensions of the COP series data in Anterior-posterior (AP) and medial-lateral (ML) directions. We analyzed correlations of the Dizziness Handicap Inventory (DHI) with the stationary parameters (excursion area and mean velocity of the COP) and the fractal dimension. Results: The fractal dimension of the COP series in AP direction decreased with aging, however that in ML direction was not dependent on aging. The fractal dimension of the COP series in ML direction under eyes open condition (EO) and eyes closed condition (EC) calculated by multifractal analysis showed a significant positive correlation with the DHI scores, which reflects the impact of dizziness on quality of life ($r = 0.48$, $r = 0.37$, $p < 0.01$). In the mean velocity of the COP under EO and EC, there was a significant difference between both groups ($p < 0.05$). The stationary parameters showed no correlation with the DHI score in both groups ($p > 0.05$). Conclusions: This result suggests that the multifractal analysis of the COP is clinically useful to assess the objective function of the postural control system and that the fractal dimension by the multifractal analysis can reflect the impact of vertigo on the quality of life in the elderly dizzy patients.

P3-C-11 Postural control and brain stimulation: A neuromodulation approach to age differences in sensory reweighting

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BACKGROUND AND AIM: A critical factor contributing to older adults' reduced postural control is age-related slowing in sensory reweighting of visual, vestibular and proprioceptive information. Despite previous research indicating age-related decline in sensory reweighting, the neural underpinnings of this process are largely unknown. In the present study we investigated the role of the cerebellum and primary motor cortex (M1) in sensory reweighting in young and older adults using transcranial Direct Current Stimulation' (tDCS). METHODS: Postural control was assessed using support surface sway referencing, which introduces inaccurate proprioceptive information about body sway, by moving the support surface in proportion to body sway. Young (aged 18-35, N= 24) and older adults (aged 65-80, N= 18) were asked to stand on the sway-referenced surface for 3 minutes with and 3 minutes without vision. This was assessed before (pre), during (DC), immediately after (post0) and 30 minutes after (post30) tDCS stimulation. Compliance of the support surface was greater for the younger (gain = 2) compared to the older group (gain=1) in order to produce comparable levels of sway. The effect of anodal tDCS over M1 and the cerebellum on postural control was examined by means of a double-blinded, sham-controlled design, in which each participant experienced all 3 types of stimulation (sham, M1 and cerebellar) in 3 separate sessions. Changes in corticospinal excitability were evaluated using single-pulse transcranial magnetic stimulation (TMS), before, immediately after and 30 minutes after tDCS stimulation. RESULTS: Our compliance adjustment was successful as shown by comparable levels of sway in young and older adults. Despite a general reduction in postural sway within each session, the effect of stimulation on postural sway was minimal. Additionally, corticospinal excitability was not altered as a result of stimulation but it did change within each session: young adults showed decreased excitability from pre-stimulation to post30, however, older adults showed a slight increase. CONCLUSIONS: The objective to match levels of sway in both age groups was successfully obtained by altering the compliance of the support surface. However, the effects of tDCS on postural control were limited. Nevertheless, the divergent changes in corticospinal excitability in young and older adults over the course of assessment suggest that with age, different neural strategies are developed to maintain stability.

P3-C-12 The effects of foot type and shoes on gait characteristics during backward walking in older adults

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Background and aim: Abnormal foot type (pes planus or pes cavus) is related to decreased balance and to changes in forward walking patterns among adults. Similarly, shoes have been shown to affect gait stability, as well as the spatial-temporal characteristics of forward ambulation. Backward walking, which requires a higher degree of balance, is an essential function in daily activities, and is a common training tool in the rehabilitation of individuals with a variety of orthopedic and neurological conditions. The primary purpose of the current study was to examine the effects of foot type and footwear on the spatial-temporal characteristics during backward ambulation of elderly individuals. Method: Forty-seven community dwelling elderly individuals, average age 76.7±7.7 years, who were able to walk 50 meters without an assistive device, participated in the study. Gait analysis was conducted using the GAITRite®

system. The participants were requested to walk at a self-selected, comfortable walking speed under four conditions: forward and backward with and without shoes. The gait parameters of velocity, cadence, stride length and double limb support percentage time (%DLS) were extracted from the computerized system. Cognitive status and balance capabilities were determined with the Montreal Cognitive Assessment Test and the Berg Balance Test, respectively. The Foot Posture-Index (FPI) was used to evaluate foot type, which is based on observation and palpating bony points. A mixed design ANCOVA, with adjustments for cognitive status and balance as covariates, was used to determine the effect of foot type on gait parameters while walking with shoes or barefoot. Significance was considered at p=0.05. Results: Among the 47 participants, 25 (53.2%) had a normal foot type, 5 (10.6%) had pes cavus and 17 (36.2%) pes planus. Gait velocity, cadence, and stride length were significantly greater and DLS% was significantly lower in forward versus backward walking. Foot type did not affect gait parameters regardless as to gait direction or presence of footwear. Footwear had a significant effect on gait parameters. Lower cadence and higher DLS% time were demonstrated while walking with shoes compared to barefoot in both forward and backward directions. Gait velocity was faster without shoes than with shoes only during backward walking. Stride length was significantly longer with shoes as opposed to barefoot, only in the forward direction. Conclusion: Foot type is not a significant factor in terms of stability during gait in elderly individuals. Wearing shoes has a different effect on forward versus backward walking in terms of velocity and stride length. These results may be due to different sensory feedback strategies (visual versus tactile) used to achieve a steady gait during forward versus backward ambulation.

P3-C-13 Single and dual task gait speed: Implications for older pedestrians crossing the road

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Background and Aims: As people age, walking becomes an increasingly popular activity for both health and transport reasons, however walking speed declines with increasing age. In many countries including Ireland, a minimum walking speed of 1.2 m/s is required to cross the road at light controlled pedestrian crossings. Crossing the road is a complex task and many older adults report fear, anxiety and insufficient time to complete the crossing in the time provided. Walking while doing another activity is common, and in most cases, is associated with further reductions in walking speed. The aims of this study were to examine (i) how many older Irish adults have insufficient time to cross a road based on the minimum required walking speed and (ii) how dual task walking affects the ability to walk at this speed. Methods: Data were obtained from the first wave of the Irish Longitudinal Study on Ageing (TILDA), a nationally representative sample of community-dwelling adults aged 50 years and older, resident in Ireland. 5,035 participants agreed to take part in a comprehensive centre-based health assessment. Of these, 4,909 participants (mean age 63.3 years, range 50-93 years, 52.2% female) completed usual and dual task gait speed tests, measured using a 4.88 m GAITRite walkway. The weighted proportion of older adults with walking speeds of less than 1.2 m/s was obtained, stratified by age and sex. Results: Mean usual gait speed was 1.33 m/s (sd 0.21 m/s) while mean dual task gait speed was 1.09 m/s (sd 0.27 m/s). 31% of Irish adults aged 65-74 years and 61% of the over 75s walked slower than the minimum required walking speed of 1.2 m/s and therefore would have insufficient time to cross the road at pedestrian crossings. 54% of the under 65s and 91% of the over 75s would be unable to cross if they were walking while also carrying out a cognitive based task. Conclusions: A substantial proportion of Irish adults especially those aged over 75 would have insufficient time to cross the road based on their usual walking speeds. This illustrates that pedestrian light settings are not compatible with older adults' walking abilities which may impact on functional independence and quality of life. Dual tasking is associated with reduced walking speed across all age groups. An increased awareness about the hazards of dual tasking while crossing the road is required to target this issue.

P3-C-14 Muscle co-contraction in the ankle joint at different performance speeds in elderly adults.

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Background and Aim: As more than 25% of the population in Japan is elderly, aging is becoming a critical public health issue. Muscle co-contraction between agonist and antagonist muscles during postural control has been observed in the elderly. Several studies have concluded that poor ankle joint control might lead to muscle co-contraction. In addition, greater co-contraction has been found in fast, compared to slow, movement in healthy young adults. However, it is still not known whether similar patterns are observed in older populations with variations in speed of movement. The purpose of this study was to clarify how the speed of voluntary body sway affects muscle co-contraction in the ankle joint in the elderly population. Methods: Seventeen healthy older subjects (8 males, 9 females, age: 73.6 ± 2.8 years) participated in this study. We selected one voluntary postural control as a task. The subjects were required to shift their weight toward their toes, thereby leaning as far forward as possible under three speed conditions: normal, fast, and fixed. In the fixed condition, the participants were asked to lean forward with auditory signals. We recorded the coordinates of 47 retro-reflective markers on anatomical landmarks, using a three-dimensional motion analysis system. Two force plates on the floor recorded the ground reaction force. The coordinate of the center of mass (COM) was calculated from the marker positions to define the boundaries of movement on leaning forward. Electromyography data were collected with surface electromyograms from the tibialis anterior (TA) and soleus (SOL) in the dominant leg. To evaluate the relative level of co-contraction of the TA and SOL muscles, the co-contraction index (CI) was calculated according to the method described by Falconer and Winter (1985). The Friedman test was used to investigate the effects under different conditions and the Spearman rank test was used to measure the correlation between different conditions. The statistical significant level

was set at 5%. Results: CI was not significantly different between the three speed conditions ($p = 0.47$). The Spearman rank correlation coefficient revealed moderate positive correlation in CI between the normal and fast conditions ($\rho = 0.58$, $p < 0.05$), moderate positive correlation in CI between fast and fixed conditions ($\rho = 0.52$, $p < 0.05$), and strong positive correlation in CI between fixed and normal conditions ($\rho = 0.9$, $p < 0.01$). Conclusion(s): The effect of different speeds did not have an impact on CI. In addition, there were correlations in CI under different conditions. These results demonstrate that healthy elderly adults use similar muscle co-contraction strategies regardless of performance speed. Elderly adults may have to co-contract their muscles because of decreased balance. Therefore, it is important to recognize muscle co-contraction as one of the strategies used in the elderly to maintain postural control.

P3-C-15 Co-contraction during quiet standing in the elderly does not reduce postural sway

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BACKGROUND AND AIM: It has been reported that the elderly use tibialis anterior (TA) for longer duration and with larger amount during quiet standing, compared to the young. As the plantarflexors are always active, the ankle joint is stabilized by co-contracted the plantarflexors and TA when TA is active. However, it remains unclear if this co-contraction precludes greater postural instability or if it is a compensatory response to other factors. The purpose of this study was to compare postural sway during the periods with and without the co-contraction between plantarflexors and dorsiflexor, to investigate the role of the co-contraction frequently observed in the elderly during quiet standing. METHODS: Twenty-seven young (27.2±4.5 yrs) and twenty-three elderly (66.2±5.0 yrs) subjects participated in this study. Each subject was requested to stand quietly on a force plate for 5 trials of 90 sec each. The center of pressure (COP) trajectory and its derivative (COPv), the center of mass (COM) acceleration (ACC) were calculated using the force plate outputs. The period when TA was active (TA-on) was determined as three S.D. above baseline level measured during resting conditions in sitting. RESULTS: The root mean square (RMS) was used to quantify the postural sway amount for each variable. The percentages of TA-on duration were 19.0% (median) and 91.5%, respectively for the young and the elderly. When postural sway measures between TA-on and TA-off (period when TA was not active) are compared, the results indicate that (1) the elderly showed more sway in COP during TA-on, while the young showed less sway, and (2) both groups showed more fluctuation in COPv and ACC during TA-on. These results suggest that the additional TA activity destabilizes the posture in the elderly while not in the young. However, the COP has an inherent characteristic that it shows larger variance with longer duration (not stationary for a short duration). Therefore, this result may depend on the different total durations between TA-on and TA-off. On the contrary to COP, COPv and ACC are more stationary. For those measures, there is a tendency that COPv and ACC fluctuated more during TA-on in both groups, especially, for the subjects who swayed larger. This result suggests that the co-contraction of the ankle joint muscles increases the postural sway in comparison with the plantarflexors' activity alone. CONCLUSIONS: We conclude that the co-contraction frequently observed during quiet standing in the elderly does not successfully preclude the increased postural sway. Rather, the co-contraction induces further postural sway probably due to increment of controlling parameters. The elderly shows the co-contraction for rather compensating reactions than reducing the postural sway.

P3-C-17 Contributors to Poor Mobility in Older Adults: Integrating Small Vessel Disease and Conditions Affecting Other Systems: the Cardiovascular Health Study

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BACKGROUND AND AIM: Age-related mobility limitations are debilitating and common. Cerebral small vessel disease (SVD) and conditions affecting other systems (OC) are known contributors, but have often been studied in isolation. METHODS: In 2703 adults aged ≥65 years, we tested the cross-sectional associations of mobility (gait speed (meters/second) and mobility disability (self-reported difficulty walking ½ mile)) with SVD (MRI-defined white matter hyperintensities) and six concurrent OC: sex-specific grip strength and lowest quartile of forced vital capacity; self-reported poor vision and joint pain; ankle-arm index (AAI)<0.9; and body mass index (BMI)>30. Separate regression models adjusted for age, gender, and race were repeated for each OC and based on a 4-level predictor: no SVD/no OC, only OC, only SVD, or both SVD and OC. RESULTS: With the exception of low AAI and high BMI, having concurrent SVD and OC was associated with the worst gait speed and highest proportion with mobility disability. For all OC except high BMI, the gait speed for those with SVD alone and the OC alone were not significantly different. The proportion with mobility disability was similar for those with SVD alone and for those with weak grip, poor vision, or low FVC alone. For example, mean gait speed was 0.96m/s (95% confidence interval: 0.94, 0.97) with no joint pain or SVD; 0.90m/s (0.89, 0.92) with joint pain only; 0.92m/s (0.90, 0.94) with SVD only; and 0.86m/s (0.84, 0.88) with both. Results were similar for mobility disability. CONCLUSIONS: In this sample of community-dwelling older adults, moderate cerebral WMH were related to slow gait speed and mobility disability as strongly as other known contributors to mobility. Moreover, coexistence of WMH with other conditions was common and for participants with both, gait speed was slowest and mobility disability most prevalent. These results indicate that WMH, either in isolation or in the presence of other conditions, should not be overlooked in the understanding and treatment of mobility problems.

P3-C-18 Gait speed in relation to cognitive scores and symptoms of depression in Mexican older adults: A secondary analysis

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Background and aim: Walking in public represents many threats for older adults and compromises even more their walking speed. A secondary analysis from data of a physical-cognitive intervention to enhance gait speed in older Mexican Adults was performed. Aim: To describe a sample of Mexican older adults according to symptoms of depression and their walking speed under single and dual task conditions. Methods: Sedentary elders able to walk were selected. Participants were classified into three groups: a) low speed those who walked <0.7 m/s; b) median those who walked 1-0.7 m/s, and c) high >1.1 m/s. The CES-D scale was used to measure depression symptoms and the Mini Mental State Examination Spanish version for cognitive state. Gait parameters were measured under simple and cognitive dual task (counting backwards) conditions using a computerized system GAITRite, CIR systems. Results: In regard to chronic diseases only those participants who reported a cardiac condition walked significantly slower than those that reported not having a cardiac condition Mean 81.00, SD=18.89 and Mean 91.32 SD=20.09, respectively (p=.001). Sixty older adults classified as low speed, 204 as median, and 112 as high speed walkers. The proportion of men who classified as low were: (7; 9.7%), median (31; 43%), high (34; 47%), while women were: low (53; 17%), median (173; 57%), and high (78; 26%). U Mann-Whitney tests showed that all three groups according to walking speed were significantly different in relation to depression symptoms; those who walked slower revealed more depression symptoms than those in a median and high speed (all ps≤ .006). Participants who classified as low speed showed significant differences in relation to those in median and high speed (p≤ .05), but median and high speed did not achieve significance (p=.051). Spearman´s correlation coefficient showed a relationship between gait speed at usual pace and the Minimental state examination test (rs =.23, p < .001), and speed at dual task (rs = .35, p < .001), and inverse relationships between gait speed and symptoms of depression rs =-.32, p < .001, and speed at dual task (rs =-.34, p < .001). The cognitive performance (MMSE) and symptoms of depression accounted for 12% of the explained variance of gait speed (F =19.64, df 2,283, p < .001). For each unit that symptoms of depression increased gait speed decrease .13 points and for each unit that the MMSE score increased gait speed increased .26. Conclusions: More women classified as low and median speed walkers, while more men as high walkers. Better performance in the mimimental state examination test showed higher scores in walking speed. The more symptoms of depression less walking speed.

P3-C-19 Enhancing adherence to technology-based exercise programs: What do older adults have to say? A Qualitative Study

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Background and aim Health benefits of physical activity have been well documented in older adults. These benefits can only be achieved and sustained if physical activity participation is maintained over extended periods of time. However, declining levels of adherence over time in older adults have been reported by various exercise intervention trials. Recently, information technologies have been increasingly used to deliver exercise programs and are thought to have the potential to increase exercise adherence in older adults. Yet, many of the solutions are still targeting tech-savvy people and do not specifically focus on the particular needs of older adults. The aim of this study was to explore older people's perceptions of technology-based exercise programs for use in the home, and gain insight on how best to design programs that will encourage older people to adhere to exercise in the long-term. Methods Study participants were older adults over 70 years of age that had recently completed a 16-week unsupervised technology-based exercise program delivered in their homes. A sample of 29 older adults were recruited using maximal variation purposive sampling to ensure inclusion of participants with different degrees of adherence to the intervention, use of technology, age, gender and health status. Semi-structured interviews were conducted within 30 days of the participants completing the intervention. Interviews transcripts were coded using NVivo software and analysed thematically using framework analysis approach. Results Three main themes emerged reflecting older adult's views on requirements of a technology-based exercise program to enhance exercise participation and facilitate long-term adherence (Figure 1). First, the program must be stimulating. Participants identified a need for programs to remain challenging over time as well as to provide a sense of achievement. Second, the user must see a perceived benefit from undertaking the program. Identified perceived benefits included improvements in physical and cognitive tasks as well as increased self-confidence and self-esteem. Third, the program must be accessible. Participants emphasised the importance for programs to be reliable and easy to use, with step-by-step user instructions that are accessible to those with little to no experience with technology. Conclusion: Technology-based exercise programs can offer an opportunity to enhance motivation to exercise provided the program is stimulating by providing varied levels of difficulty is perceived beneficial by providing instant feedback on performance and progress and accessible and easy-to-use.

P3-C-20 Foot sole sensory function is enhanced by transcranial direct current stimulation (tDCS) in older adults

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Background and aim:Foot sole somatosensation is critical for safe mobility, especially in elderly people who are at high risk of falls. Somatosensation depends not only upon afferent input to the central nervousl system, but also upon the excitability of the somatosensory cortex and related brain networks. Strategies aimed at increasing cortical excitability, such as transcranial direct current stimulation (tDCS), may therefore enhance somatosensation, and thus mobility. To establish proof of concept, we hypothesized that a single session of tDCS designed to enhance cortical excitability would improve foot-sole sensation and mobility in older adults. Methods: Twenty healthy older adults (aged: 61±4 years) completed two study visits separated by one-week. On each visit, vibratory thresholds of each foot and performance in the timed-up and go test (TUG) were assessed immediately before and after a 20-min session of real (2mA) or sham (i.e., control) tDCS targeting the left primary sensorimotor cortex. Subjects were randomized (?) and blinded to the tDCS condition. Standing vibratory thresholds were measured using a shoe insole that delivered random vibrations (Figure 1). A software program enabled the amplitude of vibrations to be automatically ramped up and down and subjects were instructed to press a button when they could feel, or no longer feel, the vibrations. This procedure was repeated three times for each foot to determine sensory thresholds values and these values were averaged. Lower values reflect better vibratory sensation. Results: Vibratory thresholds in both the left and right foot were significantly lower following real tDCS as compared to following sham tDCS, as well as both baseline conditions (left foot: F=4.6, p=0.01; right foot: F=3.4, p=0.03) (Figure 2A and B). A similar trend towards better TUG performance after real tDCS was observed (F=2.4, p=0.07) (Figure 2C). Further analysis indicated that the percent change in vibratory thresholds following real tDCS was similar across feet (Figure 3A) (R =0.46, p =0.04). Moreover, the magnitude of improvement in vibratory threshold (averaged across feet) correlated with the magnitude of improvement in TUG performance (R=0.48, p=0.03) (Figure 3B). Conclusion: A single session of tDCS targeting the left sensorimotor cortex acutely improves foot sole vibratory somatosensation in healthy older adults. While additional research is needed to determine the duration of this improvement, as well as the effects of tDCS on other forms of somatosensation, these results suggest that this form of noninvasive brain stimulation may be a safe strategy for improving lower-extremity sensory function--and potentially mobility--in the older adult population.

P3-D-21 Spectrum Analysis of Body Sway in Bipedally Standing Rat

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BACKGROUND AND AIM: While standing, human body continuously sways. In order to study the posture control mechanism with sway, this research proposes an experiment of bipedal standing rat and performs a spectrum analysis of the measured body sway. Characteristic frequency in the body sway is searched from the measured power spectrum density (PSD). PSD of rat is then compared with the PSD of human, and the mechanism of difference in the sway motion is discussed from the viewpoint of body dynamics. METHODS: In order to investigate the sway motion of rat during bipedal standing, rats are placed on a forceplate (Tec Gihan TF-4060-A) surrounded by clear case and their center of pressure (COP) are measured. Four normal rats (male Wistar rat 160-190[mm], 170-190[g]) participated in the experiment, and continuous standing for over 200 [s] was measured in each rat. Measured frequency of forceplate was 1[kHz]. In human experiment, standing motion of 6 participates were measured for 360[s] and COP were measured with 500[Hz]. Rat and human experiment were approved by the Ethics Committee of Tokyo University and Doshisha University, respectively. PSD is calculated from the measured COP using fast fourier transform (FFT) and maximum entropy method (MEM). In order to examine the slow body sway, PSD with maximum 1[Hz] is focused. Time constant of rat and human are estimated using 1-link inverted pendulum model and their difference is compared with the difference in the result of rat and human PSD. RESULTS: Steady bipedal standing was successfully measured for 10 trials in total. PSD of sagittal COP movement was then calculated using FFT and MEM as shown in Figure A. In the figure, black line is PSD of MEM and gray line is that of FFT, respectively. From the result of MEM, peak frequency under 1 [Hz] was found at approx. 0.1 [Hz] as depicted by dotted line. The same results were found in every 10 trials, and the mean (standard deviation) was 0.10 (0.05) [Hz]. PSD and peak spectrum were also calculated for human standing as shown in Figure B. Peak frequencies, what were common in every subject, were found at 0.02 (0.009) [Hz] and 0.34 (0.04) Hz. In order to evaluate the difference in peak frequency of rat and human from the point of the difference in body, time constant of rat with COM height 0.1 [m], 0.18 [kg] and human with COM height 1.0[m], 60 [kg] were calculated. As a result, the time constant of rat was 1/3 of that of human, and it was well accorded with the result of the difference in the peak frequency of rat (0.10[Hz]) and human (0.34[Hz]). CONCLUSIONS: This research analyzed PSD of rat and compared it with PSD of human, and found the peak frequencies of PSD in places corresponding to the body of rat and human. This result indicates that rat and human generate cyclic sway in a similar control mechanism with different body. Acknowledgements This paper was supported in part by a kakenhi grant (No. 26289063,26120006).

P3-D-22 What feet position must be used in standardized stabilometry?

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? BACKGROUND AND AIM : Because the feet position adopted during a stabilometric recording is likely to affect the results (Mouzat et al, 2004), standardized positions have been proposed (AFP, 1985; Imaoka et al., 1997; McIlroy and Maki, 1997; Scoppa et al,. 2013). But these compulsory positions force the subject's body to organize itself around them (Helbert, 2014). Before adopting a new standard foot position, at an international level, it is possible to see what feet position is spontaneously adopted by cohorts of subjects. ? METHODS : From a population with a 'dominant left foot', a cohort of 57 subjects has been selected according to rejection criteria. Each subject had to position himself, using a purely visual reference frame, no reference has been made to his feet position. He started from the rear left corner of the cabin SAM3D® and went to a confortable position in the center of the cabin, at a precise spot where he could see that were equal the two surfaces of a visual target situated at 4, 5 meters in front of him. Then the position of the subject was recorded by an optical device. The maneuver was repeated starting from the rear right corner of the cabin. A computer processing of the optical signal was able to locate the two feet in relation to the reference frame of the cabin, which is parallel to the visual reference frame of the subject, Oy axis directed toward the target. ? RESULTS : The axis of the right foot is at an angle of 7° ± 2°.5 from the Oy axis and the axis of the left foot at an angle of 5°.8 ± 2°. The distance between the feet, measured midway along their axes, is 233.5 ± 47.5 mm. The difference between the ordinates of the mid of the heels is 12.7 ± 3.2 mm ? CONCLUSIONS : The natural position of the feet, really, is a range position, but the angle between the two feet is only about 13° instead of 28° / 30° or 0° proposed by earlier studies. The difference between the ordinates of the mid of the heels shows a rotation between the visual reference frame of the subject and his proprioceptive reference frame, built on an Ox axis tangent to the heels. Far from responding to the question of the feet position for standardized recordings, these measures therefore pose a new question: should the subject be placed in his visual reference frame or within his proprioceptive reference frame? References AFP (1985).Normes85. ADAP, Paris. Helbert S. (2014) "Gérard a raison". http://clinicalstabilometry.freeforums.org/post110.html#p110 Imaoka K, Murase H, Fukuhara M. (1997) Equilibrium Research,Supp.12:1-84 McIlroy WE, Maki BE. (1997) Clin Biomech (Bristol, Avon). Jan;12(1):66-70 Mouzat A, Dabonneville M, Bertrand P. (2004) Neurosci Lett. 22;365(2):79-82 Scoppa F, Capra R, Gallamini M, Shiffer R. (2013) Gait & Posture. 37 (2):290-2

P3-D-23 Effects of shoe bending stiffness on running economy

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Background and aim Stiffening the longitudinal bending stiffness of shoes was known to help a runner reduce metabolic cost. There were much controversies over that how the stiff shoes improves running efficiency and the existence of optimal bending stiffness of shoes maximizing running efficiency. In this study, underlying mechanisms of the increased running efficiency were analyzed to answer a question about whether the stiff shoes help a runner make propulsion force and reduce metabolic cost. An optimal bending stiffness of shoes was also suggested to get best running efficiency. Methods Five healthy young man ran on the force treadmill at 2.78 m/s. To stiffen the shoes, carbon fiber plates with five different stiffnesses were inserted into the bottom of the insoles. One hypothesis is that the stiff insoles assist runner's own work to make propulsion using the elastic energy stored inside that insoles. The mechanical work done by each joint and inserted carbon fiber insoles was calculated to see whether

the increased bending stiffness of shoes reduce runner's own work. We also hypothesized too stiff insoles might disturb the natural joint motion so it could change the working condition of the related muscles. A moment arm of the ankle joint was calculated to predict actual muscle contraction force of the plantar flexors. Lastly, a specific bending stiffness of shoes to maximize the running efficiency without disturbing the natural joint motion was suggested. The suggested value was then compared to the bending stiffness of the metatarsophalangeal (MTP) joint, to find the runner-dependency of the suggested bending stiffness. Results As the bending stiffness of shoes was increased, elastic energy stored inside the stiff insoles during its flexion and its reutilization was increased. Similarly, work done by the ankle and MTP joint decreased so the stiff shoes could help a runner reduce his work as hypothesized. Beyond a specific bending stiffness, the MTP flexion was significantly decreased so moment arm of the ankle torque was increased. To make a certain magnitude of ground reaction force the contraction force of the plantar flexors has to be increased, which could be more challenging and costly conditions. To get higher running efficiency with help of the reutilization of the elastic energy stored inside the stiff insole, larger bending stiffness would be helpful within the range that natural MTP flexion was not disturbed. Interestingly, the MTP flexion was decreased when the bending stiffness of shoes became larger than that value of runner's own bending stiffness of MTP joint. Conclusions With the help of reutilization of the elastic energy stored inside the stiff insoles, runners could reduce work and improve running efficiency. Not to disturb the natural MTP flexion and maximize the running efficiency, a specific bending stiffness was suggested and its value was very similar to runner's bending stiffness of MTP joint.

P3-D-24 Effect of nigral stimulation on gait in Parkinson?s disease

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BACKGROUND AND AIM: Freezing of gait is a debilitating symptom of Parkinson's disease with a major unmet therapeutic need. Interleaved deep brain stimulation of the subthalamic nucleus (STN-DBS) and the substantia nigra pars reticulata (SNr) may improve freezing of gait (Weiss et al., 2013). SNr stimulation alone can have a positive effect on the axial symptoms, whereas it doesn't improve the segmental symptoms (Chastan et al., 2009). Here, we study the effect of different STN-DBS parameters on gait. METHODS: We analyzed 8 patients with Parkinson's disease and STN-DBS (7 male, 59 ± 8 years) of whom 7 patients were also analyzed with SNr stimulation (lowest electrode implanted in the SNr) during walking at their own comfortable pace on a straight walkway of nine meters. Patients were measured in 3 conditions: with stimulation of the STN, with stimulation of the SNr and without stimulation (off). Gait was recorded by 3 sensors attached on both left and right ankle and lumbar, measuring acceleration, angular velocity, and the direction of the magnetic field in 3 directions. We calculated the gait cycle time (time to complete one gait cycle) and the peak shank angular velocity during the swing phase (highest angular velocity during the swing phase). RESULTS: Preliminary results (more data will be measured in the next months) show that the gait cycle time during stimulation off (1.14 ± 0.09 s) was similar as during STN (1.13 ± 0.06 s) or SNr (1.12 ± 0.10 s). The peak shank angular velocity showed an improvement with stimulation: the lowest velocity was during stimulation off (209.2 ± 26.3 °/s), higher velocities were observed during STN (273.8 ± 23.46 °/s) and SNr (236.63 ± 25.6 °/s). CONCLUSION: SNr stimulation, as STN stimulation improves the peak shank angular velocity in patients with Parkinson's disease. The gait cycle time appeared to be similar in the conditions. These results are based on preliminary data, further measurements and analysis will reveal a more comprehensive effect of SNr stimulation. REFERENCES: Chastan N, Westby GW, Yelnik J, Bardinet E, Do MC, Agid Y, et al. Effects of nigral stimulation on locomotion and postural stability in patients with Parkinson's disease. Brain 2009; 132: 172-84 Weiss D, Walach M, Meisner C, Fritz M, Scholten M, Breit S, et al. Nigral stimulation for resistant axial motor impairment in Parkinson's disease? A randomized controlled trial. Brain. 2013; 136:2098-108.

P3-E-25 Cortical correlates of congruent and incongruent visuo-vestibular inputs

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R.E. Roberts1, H. Ahmad1, Q. Arshad1, D. Dima3, R Leech2, B.M. Seemungal1, D. Sharp2, A.M. Bronstein1 1. Neuro-otology Unit, Division of Brain Sciences, Charing Cross Hospital, Imperial College London, London, UK 2. Computational, Cognitive and Clinical Neuroimaging Laboratory, Imperial College London, Hammersmith Hospital, London, UK 3. Social Genetic and Developmental Psychiatry, Institute of Psychiatry, King's College London, London, UK Background and aim: Visual and vestibular inputs mediate the control of spatial orientation and postural balance. The brain combines visual and vestibular information to distinguish between self- and world-motion. In most situations these signals are complementary and predominately indicate that the individual is moving or stationary with respect to the surroundings. However, in situations where visual motion and vestibular cues conflict this can lead to ambiguous or false sensations of motion. Methods: In this study we used functional magnetic resonance imaging to explore the brain activation when visual and vestibular cues were complementary or in conflict. We combined a horizontally moving optokinetic stimulus with a caloric irrigation of the right ear to produce conditions where the vestibular activation and visual motion would indicate the same or opposite direction of self-motion. Results: We found that visuo-vestibular conflict was associated with increased activation of the left posterior insular cortex. In the congruent condition there was increased activation in primary and secondary visual cortex. Visual dependency and subjective or objective measures of the intensity of the vestibular activation were not predictive of individual differences in activity within these regions. Conclusion: These findings suggest that when there is conflicting information regarding self-motion there is preferential activation of our vestibular areas, whereas when the sensory cues for self-motion are congruent there is a bias towards the visual stimulus. These data support the view that posterior insular cortex may play an important role in a network of regions responsible for integrating visual and vestibular cues for self-motion during sensory conflict.

P3-E-26 Cortical load of human gait in a dual task

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Background & aim. Research on attention during walking revealed the need of cortical control to walk safely. α and β band cortical oscillatory activities measured over the motor cortex are closely related to the gait cycle. We investigated whether (parts of) these brain activities are associated with the degree of attention directed towards gait. Brain activity was assessed using electroencephalography (EEG) in walking, while attention was either directed towards gait through visual stepping-stones, or away from gait through a cognitive dual task. Methods. We used the maximum Lyapunov exponent to quantify gait performance and the percentage of proper responses combined with median response time to quantify performance in the dual task. The EEG data were subjected to a a time-frequency analysis around gait events, stimulus presentation, or button press. We finally used a linear mixed effect analysis was used to evaluate relations between brain activity, gait performance, and performance on the cognitive task. Results. Gait stability decreased only when gait was combined with the dual-task and when participants also had to walk precisely on a random stepping pattern. Performance in the dual task was similar among conditions. The linear mixed effect analysis revealed a relation between median response times and mean β power, but we found no relation between gait performance and α or β band activity. This indicates that during dual tasking participants needed to pay more attention when the dual task was perceived as more difficult. Conclusion. The preservation of gait got higher priority than the cognitive task.

P3-E-27 Cortical activations associated with the anticipatory postural adjustments prior to stepping

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The central nervous system (CNS) controls the challenge of maintaining human balance in two ways: reactively and predictively. Reactive control involves generation of compensatory postural adjustments to counteract unpredictable postural perturbations. Predictive control involves generating anticipatory postural adjustments (APAs) prior to instability caused either by anticipated postural perturbations or voluntary movements. The current study is focused on advancing understanding of CNS control of APAs. It is postulated that the basal ganglia-thalamo-cortical motor circuit controls APAs. However, the role of

the cortex in the generation of APA remains unclear. The present study examined the cortical activations related to generation of APA during stepping. The APA element of stepping is the lateral displacement of the center of mass (COM) towards the stance leg prior to limb swing. This lateral motion of the COM is accomplished by generation of a medial-lateral (ML) shift in the center of pressure (COP) towards the swing limb, followed by unloading of the swing limb. The complexity in stepping is that there is also concurrent antero-posterior displacement of the COM related to the task of forward stepping as well as the onset of limb unloading. The challenge is to isolate the cortical activity specifically associated with preparation of APA as opposed to the activity linked to forward movement of the COM and the onset of limb unloading for the swing phase. In order to distinguish cortical activity linked to the APA from other elements of stepping, we compared cortical activations prior to the onset of three variations of movements: 1) lateral stepping (equal weight on each limb to evoke an APA), 2) unloaded lateral stepping (swing limb unloaded to eliminate need to evoke an APA) and 3) lateral weight shift (no stepping). 14 healthy young adults stood with each foot on a force plate and performed lateral weight shift and lateral stepping tasks in response to an auditory cue. Cortical potentials were recorded using EEG, filtered offline (2-50 Hz) and analyzed by time-locking to the onset of APA as indicated by MLCOP changes in the swing limb. The preliminary results showed a negative potential that precedes the onset of APA during lateral stepping (peak latency: -85±38 ms, peak amplitude: -4.43±1.46 µV at FCz) and prior to the lateral weight shift (-95.71±45.49 ms and -3.12±1.17 µV at FCz) in the fronto-central regions. The negative potential prior to APA onset suggests that the cortex might contribute to the generation of APA. The fronto-central representation and timing of the negative potential may link the activation to the contingent negative variation or Bereitschafts potential generated by prefrontal cortex and/or supplementary motor area. Ongoing analysis is focused on attempting to dissociate the cortical activity associated with the generation of the APA from cortical activity associated with the focal task of stepping.

P3-E-28 The neural correlates underlying dual tasking in Parkinson's disease

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BACKGROUND AND AIM: The ability to divide attention plays an important role in dual tasking (DT) and in the so called "DT decrement". In the context of gait, this decrement has major negative consequences as it impacts safe ambulation, increases fall risk, and restricts functional independence. The DT decrement is generally exaggerated with ageing and in Parkinson's disease (PD), however, the understandings of its underlying brain mechanisms are still lacking. The aim of this study was to use functional MRI (fMRI) to study the neural mechanisms underlying DT in PD. METHODS: Twenty-two patients with PD (mean age: 72.69±4.17 yrs) and 14 healthy controls (mean age: 71.18±5.97 yrs) were

studied using an fMRI paradigm that included three conditions that were presented in a block design: 1) alternating feet movements against foot pedals (single task), 2) subtracting 3s from a predefined number (single task), and 3) performing both tasks simultaneously (DT). Each of the blocks was presented 5 times and lasted 12 second, followed by a rest block of 9 seconds. DT related brain activations were examined by comparing the DT condition with both of the single tasks conditions. DT related brain activations were further correlated with measures related to attention and task switching, the Trail Making Test (TMT), and with DT gait speed decrement (i.e., usual walking gait speed minus DT speed). RESULTS: Both groups showed significant increase in DT related activations in the middle frontal gyrus, precentral gyrus, inferior frontal gyrus (Broca's areas), thalamus, and superior parietal lobe (SPL) (p FWEcorr <0.05). Compared to the healthy elderly, patients with PD had significantly lower DT related activations in the occipital cuneus and lingual gyrus (p FWEcorr <0.05), SPL, middle frontal gyrus, medial frontal gyrus/anterior cingulate and right caudate nucleus (p<0.0005, uncorrected). The SPL fMRI beta values of DT related activations were negatively correlated with the time to complete the TMT part b (r=-0.412, p<0.01, corrected for age) but not with TMT part a duration (r=-0.247, p=0.159, corrected for age). In addition, higher SPL beta values were correlated with lower DT gait speed decrement (r= -0.345, p<0.05). This effect was significant in the healthy controls (r=-0.717, p<0.0004), but not in PD (r=0.034, p=0.898). CONCLUSIONS: These findings suggest that part of the difficulties that patients with PD have during DT are related to a decreased ability to recruit brain regions including occipital, parietal, frontal and motor regions. Our results support the involvement of the SPL as a principal factor in DT as it was correlated with both the DT gait decrement and with attention. The lack of correlation between the SPL with the DT gait speed decrement in PD suggests that the adjustment of gait to DT is not strongly controlled by parietal regions in PD.

P3-F-29 Relationship between balance and cognitive impairment in older people

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Background and aim It has been demonstrated that there is a significant impairment in some balance measures in people with diagnosed Alzheimer's disease (AD) and mild cognitive impairment (MCI) compared to age matched normals, implicating damage to the vestibular pathways as the most probable cause (1) . This study extends this to examining the relationship between cognitive ability and the vestibular component of balance in a population of older women with no definite AD or MCI diagnosis, no complaint of memory loss, and without impairment of daily activity, with a view to future consideration of balance as a possible diagnostic or prognostic indicator Methods 70 physically active women with a mean age of 73 (sd=9) years were given the Italian version of the MoCA test and their static balance parameters (AP and ML total sway path length) were measured on a balance platform with and without a 30mm rubber mat. This paper only considers those measurements made with closed eyes to exclude visual balance components. Results 30 (43%) of participants had total adjusted MoCA scores below the normal range (<26). The range of MoCA scores recorded was 19-30. A multiple regression model (forced entry) showed that only the AP sway on a firm surface was a significant predictor of the total adjusted MoCA score (R2=0.172). Age was not a significant predictor. Although the AP sway (eyes closed) by itself accounts for less than a fifth of the total variation in cognition as measured by the MoCA, it does show a positive association and is likely to make a significant improvement in any existing risk model for cognitive impairment. An independent-samples median test was used to compare the AP sway, eyes closed values between those with normal and below normal MoCA scores. There was a statistically significant difference (p<0.001) between the groups, with the group with lower MoCA score having greater sway This is illustrated in Figure 1. It can also be seen that the AP sway measure in the lower MoCA score group is more variable than in the normal score group. Conclusions The antero-posterior sway component of static balance was demonstrated to be the best predictor of the MoCA overall score in physically active older women. As visual and proprioceptive components of balance were excluded in our assessments, the vestibular system is to be considered as a putative link between balance and cognitive impairment. (1)Leandri M, Cammisuli S, Cammarata S, Baratto L, Campbell J, Simonini M, Tabaton M (2009) Balance features in Alzheimer's disease and amnestic mild cognitive impairment. J Alzheimers Dis 16, 113-120

P3-F-30 Stepping task requiring memory and mimic and cognitive function

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BACKGROUND AND AIM: Screening older adults with mild cognitive impairment (MCI) is significant because MCI is often considered to be a transition stage between normal cognition and dementia. Some screening methods have been developed; however, these methods require a lot of human resources and time. Square-Stepping Exercise (SSE) is a novel form of exercise, which requires both attention and memory (i.e., watching, remembering, and then executing stepping patterns) and could improve cognitive function in older adults. The purpose of this study was to test relationships between stepping task performance and cognitive function. METHODS: In total, 170 community-dwelling adults aged 65 years or older participated. If participants scored less than 26 on the Montreal Cognitive Assessment, they were considered to have probable MCI. Ten different SSE patterns were selected based on previous experiences and examined whether or not participants could correctly execute the stepping patterns. RESULTS: 43 (25%) in the 170 participants were defined as having MCI. Reliability in each pattern was significantly high. There were significant differences in the success ratios in three SSE patterns between MCI and non-MCI participants. The patterns also showed significant differences in sex and the number of trials. CONCLUSIONS: The SSE patterns may discriminate among older adults with and without MCI.

Future research should develop a screening method for MCI, including information on the SSE patterns, sex, and a trial number.

P3-G-31 Remote monitoring reveals how clinical factors influence walking patterns in older people

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BACKGROUND AND AIMS: Impaired gait in older people is associated with disabilities in daily life and increased risk of falling, but knowledge is still limited on what underpins the quantity, quality, and intensity of walks in daily life. Advances in wearable accelerometers enable the remote monitoring of daily activities in older people providing new insights into the complex problem of age-associated health decline. Recent research suggests that walks performed during activities of daily life are both less vigorous and more variable than walks performed in a clinical setting. Activity monitoring over several days has revealed important associations between reduced gait quality during daily life and increased falls in both healthy and cognitively impaired older people. However, it is not certain if the gait of older people during daily life can be modified, or even which physiological, psychological, cognitive, and health characteristics should be targeted by future interventions. In the current study, we investigated which clinical factors were most strongly associated with the quantity, quality, and intensity of walks performed by thirty-eight independent living older people over two weeks of continuous monitoring. METHODS: Thirty-eight participants (mean age: 82 years) wore a small pendant accelerometer in their home environment, over a period of two weeks from which several accelerometer-derived gait measures were calculated comprising: 1) Number of steps. 2) Number of walks 3) Gait vigour. 4) Cadence. And 5) Step time variability. A comprehensive battery comprising of health, psychological, sensorimotor, cognitive, and physiological tests was also conducted in the laboratory. RESULTS: Better functional mobility, reduced fear of falling, and increased physiological capacity were all associated with the three domains of the gait assessment (quantity, quality and intensity). Age and depressive symptoms were primarily correlated with a reduced number of walks (quantity). Processing speed, executive functioning, and health factors were primarily associated with increased gait variability (quality). CONCLUSION: The study confirms that older people with better performance on clinical tests are also more likely to perform more walks of higher intensity and with less step time variability in daily life. Our findings support previous contentions that impaired attentional and executive function primarily affects gait quality, which may increase fall risk. This insight into which clinical factors influence different aspects of gait performance in daily life may help in tailoring fall prevention interventions and reduce the global burden of increasing morbidity in older people. FIGURE CAPTION: Daily activity

recorded by a participant wearing a pendent sensor on one of the 60 active days. The first fourteen recorded days by each participant were used for this study.

P3-G-32 The impact of anxiety on the attentional control of older adults during adaptive dual-task walking

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BACKGROUND AND AIM: Anxiety has been shown to impact performance of postural and gait factors within both younger and older adults and is associated with increased fall risk. It is also well established in psychological literature that anxiety causes alterations in attentional control, particularly in regard to visual search behaviour. It is therefore surprising that there is a lack of a theoretical framework that attempts to explain the effects of anxiety on attentional control in relation to fall risk in the elderly. Attentional Control Theory (ACT) suggests that under heightened anxiety task performance can be maintained at the cost of processing efficiency due to a disengagement of the goal-directed attentional system. However, if task demands increase performance starts to decline. The aim of this study was to test the predictions of ACT and to ascertain whether it could be supported in a more dynamic environment, thereby investigating its application as a potential theoretical framework to underpin the attentional costs associated with fear of falling in older adults. METHODS: Two groups of older adults were formed. One group consisted of older adults high in both state and trait anxiety, whereas the second group were considered to be low in these two anxiety types. The investigation employed a novel adaptive walking task that represents walking along paving stones within a designated pattern. In conjunction with walking along this pathway, participants were asked to perform a second task (serial subtraction) of varying difficulties (low difficulty = subtracting in 2s, medium difficulty = subtracting in 3s, and high difficulty = subtracting in 7s from a designated number). Visual search, secondary task performance, and mental effort ratings were collected to determine processing efficiency. Walking performance was assessed by kinematic parameters, namely; gait speed, stepping accuracy, and time spent in double limb support. RESULTS: The results indicated moderate support for the application of ACT to such a dynamic environment. Performance on the secondary task indicated that there was a decrease in processing efficiency, with the amount of numbers and proportion of correct responses reducing as task difficulty increased. Greater task difficulty also lead to increased ratings of mental effort, decreased gait speed, and more erratic visual search behaviour, as indicated by an increased number of fixations on task irrelevant locations. CONCLUSIONS: The adoption of ACT to explain some of the attentional inefficiencies during dual-task walking in anxious older adults should be considered. Accordingly, ACT may serve to provide a much needed bases for a theoretical framework within the area and help inform future study and discussion.

P3-G-33 Effect of cognitive interference on postural stability

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Purpose: The interplay between the level of cognitive load and the control of body posture is still a matter of debate. The aim of the present study was to determine the effect of cognitive interference on the postural stability. Methods: Thirty-four subjects participated in the experiment: 16 young adults (aged between 22 and 29) and 18 elderly (aged 60 and over). They stood, barefoot and arms crossed, in front of a projection screen. Optical motion sensors, located on a helmet, and 6 IR cameras (Optotrak system), were used to track and register head movements during trials. Each trial lasted 64s. The stimulus displayed on the screen was a black and white checkerboard with an empty grey area (5° of visual angle) in front of the subject's eyes. This peripheral checkerboard could be either static or in motion (left-right and up-down movements). Three different tasks, proposed in different orders, were considered: i) subjects were instructed to look at a fixation point, located in the middle of the central empty area; ii) subjects had to say aloud the color of the words displayed in the central empty area; in this second task, the words displayed were color names and they were congruent with the color of the font (e.g. "Yellow" displayed with yellow font); iii) the third task was the same as the second one but the color name and the word font were noncongruent (e.g. "Yellow" displayed with red font). Each trial was repeated 3 times. We calculated the Velocity Root Mean Square (VRMS) of head movements based on the signal provided by the optical sensors. VRMS represented a measure of postural instability induced by the various visual conditions and tasks. Response time for color naming was recorded as well. Results: Results showed that, when the visual surrounding was static, the postural stability was better in task 1 compared to both color naming tasks. When the peripheral checkerboard was in motion, subjects' instability increased, compared to static conditions, but remained similar for the 3 tasks. As expected, response time increased when the color name and the font were noncongruent. However, results also showed that response time with static checkerboard was faster than in moving conditions. Conclusion: These results showed that the interplay between a cognitive task and the control of body posture might change depending on the relative complexity of both cognitive and visual loads. Furthermore, this interplay works in both directions: a given cognitive load may affect the control of stance and the energy used to control postural stability may also decrease cognitive abilities.

P3-G-34 Changes in metabolic parameters during dual-task while walking; comparison between younger and older adults

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BACKGROUND AND AIM: The effect of aging on dual-task performance was studied extensively. In addition, older adults demonstrate changes in metabolic parameters during performance of daily activities. Neural circuitry involved in the initiation, control and maintenance of motor movements while simultaneously performing a cognitive task, requires considerable metabolic resources. However, studies that investigated the metabolic cost during dual tasking, especially in older adults, are scarce. The aim of this study was to compare the changes in metabolic and gait parameters that accompany dual-task performance while walking, between younger and older adults. METHODS: Twenty-two young (25.6±4.2 years) and 14 community dwelling older adults (69.1±6.1 years) participated. Participants performed an auditory working-memory (cognitive) task while sitting (single-task) and then walked on a treadmill in their comfortable speed with and without a similar cognitive task (i.e. gait speed was the same for single and dual tasks conditions). Cardio-pulmonary parameters were recorded with the Cosmed, K42 system and gait parameters were recorded with the OptoGait. Dual-task cost was calculated for metabolic equivalents (metabolic equivalents in single task- metabolic equivalents in dual task/ metabolic equivalents in single task). ANCOVA repeated measures with gait speed as a covariate was performed. RESULTS: Heart rate increased during dual-task and almost reached significance only in the older group ($p=.055$). Oxygen consumption (VO2/Kg) increased during dual task ($p<.05$). In the younger group higher metabolic equivalents cost was associated with slower gait speed ($r=.-53$;$p<.05$). Within the older group, those with a slower gait speed had higher metabolic equivalents and higher step time variability ($p<0.047$) during the dual task condition. A trend ($p=.073$) of higher metabolic equivalents cost in the older compared to younger group was found. Step time variability increased significantly only for the older group ($p<.05$). Cognitive task performance was better in young vs. old group ($p<.05$) but was not affected by walking. CONCLUSIONS: The changes in metabolic parameters during dual-task performance, albeit small, indicate that the cost of dual-task performance goes beyond the changes in gait and cognitive performance especially in older adults. This paradigm should be further investigated in clinical populations.

P3-G-35 Effects of different visual attention tasks on obstacle crossing in healthy young adults

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BACKGROUND AND AIM: Dual-task obstacle crossing gait paradigm is commonly adopted to examine how attentional demands are associated with sensory-motor processing. Various attention tasks have been used; but the findings in the young healthy adults are mixed as some attention tasks affect motor performance but some don't. This raises a question whether different attention tasks could affect motor control through similar pathways. Although it is common to select a non-visual attention task as a secondary task to avoid structural interference, the visual attention is more relevant to the underlying mechanism due to its overlapping resources with locomotion. Therefore, we investigated the effects of two visual attention tasks - visuospatial attention and visual Stroop tasks - on obstacle crossing in

healthy young adults. METHODS: Two experiments were conducted. In both experiments, subjects completed a dual-task obstacle crossing task (DO), an obstacle crossing only task (SO), and a visual attention only task (VO) in a random order. For the DO in the first experiment, 11 healthy adults (25.9±5.5yrs) responded to a 200ms visuospatial attention task (VSA) during the approaching phase of obstacle crossing. In the second experiment, 10 healthy adults (21.5±2.1yrs) responded to a visual Stroop task (Stroop) via a smartphone while approaching and crossing an obstacle. Dependent variables included tripping incidence, toe-obstacle clearance, gait velocity and accuracy rate of the visual attention tasks. RESULTS: Two tripping incidences occurred only in the first experiment. Toe-obstacle clearances (cm) were reduced in the first experiment [Leading: SO 15.29±3.75 vs DO 13.67±3.33, ns; Trailing: SO 15.16±2.50 vs DO 12.90±2.25, $p = .038$] but increased in the second experiment [Leading: SO 15.73±3.52 vs DO 21.16±4.31, $p = .006$; Trailing: SO 18.69±4.45 vs DO 26.29±5.98, $p = .005$]. Similar gait velocities (m/s) were observed for the first experiment [SO 1.24±0.06 vs DO 1.29±0.13]. However, significant differences in gait velocities were demonstrated in the second experiment [SO 1.17±0.07 vs DO 1.03±0.05, $p<.001$]. Accuracy rates of the visual attention task (%) revealed no significant differences between single and dual tasks for both experiments [VSA: VO 83.14±9.52 vs DO 82.77±10.87; Stroop: VO 93.18±7.70 vs DO 91.63±8.40]. CONCLUSION: Our findings demonstrated that different visual attention tasks lead to distinct modifications on obstacle crossing behaviors. We proposed that a brief distraction of visuospatial attentional resource during the approaching phase interferes with one's planning for crossing. In addition, such a brief stimulus does not allow for a sufficient time to modify the crossing strategy. Conversely, when approaching an obstacle with a visual Stroop task that involved further executive demand and with a longer time, young healthy adults could adopt a conservative crossing strategy to avoid tripping.

P3-G-36 Walking while talking is cognitively demanding for young adults.

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BACKGROUND AND AIM: Walking while talking is a common daily activity that is easily accomplished by most healthy individuals. However, conversational speech is a complex cognitively demanding task that interferes with gait in impaired individuals as demonstrated by the Stops Walking While Talking test. In this test, older adults at risk of falling will often stop walking when they begin to talk (Lundin-Olsson et al., 1997). Generally, gait kinematics change while performing other concurrent cognitively demanding tasks, but typical dual-task methodology often utilizes standard tests of cognition (e.g. mental arithmetic). These tasks are cognitively demanding but are not ecologically valid and tend to be discrete or rhythmic tasks. In contrast, speech production is a well practiced, non-rhythmic, and continuous task. It is possible conversation is more easily performed than laboratory-based tests and thus does not produce the same deficits to performance, known as dual task costs. In this study, we examine the

interference between gait and speech while systematically increasing the difficulty of the gait task. Additionally, we quantify dual tasks costs for both gait and speech measures to examine task prioritization. METHODS: 16 participants (21±1.6 yrs, 9 males) performed three gait tasks in a random order with and without speech; unobstructed gait (easy), obstacle crossing (moderate), obstacle crossing and tray carrying (difficult). Gait speed was measured with a GAITRite mat. Conversational speech was recorded and the average duration of silent pauses was determined via spectrograms. Silent pauses in speech are indicative of cognitive processes involved in word selection and sentence planning. Dual task costs (DTC) were calculated for gait speed and speech pauses (DTC=baseline-dual/baseline*100). RESULTS: DTC for gait speed was 7, 8, and 6% for easy, moderate, and difficult, and DTC for speech pauses was 8, 16, and 17% for easy, moderate, and difficult. A repeated measures ANOVA revealed an interaction of gait condition*type of measure (p=0.04). Post hoc comparisons showed DTC for gait speed decreased as task challenge increased. That is, subjects slowed down less when speaking in the challenging gait task than when speaking in the easy gait task. In contrast, DTC for the speech pauses increased as task challenge increased, demonstrating that participants took longer pauses when speaking in the moderate and difficult gait tasks (Figure 1). Longer speech pauses reflect the increased time needed to select words and plan sentences. CONCLUSIONS: When walking and talking, both gait and speech measures were affected in young adults. However, speech measures were affected to a greater extent as gait task difficulty increased, consistent with the 'posture first' strategy. These findings highlight the substantial cognitive demands of walking while talking, even in young adults.

P3-H-104 Control of standing and gait in autism spectrum disorders

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BACKGROUND AND AIM: Autism Spectrum Disorders (ASDs) are characterized by persistent deficits in social communication and social interaction, constrained, repetitive patterns of behavior, and restricted interests or activities. With the introduction of the DSM-5, motor abnormalities figure more prominently in the diagnostic criteria of autism than in its predecessor (DSM-IV). Children with ASD have, in comparison with their peers, less developed motor skills, especially gross motor skills. Little is known about the underlying motor control mechanisms responsible for these motor abnormalities, especially related to the control of static balance and gait. In one experiment (Exp 1) we assessed to what extent vision and cognition contribute to the regulation of balance in this group. In another experiment (Exp 2) we assessed the impact of difficulty level of a gait trajectory on smoothness of gait. METHODS: Exp 1: Children with mild autism and a group of unaffected controls stood on a Wii Balance Board, under sensory disturbance (closing the eyes) and a cognitive disturbance (word memorization), for 30 seconds. We tested the effects of these disturbances on COP fluctuations. Exp 2: A new group of children walked at a self-selected pace along a straight path (easy), or in a circular trajectory (difficult) of 30 m each. Acceleration data were collected using a tri-axial accelerometer (McRoberts) attached at the height of L5 . We analyzed harmonic ratios (HR) along the three movement axes as a measure of smoothness. RESULTS: Exp 1: We found a greater destabilizing effect of closing the eyes (greater postural excursions in the medio-lateral direction) for the ASD group than for controls, but little effects of cognition. Exp 2: walking in a circular trajectory resulted in lower HR values in the AP-and vertical direction than controls. Walking in a straight line revealed no group differences. Also there were no differences in amount and type of physical activity measured for 5 consecutive days. CONCLUSIONS: Group differences between ASD and controls during quiet standing and during locomotion only become apparent with more challenging tasks. The results suggest that ASD is characterized by a greater reliance on vision to regulate standing [1], and by an emphasis on online (feedback) control of movement instead of feedforward control, which is probably due to difficulty building an internal model of the body schema [2]. [1] Travers BG, Powell PS, Klinger LG, Klinger MR. Motor difficulties in autism spectrum disorder: linking symptom severity and postural stability. J Autism Dev Disord 2013;43:1568-83. [2] Nobile M, et al. Further evidence of complex motor dysfunction in drug naive children with autism using automatic motion analysis of gait. Autism 2011; 15: 263-83.

P3-H-37 Tuning of postural responses to instability and cost function

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BACKGROUND AND AIM: Awareness of risk guides all of our actions, and this is essential for our survival in an unpredictable and potentially hostile environment. We describe risk specifically as the product of two factors: the probability of failure and the cost of failure. Human standing posture is a distinctive risky state during daily actions in which we continuously face with unstable conditions (high probability of failure due to, for example, slippery surfaces or rough terrain) and cost of failures (e.g. falling injuries). The aim of the study was to investigate how humans control the posture under unstable conditions and different costs of failure. We consider the hypothesis that humans actively and continuously estimate both the probability of failure and the cost of failure, and that they make ongoing corrections to movement based on these estimates. METHODS To test this hypothesis, we designed a driving simulation with iPad® experiment with a loss function using a 1-degree of freedom balance board. Healthy young adults were asked to maintain one-dimensional steering control of a vehicle in a driving simulation with both legs while standing on the balance board. The iPad® was embedded into the balance board such that the inclination of the board resulted with the steering control of the vehicle. The goal of the game was to complete each trial as quickly as possible, where the speed of the vehicle was determined solely by position on a two-lane road. While on the road, driving within a lane yielded acceleration to the maximum velocity, driving on the dashed line between the two lanes caused the vehicle to decelerate. Points awarded were inversely proportional to the time taken to complete each trial. Different cost (loss) functions were provided with different penalties on the score when driving the vehicle outside of the road. By manipulating the sensibility of the accelerometer in the iPad®, we were able to simulate different instability levels while controlling the vehicle with the board. We calculated the probability distribution of the position of the car during the experiment. Moreover we collected the EMG activity of the calf muscles and calculated the joint angles in both the legs. RESULTS Interestingly the results demonstrated the subjects' awareness to changes of task cost and provide evidence that they avoid risk even in the absence of errors. As expected, position data resemble bimodal Gaussian distributions as shown in figure 1. As instability and cost increase, the two peaks of the distribution tend toward each other, merging into a single normal distribution at high motor uncertainty. The results of muscle activity and the joints angles of both legs will be shown. CONCLUSIONS The findings support our hypothesis that humans tune their statistical postural behavior based on cost, taking into account entire probability distributions of all possible outcomes in response to environmental uncertainty/instability.

P3-H-38 The equilibration of the elderly person used with hip strategy can be changed by postural Insoles treatment

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Background and aim: As vestibular and visual informations are less used with age, exteroceptive and proprioceptive plantar informations role is very important. (1) Equilibration strategy during hips tactic predisposes the elderly to a fall. This study tries to demonstrate the effect of postural insoles on this pathology. (2) Method: 2 groups of people over 65: 1 control group (20 subjects m=80 y +/-9.2) who had pedicure care, 1 group with insoles (50 subjects m=72 y +/-5.8). 6 weeks later, a control is made (T1). Postural tests used: posturodynamic test (3), one foot stand test (4), equilibration tactic (5) Results: The insoles group: postural tests are improved, as well as equilibration tactic: Improvement in posturodynamic test and equilibration tactic, time of one foot stand has increased, pain sensation drop-off. The control group doesn't make meaningful improvements. Conclusion: The equilibration tactic management as hip strategy can be improved by postural insoles. This study shows that postural care can improved the standard of living and comfort condition of the elderly. References: (1) Diard JP et Al 1993 ; Vitte E et Al 1993 ; Toupet M et Gagey P.M 1992 (2) Amiridis et al, Age-induced modification of static postural control in humans, neuroscience letter, 350, 137-140 (3) Villeneuve Ph et col, Epreuve posturo-dynamique, entrée du système postural fin, ed MASSON 1995, 51-56 (4) Appui unipodal HAS, prévention des chutes des personnes âgées 2005, 2009 (5) Villeneuve S, validation d'une épreuve clinique mettant en évidence la stratégie d'équilibration posturale, mémoire en vu de l'obtention du DIU de posturologie clinique, 2001

P3-H-39 Effect of postural deviations on trunk and hip muscle activity during walking

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BACKGROUND AND AIM: Lordosis (LO) and Sway-back posture (SW) are the typical postural abnormalities associated with low back pain. Altered activities in the abdominal muscles and hip flexors have been reported in the LO and SW during standing and/or sitting. Such muscle imbalances would impose increased stress on the joints and surrounding structures, which may be the cause of the pain. However, it still remains unclear if such altered muscle activities due to postural deviations would be observed during the task that requires dynamic postural control, such as walking. This study investigated the effects of postural deviations on activities of the abdominal muscles and hip flexors during walking. METHODS: Fifteen healthy young male adults were instructed to maintain three different postures: Neutral (NU), SW, and LO, while walking at a constant speed on a treadmill. Electromyographic (EMG) data were collected at 1000Hz to measure activity in the superficial abdominal muscles: (1) rectus abdominis, (2) external oblique, (3) thoracic elector spinae, and deep abdominal muscles: (4) internal oblique and (5) lumbar multifidus, as well as hip flexors (6) iliopsoas, (7) sartorius, and (8) rectus femoris. RMS amplitude of the band-pass filtered EMG signals (20-500Hz) was calculated as the mean over the stance and swing phases of the gait cycle and normalized to the relevant MVC. RESULTS: During the stance phase, significantly reduced activity was found in the internal oblique and iliopsoas, while the rectus abdominis, sartorius, and rectus femoris showed significantly increased muscle activity for SW as compared with NU (Fig.1). No significant difference was detected in the lumbar multifidus activity between SW and NU. For LO, the internal oblique showed a significant decrease in activity, whereas the thoracic elector spinae and lumbar multifidus demonstrated a significant increase in activity as compared with NU (Fig.1). No significant difference was observed in the iliopsoas activity between LO and NU. The same differences in muscle activity were seen during the swing phase, except for the sartorius and rectus femoris, where no significant differences were found among the three postural conditions. CONCLUSIONS: Different muscle groups were involved to compensate for the different types of postural deviations during walking. Although both SW and LO postures caused reduced activity in the deep abdominal muscles, the superficial abdominal muscles and hip flexors were activated for SW and the back muscles were activated for LO. These results implied that lumbo-pelvic stabilizing muscles were activated to compensate for postural deviations during the task that requires dynamic postural stability. The findings demonstrated a link between lumbo-pelvic muscles and the maintenance of dynamic balance, which would facilitate effective rehabilitation treatments to reduce pain during movement due to postural abnormalities.

P3-H-40 The step width of young and middle-aged adults was substantially reduced by texting and walking

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BACKGROUND AND AIM: Mobile phone use while walking has become common in both young and middle-aged adults. Injuries due to phone use among pedestrians have more than quadrupled over the past years (Nasar and Troyer, 2013). Age-related changes affect not only gait adaptability, but also the ability to flexibly allocate attention between two tasks (Yogev-Seligmann et al., 2010). Therefore, gait parameters may be affected differently between young and middle-aged adults when texting while walking. We examined differences in gait parameters between walking versus walking while texting in young and middle-aged adults. METHODS: Fourteen young (24.4±3.5 yrs) and six middle-aged adults (43.8±7.1 yrs) participated in two conditions (walking and walking while texting) for a total of 16 trials presented in a randomized order. All subjects reported that they walk and text in their everyday lives. Subjects walked on a 50 m walkway at a self-selected speed. During the walking while texting task, subjects texted about a previously selected topic. For each texting trial, a different topic was selected. Spatial and temporal gait parameters were measured with SmartGait (a smartphone based application that measures position of foot markers). Dual task cost (DTC) was calculated as the percent change in step length and step width for the dual task vs the single task. Data collection is ongoing; more subjects will be reported at the conference. RESULTS: Young and middle-aged adults decreased both step length and step width when walking while texting, compared to walking ($p<0.02$). Step length DTC was not different between the two age groups (-5.4% vs -8.8%, young vs middle-aged, $p = 0.30$). However, there was a trend towards middle-aged adults having a greater DTC for step width than young adults (-10.6% vs -19.8%%, young vs middle-aged, $p=0.06$). The shorter step length is consistent with adopting a safer strategy for locomotion. However, the narrower step width likely compromises stability in the medial-lateral direction due to a smaller base of support. Decreased step width was a robust observation, apparent in 71% of the young and 100% of the middle-aged adults, and may be related to the requirement to stabilize the trunk relative to the smartphone to facilitate texting. Decreased trunk motion, in turn, may lead to decreased step width. CONCLUSIONS: Both young and middle-aged adults are choosing to walk and text in their everyday lives, yet their gait stability may be compromised in the frontal plane by this dual task due to a narrower base of support.

P3-H-41 Human cervical spinal cord circuitries can be activated by tonic input to generate rhythmic arm movements

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BACKGROUND AND AIM: Substantial evidence indicates that humans use quadrupedal coordination during locomotion (Zehr et al., 2009; Dietz, 2011). The coordination between arms and legs during human locomotion shares many features with that in quadrupeds, including the reliance on propriospinal connections. Nevertheless, the existence of the central pattern generator for the upper limbs in humans has not been directly demonstrated. Here we investigated whether different types of tonic stimulation, used for eliciting stepping-like leg movements (Selionov et al., 2009; Gerasimenko et al., 2010), may evoke non-voluntary rhythmic arm movements in humans. METHODS: Twenty four healthy subjects participated in this study. We used air-stepping as a model for investigating human rhythmogenesis since its manifestation is largely facilitated by a reduction of external resistance (Selionov et al., 2009; Sylos-Labini et al., 2014). The subject was lying on the side, the trunk was fixed and all four limbs were suspended in a gravity neutral position, allowing unrestricted limb movements in the horizontal plane. Both peripheral (60-80 Hz muscle vibration) and central tonic activation (post-contraction Kohnstamm phenomenon, mental task) were used for eliciting arm movements. RESULTS: Tonic shoulder muscle vibration evoked non-voluntary movements in about 50% of subjects and the concurrent mental task facilitated the occurrence of arm movements (90% of subjects). In six subjects, non-voluntary rhythmic arm movements elicited also stepping-like movements of suspended legs. Interestingly, in this case, the diagonal coordination of lower and upper limbs was observed. The characteristics of evoked non-voluntary movements (frequency, amplitude and phases) were calculated. Limb perturbations during stepping-like movements resulted in limb-specific and phase-specific responses. Central tonic influences (Kohnstamm phenomenon) could also activate central pattern generation of the upper limbs. CONCLUSIONS: The results suggest that the tonic input can activate the central pattern generator for arm movements in humans. The characteristics of evoked movements highlight inherent interactions between cervical and lumbosacral CPGs. The present results also suggest that tonic activation of the cervical spinal cord could be an effective tool in facilitating locomotor-like activity and coordination of arms and legs.

P3-H-42 Does the passability of apertures change depending on the size of the obstacles?

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BACKGROUND/AIM: Affordances are defined as functional possibilities for action, which are established by the relationship between properties of the environment and properties of an individual's body size and/or action capabilities [1]. With respect to apertures and locomotion, an aperture affords passage if it has a greater width than the organism's narrowest horizontal measurement [1]. Previous research found that apertures created by vertical pole-like obstacles were deemed passable, and not circumvented, if they were greater than 1.4 times the shoulder width (SW) (i.e., critical point) of an individual [2]. The purpose of this study was to determine whether changes to the size of obstacles' diameters have an effect on one's critical point. It is hypothesized that the critical point for the largest obstacle would be smaller, since individuals would be more reluctant to circumvent larger obstacles in order to reduce the magnitude of deviation from one's straight path towards the goal. METHODS: 7

participants (2 males & 5 females; mean age = 21.3, ± 0.78 years) walked at a self-selected pace along a 10m path toward a goal. Half way along the path, two obstacles were place equidistant from the midline, creating an aperture. The participants were instructed to avoid colliding with the obstacles enroute to the goal. The obstacles varied in diameter size between 6 inches, 8 inches, and 12 inches. In all conditions, the width of the aperture ranged between 0.8-1.6 times SW in increments of 0.2. The study was conducted as a block design (obstacle sizes) and the aperture widths were randomly generated within each block. Participants were exposed to three trials of each aperture width for each obstacle diameter (3x5x3) for a total of 45 trials. Full body kinematic data was collected using an Optotrak motion capture system to quantify actions, however for the purpose of this abstract, only the behavioural observations at the time of passing the obstacles will be reported. Any body or path changes from a straight passage through the obstacles were considered action changes. The critical point for each obstacle width was determined as the smallest aperture width that did not produce an action change for at least 2/3 trials. RESULTS: Obstacle diameters did not produce different critical points. All obstacle widths (6, 8, and 12 inch) resulted in critical points of 1.4 times SW. CONCLUSIONS: Initial results reveal the robustness of the previously reported critical point during aperture crossings. The findings from the current study further suggest that individuals' behaviours, with respect to passability of an aperture, are dependent on the aperture's width relative to one's body and not dependent on the size of the obstacles' widths. Although the different obstacle widths did not reveal any differences in critical points, further body kinematic analysis will determine whether they affected other behavioural parameters.

P3-H-43 The application of functional principal components analysis to the study of gait with high heel shoes

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Background and aim A huge proportion of women wears high heel shoes (HHS) in a daily basis. The use of HHS disturbs the natural position of foot causing an alteration of the temporal-spatial parameters of gait, joint kinematics, muscular activity, energy consumption and plantar foot pressures. This changes in natural gait kinematics may generate or aggravate musculoskeletal injuries. Although changes in several gait parameters have already been reported, no previous studies were found that used functional analysis of reaction forces and joint angle waveforms. The aim of the study was to analyze the influence of heel height on gait biomechanics by means of a functional principal components analysis (FPCA). Methods Eight women, users of HHS, participated in the experiment. Two models of HHS were used. The two models of shoes were from the same manufacturer and presented the same design characteristics with the exception of the heel height (80mm and 125mm). Gait kinematics and ground reaction forces (GRF) were recorded for each user wearing the two pairs of shoes in randomized order. The analysis was performed in the following steps: (i) Functional Principal Components Analysis for the knee and ankle joint angles and for the ground reaction forces; (ii) one way ANOVA was made, being the factor the pair of shoes under comparison and the output the FPCA score of the related measurements and (iii) the marginal mean curves were reconstructed using the scores that showed significant differences. Results We found differences both in the GRF and in the joint angle waveforms. An increment on the peak of force in load reception was observed in the gait with the higher heel shoe. The higher heels also showed a shorter time in the transference of loads from the rear to the front part of the foot, reducing effectively the midstance phase of gait, a smaller lateral excursions of forces that could be due to a less stability. Regarding the joint angles, the gait with higher heels presented more knee flexion and abduction in contrast to the lower values of flexion and abduction of the ankle. It seems that there is an increase in knee joint motion to compensate the lack of mobility of the ankle joint. Conclusions FPCA has shown as a useful technique for the study of gait with high heels and the effect of heel height. The qualitative analysis of the marginal mean curves reconstructed from the PFCA scores may provide very useful information to better understand the biomechanical adaptations that occur during high heels gait. The work is part of the activities driven by ADDFactor, ADvanced Digital technologies and virtual engineering for mini-Factories. This project has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° [609386].

P3-H-44 Anticipatory postural adjustment in patients with Parkinson´s disease assessed with wearable sensors

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Anticipatory postural adjustment in patients with Parkinson´s disease assessed with wearable sensors Katrin S. Maier, Susanne Nußbaum, Morad Elshehabi, Markus A. Hobert, Martina Mancini, Daniela Berg, Sandra E. Hasmann, Walter Maetzler Hertie Institute for Clinical Brain Research, Department of Neurodegeneration, Center of Neurology, University of Tuebingen, Germany DZNE, German Center for Neurodegenerative Diseases, Tuebingen Balance Disorders Laboratory, Department of Neurology, School of Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Road, 97239 Portland OR, USA Background: Anticipatory postural adjustment (APA) is necessary for step initiation, and deficits are associated with balance disturbances and falls. These deficits are often observed in Parkinson's disease (PD). Still, little is known about (i) the characteristic parameters of APA associated with the balance impairment in PD, (ii) whether the akinetic-rigid PD subtype (more prone to balance deficits and falls than the tremor subtype) and PD fallers (compared to PD non-fallers) are particularly affected by APA deficits, and (iii) the influence of dopaminergic treatment on APA. Methods: APA was assessed with a standardized protocol in 68 PD patients (18 female, mean age 66 years, 4.4 years disease duration) during their medication Off state. Thirty-nine also underwent the assessment during medication On. As a control cohort, 79 well-matched older adults were included. All wore a sensor at the lower back and one sensor on each ankle (Mobility Lab®, APDM). The following APA measures were extracted: total duration, peak acceleration AP and ML, time-to-peak AP and ML, latency, area AP and ML, first step latency and first step length. In addition, the Unified Parkinson´s disease Rating scale, Mini Mental Status Examination, Montreal Cognitive Assessment and Becks Depressions Inventory were assessed. Results were corrected for gender and height. Results: During their Off condition, PD patients differed significantly from controls in all parameters. The axial-rigid subtype cohort (N=33) showed significantly lower ("worse") values than the tremor subtype (N=16) in the following measures: peak acceleration ML and area AP. PD fallers (N=12) differed from PD non-fallers (N=40) in total duration, time-to-peak ML and area ML. Compared to Off state, On medication led to a significant change ("improvement") in the following parameters: latency and area ML. Conclusion: This case-control study on a relatively large cohort of PD patients with a mean disease duration <5 years shows that APA measures have a high potential to differentiate not only disease from control state, but also akinetic-rigid from tremor subtype, and PD fallers from non-fallers. Dopaminergic treatment has an effect on only some APA measures. All these different patterns of APA changes in PD indicate that APA is a complex movement, which should be specifically assessed, and APA deficits individually treated.

P3-H-45 Effect of muscle atrophy on standing postural response to perturbation in older adults

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Background and aim: Sarcopenia is a syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability. It also increases the risk of falling in older adults. Coordinated postural response to perturbation is important to prevent falling. However, there is no information about the relationship between muscle atrophy and postural response to perturbation. The purpose of this study is to investigate how muscle atrophy affects standing postural response to perturbation in older adults. Methods: Twenty-six community dwelling older adults (aged 73 ± 5) participated in this study. They were allocated to healthy group (HG: n = 10) and muscle atrophy group (AG: n = 16) according to the definition of sarcopenia, which means skeletal mass index is 6.4kg/m2 or less measured by bioimpedance analysis. Participants were made to stand on a platform, which moved forward or backward with the help of a perturbation device. Electromyography data were collected from the tibialis anterior, soleus, rectus femoris, and biceps femoris. We moved the platform with a constant amplitude (6 cm) and velocity (15 cm/s). After a trial of perturbations, we added 10 perturbations in random direction for each group. A two-dimensional motion analysis was performed with a digital video camera positioned perpendicularly to the sagittal plane. We calculated joint kinematics at ankle, knee, hip and trunk. We analyzed the differences between group parameters at 100 ms intervals from the onset of perturbation to 1000 ms. Results: During forward transfer, there was no kinematic and electromyographic difference between the groups in any joints and muscles. During backward transfer, the dorsiflexion of ankle joint in AG was higher than that of HG at 100 - 500 ms after perturbation ($p < 0.05$). There was no significant difference in the other joints between the groups. As for EMG data, the activity of soleus in AG was higher than that of HG at 100-200 ms after perturbation ($P < 0.05$). Conclusions: Our study found that muscle atrophy leads to increase of joint movement and EMG activity of the ankle joint after perturbation in the case of backward perturbation. This result indicates that people with muscle atrophy cannot inhibit perturbed joint movement during postural control, in spite of larger muscle response because of muscle weakness. It might increase the risk of falling during perturbed condition in older people.

P3-H-46 Impact of Spasticity on Balance Control During Quiet Standing in Persons Post-Stroke

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Background and aim: Spasticity is a neuromuscular condition from damage to the upper motor neurons and can be present in up to 40% of individuals post-stroke. Although falls and balance impairments are also common in up to 73% of stroke survivors, the relationship between spasticity and balance control following stroke is not clear. In this study, we used sensitive measures of balance control to better understand balance control challenges in individuals post-stroke who have spasticity in the upper and lower limbs. Methods: 14 participants with ankle plantar flexor spasticity post-stroke were divided into two groups: a) high ankle spasticity (n=5) - Modified Ashworth Scale (MAS) scores of ≥ 2, and b) low ankle spasticity (n=9) - MAS scores of < 2. Balance control was measured during 60 seconds of quiet standing on a force plate using centre of pressure (COP) displacements in the anterioposterior (AP) and mediolateral (ML) directions. Trunk angle and angular velocity sway near the centre of mass was also measured in the pitch and roll directions as participants stood on the force plate. A total of 4 trials (2 with eyes open; 2 with eyes closed) were performed by each participant. Chedoke McMaster Stroke Assessment (CMSA) was used to measure the motor recovery stage of the hemiparetic upper and lower limbs, and balance confidence was measured using the Activities-specific Balance Confidence Scale (ABC). Results: Preliminary results suggest that COP displacement in the ML direction was significantly greater in the high ankle spasticity group ($p= 0.010$). Additionally, peak-to-peak trunk roll angle (p=

0.005) and roll angular velocity (p= 0.030) sway were significantly greater in individuals with high ankle spasticity. CMSA scores indicate that leg and foot motor recovery stages were significantly lower in the high ankle spasticity group (p= 0.013 and p= 0.011, respectively). Furthermore, participants demonstrated a significant negative correlation between the ABC and lower limb spasticity (rho= -0.604, p= 0.011). Conclusions: Our results suggest that individuals with high ankle spasticity post-stroke have higher ML instability as compared to individuals with low ankle spasticity post-stroke. High ML instability was reflected in both COP and trunk sway measures. It can also be suggested that higher ankle spasticity may contribute to lower level of motor function in the lower limb. Additionally, the results suggest that greater lower limb spasticity is associated with reduced balance confidence. We are continuing to collect data in anticipation of a final sample size of n=15 for each group. Current results highlight that the severity of spasticity post-stroke can play an important role in balance control of stroke survivors with spasticity. The results of this study may be important to the treatment of spasticity and balance control of persons with stroke in the clinical and rehabilitative settings.

P3-H-47 Patients with Parkinson disease and healthy elderlies share the same walking strategy: ground reaction forces (GRF) and trunk inclination during linear and curved trajectories.

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BACKGROUND AND AIM During activities of daily living, linear walking is frequently intermingled with turns while moving within the environment [1]. Patients affected by Parkinson's disease(PD), typically report turning difficulties [2]. It is unclear whether this abnormality is the expression of abnormal control strategies of walking, or the consequence of reduced gait speed. The present investigation addresses the distribution of the GRF under the feet, and their relation with trajectories and body inclination during linear and curved walking, in healthy young (Y) and elderly subjects (E), and PD patients. METHODS 26 Y, mean age 25.1 years ± 4.3 SD; 14 PD(mean age 67.1 ± 6.5; Hoehn-Yahr 1-2.5; all medicated) and 14 age- and gait speed-matched E (mean age 67.7 ± 2.7) were required to walk at self-selected speed along three trajectories: linear (Lin) and curved along a circle path, clockwise (CW) and counter clockwise (CCW). Both feet were instrumented with pressure insoles Pedar-X. We analysed the vertical component of the GRF of both feet during the entire stance and the different contribution of 8 selected foot region to the total GRF. An accelerometer fixed to the trunk detected the medio-lateral inclination. RESULTS Gait speed was faster in Y than E or PD, but not different between the latter two groups. In each group, speed decreased (30%) from Lin to curved trajectories, being unaffected by the direction of trajectory, age or disease. Cadence was not different between the subject groups, and decreased (13%) in all during curved trajectory. Both at heel strike and at toe off, the peak of GRF was larger in Y than E and PD, regardless of the trajectory. The regions of the foot inside and of that outside the curved trajectory were differently loaded with respect to Lin. This pattern of loading was common to all groups across the different foot regions (Fig.1). Trunk inclination was evident only during curved trajectories, toward the centre of the path. The inclination was larger in Y than E and PD, but not different between the latter two groups. CONCLUSIONS When comparing E and PD walking at the same speed, no major changes in cadence as well as GRF and trunk inclination are observed under either Lin or curved trajectories in PD. Changes in both E and PD with respect to Y are therefore dependent on the slower gait speed. Gait patterns adopted during circular trajectories are analogous between PD and E. Therefore, both groups have the same ability to exploit the biomechanical laws underpinning curved walking [3], including those for production of the centripetal force. The results also emphasize the need for comparing PD to age-matched healthy subjects under the same walking conditions, since differences in gait speed do not necessarily witness different locomotor strategies. REFERENCES [1]Glaister et al. Gait Posture,2007.[2]Guglielmetti et al. Mov Disord,2009.[3]Turcato et al. J Neuroeng Rehabil-submitted.

P3-H-48 A comparison of platform translation and shoulder pull paradigms through the analysis of balance correcting responses induced using both methods

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BACKGROUND AND AIM: The understanding of postural control mechanisms in humans emanates from studies utilizing variety of perturbation paradigms, among which the most common and ecologically valid, are support surface translation and upper body pull perturbations. The use of different perturbation methods may produce paradigm-specific balance recovery responses. The current study compared stepping balance correcting responses following platform translation and upper body pull perturbations. METHODS: Fifteen healthy participants (age 24.3±3.0, height 181.2±5.9cm, body weight 82.4±14kg, foot length 27.2±1.0cm) volunteered. Unexpected forward and backward platform translation and forward and backward shoulder pull perturbations were induced. Release of an electromagnet allowed a predetermined mass to fall a controlled distance exerting a pull either to the translating platform on which the participant stood, or to the participant via a shoulder harness. Participants were asked to behave naturally. The pull force was set to 8.75% of body weight, and the pull distance was set to 105% of base of support (defined as the participant's foot length), parameters determined previously to consistently induce a stepping response to recover balance (presented at ISPGR in 2014). Center of mass (COM) and margin of stability (MOS) were calculated from position data of reflective markers placed at strategic locations on the body. Smaller MOS during balance recovery was interpreted to suggest poorer balance control and to be less favorable for successful balance recovery. RESULTS: Repeated measures analysis of variance revealed a significant effect of perturbation type (platform/shoulder pull) on MOS at step start ($F(1,14)=12.4$, $p=0.003$) and at foot contact ($F(1,14)=143.0$, $p<0.001$). MOS was smaller at step start and at foot contact during platform translation (0.008±0.006m and 0.092±0.007m, respectively) than at each time point during shoulder pull (0.037±0.007m and 0.173±0.007m, respectively). Further analysis revealed that the step start and foot contact COM distance to BOS was smaller ($p<0.01$) and COM velocity was higher ($p<0.01$) during platform translation than during shoulder pull, explaining the observed differences in MOS. Participants required a second correcting step to recover balance in 14% of the platform trials, as opposed to 3% of the pull trials. CONCLUSIONS: During platform translation participants allowed their COM to displace closer to the boundary of BOS and at a higher velocity at step start and at foot contact, effectively placing themselves in a less favorable circumstance for balance recovery. In line with current findings, Mansfield et al. (2009) reported that platform perturbations are more destabilizing than upper body pull perturbations. The current research highlights differences in MOS, a marker of postural stability, and underscores that caution is required when interpreting results of studies utilizing different perturbation paradigms.

P3-H-49 Characterization of stability control in early recovery from traumatic brain injury

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BACKGROUND AND AIM: Traumatic brain injury (TBI) is a leading cause of disability in developed countries[1]. Research to date has identified unilateral motor weakness and asymmetrical standing posture after TBI [2, 3]. However, the impact of these postural asymmetries on postural control has not been investigated. Net centre-of-pressure (COP) displacements have been used as an overall descriptor of balance control, but lacks information about the individual contribution of each foot. In contrast, inter-limb synchrony has shown to be a sensitive measure of individual limb contributions to postural control in healthy adults[4] and clinical populations[5, 6]. This approach was used in a retrospective analysis of balance data during the early stages of recovery in TBI patients. METHODS: Standing balance was collected from 47 moderate to severe TBI patients (33M/14F, 39.9 ±17.0 years, Glascow Coma Score = 6.7 ±3.7) approximately 1.5 months after injury and from 12 healthy controls (HC; 7M/5F, 27.5 ±3.5 years). Force data was sampled at 50 Hz from two force plates, with each foot on adjacent force plates. Participants were instructed to stand for 45 seconds in a standardized position with eyes open. Root mean square (RMS) measures of standing balance and cross-correlation coefficient at zero phase lag (Rxy(0)) of COP in the AP and ML direction were calculated. RESULTS: Independent t-tests revealed that net COP RMS was significantly higher in TBI patients than HC in both the AP and ML direction ($p<0.05$). RMS ratio (dominant/non-dominant limb) was significantly greater in HC (1.47) than TBI (.873) in the ML direction; no differences were found in AP RMS ratio. AP and ML Rxy(0) were not significantly different between groups. CONCLUSIONS: Inter-limb COP synchrony of TBI patients is not different than that of HC. However, the overall displacement of the COP and the relative displacement of the COP between limbs in the ML direction did differ between groups. These preliminary results indicate that postural control in the ML direction is disrupted in the early recovery after TBI. REFERENCES: [1] Colantonio A, et al. J Trauma. 2009;66:179-83. [2] Newton RA. Brain Inj. 1995;9:445-51. [3] Choi GS, et al. Arch Neurol. 2012;69:363-7. [4] Winter DA, et al. Neurosci Res Commun. 1993;12:141-8. [5] Mansfield A, et al. Clin Biomech. 2011;26:312-7. [6] Singer JC, et al. Clin Biomech. 2013;28:921-6.

P3-H-50 Effect of wearable sensors on leg movement quantity in infants

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Background and Aim Our overall goal is to use full-day monitoring with wearable movement sensors to determine whether quantity, type and quality of infants' leg movements relate to time of walking onset and to differentiate typical, delayed and impaired developmental trajectories very early in infancy. Our goal here is to determine whether wearing the sensors affects quantity of infant leg movements. Methods We collected data from 10 infants (2-6 months of age) and have analyzed data from 3 infants to date. Infants were placed in supine and video data were recorded at 30 Hz for 4 minutes. Condition order was randomized: infants either had movement sensors on their legs or were not wearing movement sensors. Trained behavior coders identified the start and stop time of leg movements from frame-by-frame video analysis. Once all data are behavior coded, we will use a Repeated Measures Analysis of Variance to test for a condition difference at alpha = 0.05. Results Preliminary analysis shows no apparent difference between quantity of leg movement in 4 minutes when infants were wearing movement sensors on their legs compared to when they were not wearing sensors (see Figure 1). Conclusions Preliminary analysis supports that wearing movement sensors does not affect quantity of infant leg movements. Next steps include determining whether leg movements in early infancy relate to developmental rate and later functional outcomes. Support: Dr. Smith is supported by K12-HD055929 (PI - Ottenbacher).

P3-I-51 Planning your success: development of avoidance strategies

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BACKGROUND AND AIM: Maturation of level walking reaches adult-like behavior around the age of 5 years [1,2]. However, studies on more complex walking situations (e.g. obstacle avoidance) suggested ongoing development of anticipatory gait strategies until early adolescence [3-6]. The age at which anticipatory gait strategies are matured is not clearly defined yet because detailed data from childhood into adulthood are not available. To address this issue, we investigated anticipatory strategies in a large group (N = 44) of young children to adults. METHODS: Forty-four healthy children [8y - 18y] were asked to walk at their preferred speed along a 6 meters long walkway on which an obstacle (150% of step length x 1m) was projected with a beamer. Participants avoided the obstacle by stepping over this projection, while lower body kinematics were recorded. ANOVAs were used to detect any age related effects on step parameters. RESULTS: From age 13 onwards, strategy choices stabilized towards more efficient and adult-like behavior. Younger children took larger safety margins when crossing the obstacle than older children did (main effect of age on both take-off distances and leading limb clearances). However, these safety margins were not always refined and in accurate proportion; the younger children exaggerated the take-off distances, causing a landing step onto the obstacle which resulted in a failure. Moreover, in successful trials, younger children showed indications for a greater need of step width adjustments to anticipate the obstacle and to gain or re-gain balance, as shown by increased adjustments to their step width prior to, during and after obstacle crossing. This strategy seemed to be important in order to successfully completing the task, because the trials in which another strategy was used, i.e. in which not step width but step length was adjusted, resulted in failures. Step velocity did not differ between preferred walking, successful and failure obstacle trials. CONCLUSIONS: Maturation of gait is not finalized at age 5, but continues until early adolescence. Younger children show larger adaptations to their preferred walking pattern and inefficiently place their feet prior to obstacle crossing. The ability to plan, select and deploy an accurate anticipatory walking strategy is a top-down process which seems to reach adult-like values around the age of 13. REFERENCES: 1. Vaughan CL et al. Exp Brain Res. 2003 2. Dusing SC & Thorpe DE. Gait Posture. 2007 3. Grasso R et al. Neurosci Biobehav Rev. 1998 4. McFadyen BJ et al. Gait Posture. 2001 5. Vallis LA & McFadyen BJ. Exp Brain Res. 2005 6. Belmonti V et al. Exp Brain Res. 2013

P3-I-52 The Timed Up and Go test and Pediatric Balance scale: complementary tests in the assessment of balance control in 3 to 6-year-old children?

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Background and Aim: The Pediatric Balance Scale (PBS) and the Timed Up and Go test (TUG) have been investigated extensively in literature for the assessment of balance control in children.[1,2] Reference values, derived from American children, are available for the PBS, whereas this is not the case for the TUG.[1-3] The purpose of this study was threefold: 1) to establish reference values for the TUG, 2) to determine whether results from Belgian 3 to 6-year-old children fit into the available reference data for the PBS and 3) to assess construct and criterion validity. Methods: A cross-sectional study was performed in 188 3 to 6-year-old children between October 2013 and May 2014. The TUG was administered to the total sample and the PBS to a subsample (n=74). Results: Three-year-old children(n=46) needed a mean time of 7.86 (±1.03) seconds, 4-year-olds (n=61) 7.30 (±1.27) seconds, 5-

year-olds (n=65) 6.41 (±1.10) seconds and 6-year-olds (n=16) 5.44 (±0.81) seconds to perform the task. Cut-off values for deviating balance control could be defined as 1) the upper bound of the 95% CI which amounts for 3-year-olds 8.18 seconds, 4-year-olds 7.58 seconds, 5-year-olds 6.68 seconds and for 6-year-olds 5.99 seconds, 2) z-scores (%2B1z/%2B2z) were 8.89s/9.92s in the 3-year-olds, 8.57s/9.84s in 4-year-olds, 7.51s/8.61s in 5-year-olds and 6.24s/7.05s seconds in 6-year-olds. The number of children that did not reach the norm, are presented in table 1. The PBS scores from our Belgian children are not situated within the available reference values (95% CI)[3]: in 3-year-olds 15 out of 25 children do not reach the cut-off, this reduces to 6/21 in 4-year-olds, 10/18 in 5-year-olds and 2/10 in 6-year-olds. When z-scores (-1z/-2z) were used as cut-off points, the number of children that score below the cut-off decreased to less than 1 in 5, except in 5 year-olds (table 1). The PBS can distinguish 3-year-old children from all other age-categories ($p<0.01$), whereas the TUG discriminates between all age-categories ($p<0.05$) except between 3 and 4-year-olds. The TUG correlates moderately with the PBS (r spearman =-0.61;$p<0.001$). Conclusions: The TUG and PBS are complementary in detecting differences in balance control between age-groups in pre-school children. Therefore, both tests should be performed in 3 to 6-year-old children. References: 1 Verbecque E, Lobo Da Costa PH, Vereeck L, Hallemans A. Psychometric properties of functional balance tests in children: a literature review. Dev Med Child Neurol 2014 Dec 11. doi: 10.1111/dmcn.12657. [Epub ahead of print] 2 Nicolini-Panisson RD, D.M., Timed "Up & Go" test in children and adolescents. Rev Paul Pediatr., 2013 Sep(31(3)): p. 377-83. 3 Franjoine, M.R., et al., The performance of children developing typically on the pediatric balance scale. Pediatr Phys Ther, 2010. 22(4): p. 350-9.

P3-J-53 Postural control deficits in Autism Spectrum Disorder: The role of sensory integration

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Background and aim: Autism Spectrum Disorder (ASD) is a developmental disorder affecting not only social interactions and communication but also sensory integration and postural control. However, little is known about the manner in which ASD affects integration of sensory information from the three modalities (visual, vestibular and proprioceptive) involved in maintaining postural control. The main aim of this study was to systematically assess sensory integration of vision and proprioception in ASD. Methods: Fifteen adults with ASD and 15 age- and IQ-matched controls were asked to maintain upright stance in four postural environments: A fixed environment, and three environments in which information from visual, proprioceptive or both modalities about body sway was made inaccurate. This was achieved by means of moving the visual surround, the support surface or both in proportion to body sway, or surround/support surface sway reference. Furthermore, sway reference was implemented in direct proportion to body sway (gain = 1) and in proportion of 1.6 times body sway (gain = 1.6) thereby increasing the surround and/or support amplitude and inducing greater postural sway.

Results: Center of Pressure ellipse analyses followed by AP and ML variability analyses showed that participants with ASD showed greater sway than controls only when information from visual and both modalities about body sway was inaccurate. Gain manipulations showed smaller group effects than modality manipulations suggesting that postural control in participants with ASD is more sensitive to between-modality rather than within-modality changes in sensory information. Results also showed that the increase in sway with task difficulty was greater in participants with ASD compared with controls. Conclusions: Overall, adults with ASD were more vulnerable to environmental changes involving inaccurate visual, or visual and proprioceptive information compared with controls. This result is in agreement with previous studies on individual sensory modalities showing that individuals with ASD exhibit hypersensitivity to visual information but are relatively unaffected by changes in proprioceptive information compared with controls.

P3-K-54 Tactile ground information for navigation during locomotion

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Without sensory cues from vision or audition it is impossible to walk in a straight line. While walking we continuously receive tactile information about the terrain via our feet. If this tactile information indicates directionality it could potentially be used for maintaining a stable heading direction, especially in our frenzied lives, in which we often walk while texting. Currently there is tactile information available in the form of tactile pavement that is installed in many public places as a guide for the visually impaired. The disadvantage of tactile ground cues is that the ground surface can affect walking stability. Here we investigated how tactile pavement influences variability of heading direction and whether it influences walking stability in healthy sighted participants. In a second set of experiments, we tested whether tactile pavement would also be useful when walking while using a mobile phone. We asked participants to walk in a straight line on either tactile pavement or regular flat pavement. We varied the amount of visual information using goggles. Participants wore a cell phone attached to their back to register accelerations, and angular velocities, from which gait stability was assessed by means of maximum Lyapunov exponents. From analysis of the angular velocities, the variability of the heading direction was determined. This value can be interpreted as a measure of how well participants could used the tactile information. In a second experiment, vision was normal, but we asked subjects to type a text on their mobile phone during walking over both pavement-types With reduced vision participants were better at maintaining heading direction on tactile pavement than on regular pavement. In conditions with full vision, maximum Lyapunov Exponents were significantly higher (indicating a less stable gait) during walking on the tactile pavement. Thus, currently common used tactile information from the pavement can be used for maintaining a stable heading direction in an intuitive way without any training, but this may at the cost of impairing gait stability. Data on how tactile pavement could help during texting while walking are currently being analysed.

P3-K-55 Foot contact occurs prior to pole contact during Nordic Pole Walking among healthy young and elderly naïve pole walkers

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Background and Aim: Previous research has suggested that Nordic Pole walking may be a beneficial training method due to greater cardiorespiratory load during activity, and, relevant to those with lower limb joint pain, reduced joint loading. However, research is inconclusive regarding the effect of pole walking in terms of joint loading. The potential for Nordic poles to accept a portion of the body's weight thereby reducing loading at the joints may depend on the relative timing between foot and pole contact. A single study has reported the relative timing of foot and pole peak ground reaction force found that peak pole force occurred before peak braking force (Jollenbeck et al, 2006). Steif et al (2006) found that the first peak of external knee adduction moment (EKAM) increased with poles. The current study examined the relative timing of the onset of vertical ground reaction forces (GRF) of the foot and pole, among novice pole walkers. Methods: 10 healthy young (HY; age: 18-30 y.o.) and 10 healthy elderly (HO; age: ≥ 65 y.o.) male participants with no previous Nordic Pole walking experience were recruited. A 6m custom-made elevated walkway with four AMTI force plates (AMTI, Massachusetts, USA) embedded within the walkway; vertical ground reaction force was used to determine the temporal difference between heel and pole strike for two consecutive steps. A GAITrite mat was used to determine spatiotemporal measures of gait. Participants were asked to walk at a self-selected pace for a total of 30 trials (15 with poles: NW; 15 without: W). The same protocol was repeated 7 days after the first experiment. Measures of interest included: relative time difference (dt) between initiation of foot and pole GRF for the first (dt1) and second (dt2) steps. Results: Data collection and analysis is ongoing and the current results represent preliminary findings of the HY group. Figure 1 displays that heel strike occurred before pole strike and that relative timing was reduced for both steps during visit 2 [dt1: $t=2.90$, d.f.=9, $p=0.0339$; dt2: $t=3.19$, d.f.=9, $p=0.0111$]. Consistent with previous findings, stride length was greater [$F(1,9)= 29.3$, $p=0.0004$] during NW. In addition, time spent in single limb support (SST) increased [$F(1,9)= 13.6$, $p=0.005$] with the use of poles; there was a trend toward reduced double limb support time ($p=0.0764$). Conclusions: Relative timing between heel and pole contact was significantly reduced in visit 2, perhaps reflective of growing comfort with the Nordic walking technique, considering participants were naïve at visit 1. Decreased SST between visits supports this idea. We continue to analyze step-width data, but suggest that diminished step-width would also support this claim.

P3-K-56 Effects of different insole designs on postural control in people with Parkinson's disease and healthy elderly.

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BACKGROUND AND AIM: Information from mechanoreceptors of the sole of the foot to the central nervous system plays an important role in postural control. Reduced peripheral sensation has been related with aging process and disease like Parkinson's disease (PD). Some studies have shown that artificially enhancing somatosensory information via devices like insoles could improve postural control in people with Parkinson's disease and healthy older adults, but the relative effectiveness of different insole designs have been little studied. The aim of the current study was to evaluate the immediate effect of different insole designs on postural control in patients with PD and healthy elderly. METHODS: Fourteen elderly with PD and 14 healthy elderly were enrolled in the study. Initially, plantar sensation was assessed using Semmes-Weinstein Monofilaments before and after the postural protocol to assess changes in the sensitivity of the sole. After the plantar sensation protocol, participants were instructed to stand as still as possible on a force plate with their arms positioned along the body and looking at a target. They performed 3 trials of 30 seconds each in 3 conditions: conventional insole, insole with a raised ridge around the perimeter of the foot, and insole with half-spheres distributed across the sole of the foot. Outcome measures included anterior-posterior and medial-lateral center of pressure (CoP) parameters. RESULTS: Regardless of the insoles condition, patients with PD showed greater anterior-posterior CoP displacement and velocity than healthy elderly. However, univariate analyzes did not reveal mean effect of insole for both patients with PD and healthy elderly. Also, there were no between groups differences for plantar sensation before and after the postural protocol. CONCLUSIONS: Current findings suggest that the increased plantar cutaneous stimulation via insoles did not promote immediate benefits to postural control regardless of group. Two main explanations are possible: first, the augmented somatosensory information provided by both insole designs could be not enough to promote significant improvement in the somatosensory input to improve postural control; second, since postural control was assessed during standing with eyes open, participants may have relied more on visual information, annulling potential benefits from insoles with increased plantar cutaneous stimulation.

P3-K-57 Biomechanical effects of lateral and medial wedge insoles on unilateral weight-bearing

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BACKGROUND AND AIM: Knee osteoarthritis (OA) is one of the most common musculoskeletal disorders worldwide and a leading cause of knee pain and disability in the elderly. A high knee adduction moment

(KAM) reflects increased compressive forces acting on the medial compartment of the knee and is widely regarded as a surrogate measure of medial knee compression. Lateral wedge insoles (LW) reduce the peak KAM and are advocated for patients with knee OA. However, some patients demonstrate adverse biomechanical effects with insole treatments. Possible explanations for them are variations of foot alignments and gait patterns. The purpose of this study was to evaluate the immediate effects of LW and medial wedge insoles (MW) under unilateral weight-bearing in healthy young adults. METHODS: Thirty healthy young adults participated in this study (mean age, 21.2 ± 1.9 years; mean height, 1.62 ± 0.08 m; mean weight, 55.6 ± 9.5 kg). All subjects were divided into 3 groups using the foot posture index (FPI): normal foot, pronated foot, and supinated foot. All subjects were then requested to stand on the left leg under 3 conditions: barefoot (BF), LW, and MW. The 3 conditions were measured in a random order, and measurements were repeated 3 times for each condition. We calculated KAM and the knee-ground reaction force lever arm (KLA) under all conditions. Under LW and MW conditions, we also calculated the changes in KAM and KLA as a percentage of each value under the BF condition. These variables were measured using a 3-demensional motion capture system (Vicon MX) and force platforms (AMTI). All data were analyzed with the EZR on R commander v1.10 statistical software. Statistical significance was set at $P < 0.05$. RESULTS: All subjects were classified into 3 subgroups according to the left foot alignment results of FPI. The participants' age, height, and body weight were similar between the subgroups. In both all 30 subjects and the normal foot group (n=18), neither KAM nor KLA was significantly different between the conditions. On the other hand, as for the changes in KAM and KLA as a percentage of each value under the BF condition, both of these significantly decreased under the LW condition compared with the MW condition. In the pronated foot group (n=6), the change in KAM significantly decreased but that in KLA did not significantly decrease under LW condition compared with the MW condition. In contrast, no changes were observed in these variables in the supinated foot group (n=6). CONCLUSIONS: We found that a reduction in KAM with LW under unilateral weight-bearing closely related to that in KLA. Our findings also demonstrated that variations in foot alignment have different effects on changes in KAM. In particular, an individual with a supinated foot would not respond to LW. Our results suggest that assessment of foot alignment may provide insights on how to offer adequate insole treatments for knee OA patients.

P3-K-58 Long-term effects of electrotactile sensory substitution therapy on balance disorders

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BACKGROUND AND AIM: Peripheral vestibular disorders cause severe vertigo, nausea, nystagmus, and postural imbalances. These characteristic symptoms usually improve spontaneously with time via a behavioral recovery process known as vestibular compensation. However, in some patients a lack of central vestibular neuroplasticity renders the central vestibular compensation mechanism ineffective,

limiting the extent of any recovery in their balance performance. Such patients usually do not respond to standard therapies involving medical and vestibular balance rehabilitation therapy; therefore, they have difficulty in standing and walking without aids, such as canes and walkers, resulting in prominent reductions in their quality of life and difficulty performing daily and social activities. In this study, we proposed a new therapy using a vestibular substitution tongue device (VSTD) for such intractable balance disorders and examined whether VSTD training directly improves persistent balance problems in patients with peripheral vestibular etiologies to evaluate the practical utility of VSTD. METHODS: The VSTD trainings were performed by 17 subjects including 6 males and 11 females, who exhibited chronic dizziness and postural imbalances due to unilateral vestibular loss that had lasted for over 5 years and seriously interfered with their daily and social activities. The VSTD substitutes for the lost vestibular input by transmitting information on head position to the brain through the mechanoreceptors on the tongue. The device's electrode array was placed on the tongue, and the subjects were trained to maintain a centered body position by ensuring that the signals produced by the electrode array were being delivered to the middle of their tongue. All of the subjects completed a-10 minute training sessions 2-3 times per day for 8 weeks. Dynamic stability and gait function were evaluated using posturographic assessments of the movement of the subjects' center of gravity (COG) and functional gait assessments (FGA), respectively. In addition, the Dizziness Handicap Inventory (DHI) and the Activities-specific Balance Confidence (ABC) Scale were used to subjectively evaluate the severity of the subjects' dizziness and balance problems, respectively, before and after the training period. RESULTS: All 17 subjects showed pronounced improvements in their balance performance after the VSTD training. All of the examined parameters involving the COG movement, FGA, DHI and ABC improved immediately after the 8-week training period, and these changes were maintained for up to 2 years after the termination of the training. CONCLUSIONS: Short-term training with the VSTD had beneficial long-term effects. The VSTD examined in this study might be a useful rehabilitation tool for treating people with persistent balance disorders and could be used to enable such people to perform daily and social activities for long periods.

P3-L-59 The effect of laterally wedged insole on human lower extremity during gait cycle

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BACKGROUND AND AIM: Recently, knee osteoarthritis is common disease for many people because of population aging and obesity. Artificial joint replacement of the knee is one treatment for knee osteoarthritis. However it's not a typical treatment because it is an operative and expensive treatment. In this situation, a study on the laterally wedged insoles is being made. Laterally wedged insoles are non-operative treatment which reduces the pain, and slows the rate of disease. In previous studies, stress distribution on knee cartilage was found in normal standing case. In this study, gait cycle is grouped into

three phases, heel strike, mid stance, toe off, and muscle forces at each phase were obtained. Then stress distribution at knee and ankle was estimated by using finite element model and motion analysis together. METHODS: The finite element model was reconstructed from visible human MRI data. Bones and flesh of human lower extremity were reconstructed from MRI data, and cartilages and ligaments were attached to appropriate position refer to the anatomy literatures. Then as increasing the degree of laterally wedged insole, Vicon motion system was used to analyze gait motion. Ground reaction forces were measured by force plates. Each time of three phases is obtained by GRF graphs and Opensim calculated muscle forces of human lower extremity. Then finite element model was positioned as Opensim model at each phase of gait cycle. Muscle forces from Opensim and GRF from force plate were input data for finite element analysis. Stress distributions on knee and ankle were then analyzed by ABAQUS. RESULTS: The simulation results show that laterally wedged insoles affected knee and ankle joint in contrary manner. Von Mises stress peak value at meniscus with 0° insole at the time of heel strike was occurred at medial side. As the degree of insole increased, peak value decreased about 13% at the same place. In case of mid stance at knee joint, also peak value of von Mises stress decreased 8% as the degree of insole increased. This results verified the efficiency of laterally wedged insoles for knee osteoarthritis patients. However, at ankle joint, peak value of von Mises stress was rather increased when the degree of insole increased. In case of heel strike, von Mises stress peak value occurred at lateral side of ankle cartilage. As the degree of insole increased, peak value increased 24% at the same place. Also in case of mid stance and toe off, peak value of von Mises stress increased more than 20%. CONCLUSIONS: The change of stress distribution at knee and ankle cartilage during gait cycle was found by using motion analysis and finite element model. As the results, von Mises stress at medial meniscus was decreased. It verified that laterally wedged insoles have an effect for knee osteoarthritis patients. However, in case of ankle joint, peak value of von Mises stress at lateral side was increased. It could be a side effect of LWI.

P3-M-60 The factor of largest interpersonal variability in gait pattern when healthy adults walk normally on level ground

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BACKGROUND AND AIM: The purpose of this study is to understand which of age and sex/gender is more dominantly affect to the largest inter-personal variances of gait pattern during level walking in healthy adults. METHODS: Gait data while walking overground were obtained from 189 healthy adults (98 M and 91 F) aged 20 to 75. Participants were asked to walk barefoot at a comfortable, self-selected speed in a room with a straight 10 meter path. Three-dimensional positional data and ground reaction force of five trials were recorded using 55 IR reflective markers, the VICON nexus system (sampled at 200 Hz) and six AMTI force plates (sampled at 1000 Hz). Pelvis, right hip, knee, and ankle joint angles on

the sagittal, frontal, and horizontal planes during one gait cycle were calculated from low-pass filtered marker data of each trial. Data from each joint angle was time-normalized by the gait cycle duration determined based on the force plate data and divided into 101 variables ranging from 0% to 100%. Principle Component Analysis (PCA) was conducted to analyze the correlation matrix of 1212 (101 time points, 4 angles and 3 planes) variables to achieve the purpose of this study. Two-way ANOVA (age by sex/gender) was conducted to understand which of age and sex/gender affects more dominant. RESULTS: The PCA revealed that the first 10 principal components (PC) explained more than 80% of the variance. Two-way ANOVA revealed significant age effect ($F (2, 183) = 11.68$, $p < 0.01$, ES = 0.128), sex/gender effect ($F (2, 183) = 37.38$, $p < 0.01$, ES = 0.20), and their interactions ($F (2, 183) = 8.75$, $p < 0.01$, ES = 0.10) on the first PC (PC 1), which explained approximately 19.8% of the variance. Post-hoc analysis revealed that young female tend to have larger scores for PC 1 compared to older females and males. CONCLUSIONS: The results of the present study indicate that the most dominant factor affecting to the inter-personal variances of the gait pattern during level walking in healthy adults is whether the participant is young female or not. Further, the characteristics of reconstructed joint kinematics corresponding to the larger scores for PC 1, which indicate the young female gait pattern (thin-solid line in the Figure 1), are in good agreement with those of young adult female gait pattern reported in previous studies. On the other hand, the characteristics of reconstructed joint kinematics corresponding to the smaller scores for PC 1, which indicate the non-young female gait pattern (dotted line in the Figure 1), are in somewhat different from the young male gait pattern reported in previous studies. Such differences may be due to the differences of the target participants.

P3-M-61 Older adults alter foot trajectory with varying length of nosing projections on stairs: a pilot study

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Background and aim: For older adults, stair negotiation can be challenging given declines in function associated with aging, which impacts balance and the risk of missteps. Although many stair design features are known to contribute to increased falls risk, the nosing projection (horizontal protrusion beyond the edge of the run) has received little consideration with respect to falls prevention. The purpose of the study was to evaluate the effect of changing nosing length on the foot trajectory during stair ambulation. Methods: Data were analyzed from 6 healthy older adults (65-84 yrs; 3 males). Subjects ascended and descended a 6-step staircase (rise and run = 8 inches). Reflective markers were secured to the stairs and to the subject's shoes, providing 3D spatial coordinates collected at 200 Hz. Ten points along the edge of the shoes relative to the markers and the step edges in the global coordinate system were identified. No nosing on the step edge, a 1-inch nosing, and 2-inch nosing were randomized for each subject. Foot trajectory variables were extracted for steady-state stair gait. The absolute minimum position of the heel markers (descent) and the absolute minimum position of the toe markers (ascent) was determined: 1) horizontal foot-to-step clearance, when the foot was at the same vertical height as the step 2) vertical foot-to-step clearance, when the foot was at the same horizontal position as the step edge 3) amount of foot overhang 4) sagittal plane foot contact angle (descent only) 5) distance of the heel to the back of the riser at foot contact (descent only) Results: Due to the small sample size, statistical analyses were not possible. Preliminary results only are presented. Ongoing data collection and analysis will provide a larger sample size. Results are summarized in Table 1. During ascent, the greatest foot overhang resulted from no-nosing. In general, however, reduced foot-to-step clearance was seen with increased nosing lengths. During descent, the foot angle slightly increased in the presence of a nosing. However, foot overhang was reduced with increased nosing length. Vertical clearance of the foot did not appear to be affected by the nosing length, however, horizontal clearance was reduced with the 2-inch nosing. Conversely, the 2-inch nosing afforded greater clearance of the heel to the back of the riser. Conclusions: The current pilot work provides a descriptive evaluation of the effect of varying nosing length on foot trajectory of older adults during stair ambulation. Results suggest that the presence of a nosing is necessary for increasing the foot-to-step clearance and reducing foot overhang and foot contact angle during descent. However, the absence of a nosing during ascent results in greater foot clearance. The degree to which these foot trajectory measures relate to balance control may provide greater insight into the optimal length of the nosing to maximize safety on stairs.

P3-N-62 Assessing the physiological cost of active video games (Xbox Kinect) versus sedentary video games in young healthy males

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Background and Aim: Active video gaming (AVGs), incorporate a combination of exercise (limbs and/or whole body) and video gaming to increase levels of physical activity and make exercise enjoyable and fun, whether as a means of leisure activity or for fitness gains [1]. Preliminary results regarding the physiological response to AVGs have reported light to moderate levels of activity using a range of AVGs systems such as, Nintendo Wii [2] and Dance Dance revolution (DDR) [3] in a variety of age groups. Although promising, the variations in AVGs systems such as requiring hand held controllers (Wii?) or are have limited movement space due to a board or dance mat (Wii Fit and DDR) make the results somewhat inconclusive for any true generalizations to be made. The most recent development in AVG is the Microsoft Xbox Kinect, this allows free body, multi directional movement and is completely hands free for controlling. Therefore the aims of this study were twofold; 1) to determine the physiological cost of active video gaming (Xbox Kinect) compared to sedentary gaming (Xbox) in young healthy males and 2) compare physical activity levels attained during active video gaming to current physical activity recommendations (ACSM [4]). Methods: 19, young, apparently healthy, males participated in the study (age: 23 ± 3 years, height: 178 ± 6 cm, weight: 78 ± 15 kg). Participants completed a VO2max test (treadmill) and a video-gaming session. AVGs (Reflex Ridge, River Rush and Boxing, Kinect?) and sedentary video games (SVG), (FIFA 14 and Call of Duty Black Ops, Xbox). Heart rate (HR) and oxygen uptake (VO2) were recorded continuously during all video games. Rating of perceived exertion (RPE) was measured after every game completed (AVG and SVG). Energy expenditure, expressed as metabolic equivalents (METs) were calculated using 3.5 ml/min/kg resting oxygen consumption (VO2) is equal to 1 MET. The exercise intensity for each game was expressed as a percentage of predicted maximum HR (%HRmax) and percentage of measured maximal oxygen uptake (%VO2 max). Results: Mean exercise intensity (%HRmax and %VO2 max, RPE), energy expenditure (METs), HR and VO2 were significantly higher during active gaming compared to sedentary game play ($p < 0.01$) whereas RPE was significantly lower during active play. AVGs elicited moderate levels of exercise intensity (64-72%HRmax) in line with current recommended physical activity guidelines. Conclusions: Our findings support the promotion of active, but not sedentary, gaming as an acceptable, alternative mode of moderate intensity physical activity. Active video gaming offers potential for future preventative, and rehabilitative physical activity research. References [1] Vernadakis N, et al., Phys Ther in Sport 2014; 15: 148-155. [2] Lanningham-Foster L et al. J Pediatr 2009; 154(6):819-823. [3] Sell K, et al. J Am Coll Health 2008; 56(5):505-511 [4] ACSM Current Guidelines and Practice, 2008

P3-N-63 Effects of a music-accompanied walking program on sensory organization and postural control amongst people living with Parkinson's disease

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Background and aim: Postural instability is commonly reported to be one of the most debilitating features of Parkinson's disease (PD), placing individuals at increased risk of falls and injury. Deficits in the ability to centrally integrate information from the visual, somatosensory, and vestibular systems are considered to contribute to this postural instability. Walking interventions have been shown to be effective in maintaining or improving gait performance amongst people living with PD, however it is not known whether postural control and more specifically sensory organization can also benefit from non-specific walking programs. The aim of this study was to examine the effects of a home-based music-accompanied walking program on the sensory integration of postural control amongst people with PD. Methods: Postural control was assessed amongst healthy older adult controls (HOA) and people living with PD (PD) using computerized dynamic posturography (Sensory Organization Test; SOT) before and after a 12-week music-accompanied walking program (Ambulosono), and at follow-up. The Ambulosono program required participants to walk in their local community at least three times per week for a minimum of 20 minutes per session. Participants wore an iPod Touch® in a leg band and Bluetooth headphones whilst walking. The iPod® and GaitReminder® application served the dual purposes of providing music to the participant and recording gait parameters using the internal accelerometers and gyroscopes. The provision of music was contingent upon the participants maintaining a step size above a pre-determined threshold. Results: Pre-intervention assessment determined that people living with PD had lower equilibrium scores on the SOT than HOA. In addition, people living with PD had increased and faster sway in the anterior-posterior direction when compared to HOA. There were no significant changes to the SOT equilibrium scores for HOA or PD following the Ambulosono intervention. Participants in the PD group did, however, demonstrate decreased and slower postural sway in the anterior-posterior direction across all conditions post-intervention. These changes to postural sway were not maintained at follow-up. Conclusions: These preliminary results suggest that a home-based music-accompanied walking program can be effective in improving specific aspects of postural control amongst people living with PD. The changes to postural sway following the intervention do not appear to be related to improvements in sensory integrative ability for postural control.

P3-N-64 Long-term effects of the HiBalance program in elderly with Parkinson's disease

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Background and aim: We have developed a new balance training regime, the HiBalance program (1), where specific components of balance control related to Parkinson's disease (PD) symptoms are emphasized by using highly challenging, progressive and varying training conditions. In this group training program, four main subsystems underlying balance control were emphasized and movement complexity in combination with dual-tasking was increased. After the last training session, individually tailored physical activity on prescription was given. Short-term effects show that the HiBalance program significantly improved balance and gait abilities as well as transfer effects to everyday living when compared to care as usual (2). Reports on long-term effects of training interventions in people with PD are scarce, despite their importance for designing effective rehabilitation and training programs. The aim of this study was therefore to evaluate the long-term effects of the HiBalance program with regards to gait and balance in comparison to care as usual in elderly with mild to moderate PD. Methods: 101 elderly with PD were randomized either to a group training 3 times/week for 10 weeks (n= 51) or to a control group (n=50), trial registration: NCT01417598. The groups had similar characteristics: training group mean age 73 years (SD 5.5), 32 males, UPDRS III mean score 37 (SD11) and control group mean age 73 years (SD 5.8), 25 males, UPDRS III mean score 36 (SD10). Balance performance (Mini-BESTest, score 0-28, higher=better) and gait speed were assessed pre- and post- the intervention as well as at a 6 months post-training follow-up. The results were analyzed with an intention-to-treat analysis using repeated measurement ANOVA. Results: The control group, in contrast to the training group, remained unchanged throughout the whole period. The training group showed post-intervention improvements in balance performance (3 points) and gait speed (0.10 m/s), interaction effects, p=0.002 and p=0.017. The positive effects on balance performance were weakened at 6 month follow-up (2 points, $p<0.001$), however, still a small but significant improvement of 1 point was retained as compared to baseline values ($p=0.038$). At the 6 month follow-up, gait speed was similar to baseline values. Conclusions: The results imply that the effects of highly challenging balance exercises on balance and gait abilities wears off in 6 months. Therefore, continuous training may be indicated for elderly individuals with mild to moderate PD. Further analysis should investigate whether positive effects on physical activity level or activities of daily life are maintained in a long-term perspective. References 1) Conradsson, Löfgren, Ståhle, Hagströmer, Franzén. BMC Neurol. 2012: 12:111. 2) Conradsson, Löfgren, Nero, Hagströmer, Ståhle, Lökk, Franzén. Accepted in NNR. dec 2014

P3-N-65 Daily life activities in the elderly population: effects on gait, cognition and falls.

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BACKGROUND AND AIM: Some people are more active than others, especially beyond a certain age. Could it impact their cognition and gait capacities, and further influence their risk of falling? Many studies indicate that physical activity programs or cognitive exercises can preserve or at least reduce the functional decline in older adults. However, few studies examined the potential benefits of the activities in which people are regularly engaged. These rare studies mainly focused on physical activities because there is no questionnaire to quantify on a comparable basis the other kinds of activities. To solve this issue, we created a questionnaire that separately quantifies five types of activity regularly performed. We then tested whether regular engagement in specific activities over several years can protect from gait and cognitive decline, and from the occurrence of falls, and whether some activities are more efficient than others. METHODS: More than 100 adults aged 55 years and older, with a fall history in the previous year, were included in this study. Global cognition and gait were assessed by the Montreal Cognitive Assessment and Timed Up and Go test, respectively. Each subject was extensively questioned about its daily activities over the past 5 years. A score was computed for 5 kinds of activities (physical, intellectual, social, manual and passive) while taking into account that some activities could engaged several functions (for instance, intellectual and social for board games). We then calculated a weighted score for each activity based on its level of intensity, duration and frequency. Participants were classified into 2 groups based on their gait and cognitive scores (normal vs impaired) and occurrence of falls (single vs recurrent). For each of the 5 activity scores, intergroup comparisons were then performed using ANCOVA controlling for appropriate covariates (age, level of education...). RESULTS: Scores for a given activity could vary from 2 to 36, thus highlighting the high sensitivity of our questionnaire. Participants with impaired gait practiced less physical ($p<0.0001$), intellectual ($p<0.0175$) and social (p<0.035) activities than those with normal gait. Participants with cognitive disorders practiced less intellectual activities than cognitively preserved participants (p<0.025). Finally, recurrent fallers practiced less physical activity than participants reporting a single fall (p<0.0075). CONCLUSIONS: The newly elaborated questionnaire allows reliable quantification of the main types of activities that people regularly practice in their daily life. Furthermore, the preliminary data suggest that practicing physical and intellectual activities in a social context would be very suitable for preventing functional age-related decline. Further analyses should be performed to determine whether such a questionnaire could predict gait and cognitive declines, and help to slow the decline by the practice of targeted activities.

P3-N-66 Exergaming in older adults: The effect of the games on movement characteristics during gameplay

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BACKGROUND: There is mounting evidence that fall risk and fall rate in older adults can be reduced by exercises that combine balancing with weight shifting movements (e.g., 1). Serious videogames, so-called exergames, are increasingly used to provide enjoyable, easy access, low threshold training to improve physical functions such as balance, strength, and coordination. However, we lack knowledge about whether and how movement characteristics elicited by existing exergames are influenced by game characteristics and thereby about their potential to be an appropriate training tool for the elderly population. AIM: To investigate how two different exergames and different difficulty levels influence movement characteristics in older adults. METHODS: 20 healthy elderly (12 women and 8 men; age range 65-90 yrs, mean age 75.7±5.48 yrs) participated in a laboratory study with 3D movement registration (OQUS) with reflective markers placed on bases of 1st toe, heels, and lower back. Participants played two different stepping exergames, The Mole from SilverFit and LightRace from YourShape:Fitness Evolved, on 2 difficulty levels with 5 one-minute trials for each game and level. Difficulty was increased by an additional cognitive challenge in the Mole (avoiding lady bugs), and an additional movement direction (backwards) in LightRace. Stepping parameters included number of steps, step direction, step length, and step speed, and horizontal areas covered by the lumbar and toe markers. In addition, data on game score, perceived exertion (BORG), and enjoyment was collected. Stepping parameters were analysed with 3-way repeated measures ANOVAs on Game (2) x Level (2) x Trial (5). RESULTS: Participants preferred the medium levels over the easy levels due to the increased cognitive and physical challenge. However, even though game scores increased across trials, the score decreased from easy to medium difficulty levels. Similarly, the horizontal area covered by the feet decreased when participants played the medium levels compared to the easy levels. Furthermore, increasing difficulty level resulted in reduced step length and step length variability in both games. When playing LightRace, the players displayed a larger number of steps and higher step speed at the

medium compared to the easy level. CONCLUSION: This study illustrates that characteristics of exergame design affect the elicited movements of the players. Even though an increased game challenge boosted players` enjoyment, an increased cognitive challenge can simultaneously reduce the quantity and quality of exercise movements performed during gameplay. Therefore, in order to be beneficial as exercise for older adults, exergames need to be designed with care and combine fun cognitive challenging tasks with more basic tasks that elicit and reward the desired movements.
References: 1. Gillespie et al. Cochrane Database Syst Rev. 2012 Sep 12;9: CD007146.

P3-N-67 i-walk: a novel form of walking exercise to improve lower limb muscle strength

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BACKGROUND AND AIM: Walking exercise interventions have been widely used to improve physical fitness. However, most training regimens require moderate to high exercise intensity in a supervised setting, which deters their general use. Here we propose a novel form of walking, called "i-walk", which can be easily implemented in daily living. i-walk adds a longer step after a gait cycle of normal walking: two normal steps with leading and training limbs, followed by a longer step with the leading limb (Fig.1). The objective of this study was to investigate if i-walk would have beneficial effects on lower limb muscle strength. It was hypothesized that hip and knee extensor moments would be greater during i-walk as compared with normal walking. METHODS: Eight healthy young male adults were instructed to walk at a self-selected comfortable pace along an 8-m unobstructed walkway with five different walking conditions: normal walking (NW), long step walking (LW), fast step walking (FW), fast long step walking (FLW), and i-walk. Whole body motion data with ground reaction forces were collected to calculate gait velocity, step length, and hip and knee joint moments in the sagittal plane during the stance phase of the right leg. For i-walk, the stance phase of the right leg after performing a longer step with the right leg was used for analyses. The Friedman´s repeated measure non-parametric test followed by Scheffe´s post hoc test was performed to detect differences in the outcome measures among the five walking conditions. RESULTS: No significant difference was found in the gait velocity between NW and i-walk (NW: 4.81±0.43km/h, i-walk: 5.12±0.79km/h, $p=0.9$). Step length of i-walk was significantly longer than that of NW (NW: 0.68±0.04m/step, i-walk: 0.92±0.11m/step, $p=0.0006$), while it was not significant when compared with LW and FLW (LW: 0.85±0.08m/step, $p=0.9$, FLW: 0.86±0.07, $p=0.06$). Significantly larger hip and knee flexion angles were observed during i-walk as compared with NW ($p<0.05$), while they were not significantly different among LW, FLW, and i-walk ($p>0.05$). Hip and knee extensor torques were both significantly larger during i-walk when compared with NW ($p<0.05$), although they were not significantly different among LW FLW, and i-walk. CONCLUSIONS: Hip and knee extensor moments during i-walk were found to be larger than those during normal walking, while those increased torques were similar to those during long step walking. These results suggested that self-paced i-walk could provide the same level of training as long step walking to improve hip and knee extensor strength. Since i-walk is an easily implementable form of walking, it would provide the ease of participation during activities of daily living in the general population. This unique form of walking can be applicable for health promotion in older adults to help protect against age-associated decline in muscle strength, which would enhance one´s quality of life.

P3-O-68 Anxiety symptoms during hospitalization of elderly is associated with increased risk for post-discharge falls

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Objective: Post acute hospitalization falls among the elderly, are rarely studied. The aim of this study is to test the association between anxiety at time of hospitalization and falls occurring within one-month post-discharge and, to offer potential mechanism for this association. Method: One month prospective cohort study of 556 older adults in two Israeli medical centers. Anxiety and functional decline were assessed during hospitalization and falls were assessed one month post discharge. Results: A total of n=72 (12.9%) participants reported at least one fall during the 30-days post-discharge period. Controlling for demographic, functional decline, pre-morbid functional status, the odds of falls between discharge to 1-month follow-up were almost twice as high among patients with anxiety symptoms (OR= 1.89 ,95% CI: 1.04-3.48) compared with those who screened negative for anxiety. When accounting for in-hospital functional decline the relationship between falls and anxiety was reduced by 11% (from OR=2.13 to OR=1.89) indicates that the relationship between anxiety and falls was partially mediated by function decline during hospitalization. Conclusion: Anxiety at time of hospitalization is associated with falls 30-days post discharge, controlling for several well known confounders. This relationship is partially mediated by functional decline. Identifying patients with anxiety for inclusion in targeted rehabilitation interventions may be an important component in fall prevention strategies.

P3-O-69 Orthopaedic patients with total hip arthroplasty have a higher risk of falling than patients with total knee arthroplasty: a retrospective cohort study.

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Background and aim: A specific population of older adults that is expected to meet many of the risk factors for falling are those who underwent surgery at their lower extremities. Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are common and effective surgical interventions for the treatment of end-stage osteoarthritis. The first objective of our study was to determine the prevalence and functional consequences of falling in patients with unilateral THA or TKA. The second objective was to determine whether THA patients have a higher risk of falling compared to TKA patients. Methods: Orthopaedic patients over 65 years of age who had received either a unilateral primary THA (n=209) or TKA (n=127) in the preceding 3-18 months were included. The number of falls since their arthroplasty surgery, the presence of potential determinants of falls between type of arthroplasty and falls since surgery were assessed with validated questionnaires. Physical injuries, physical activity and functional activity declines were also assessed as direct consequences of the last fall since surgery. Results: In the THA group, 31% fell and in the TKA group 20% fell at least once in the 3-18 months since surgery, which was significantly different. Additionally, patients who had received a THA showed a significant 1.93 times higher chance of falling compared to patients with a TKA. This result was not confounded by a difference in time since surgery between groups. More than half of the fallers in both groups reported physical injuries as a consequence of a fall since surgery. Physical and functional activities declined after a fall by on average 26% and 16%, respectively in THA and 30% and 22%, respectively in TKA group. Conclusion: Patients with a unilateral THA have a significant higher risk of falling in the 3-18 months after surgery compared to patients with a unilateral TKA, indicating that they should receive higher priority for fall prevention programs aimed at improving their physical capacity and decreasing risk of falling.

P3-O-70 PARAMETERS HARVESTED FROM REAL-WORLD FALLS TO ELDERLY PEOPLE FOR THE L5 LOCATION RECORDED USING INERTIAL SENSORS

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INTRODUCTION Automatic detection of falls will reduce the consequences of falls in the elderly and promote independent living [1]. Inertial sensor technology can distinguish falls from normal activities. However, <7% of studies have used fall data recorded from elderly people in real life [2]. Using the FARSEEING project database of real-world falls harvested from elderly people (farseeingresearch.eu), we have extracted temporal and kinematic parameters to further improve the development of fall detection algorithms METHOD A total of 100 real-world falls and 1908 ADL, recorded through the Geriatric Rehabilitation Unit in Robert Bosch Hospital, Stuttgart were analyzed. Subjects with a known fall history were recruited, inertial sensors were attached to L5 and a fall report, following a fall, was used to extract the fall signal. RESULTS This data-set was examined, and variables were extracted, these include; upper and lower impact peak values from the tri-axial accelerometer, posture angle change during the fall and time of occurrence of the maximum posture angle, time when the sit to lie threshold was exceeded after a fall, and the amount of time the posture was below popular lying thresholds, Table

I. CONCLUSION Parameters have been extracted from real-world falls from older adults. These extracted parameters could potentially be used to distinguish real-world falls from ADL. REFERENCES [1] A. K. Bourke, et al., "Evaluation of waist-mounted tri-axial accelerometer based fall-detection algorithms during scripted and continuous unscripted activities," J Biomech, vol. 43, no. 15, pp. 3051-3057, 2010. [2] L. Schwickert, et al. "Fall detection with body-worn sensors : a systematic review.," Zeitschrift für Gerontologie und Geriatrie, vol. 46, no. 8, pp. 706-19, Dec. 2013.

P3-O-71 Gait and balance measured with inertial sensors in elderly men

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BACKGROUND. Falls are a leading cause of serious injury and loss of mobility in the growing elderly population. Accurate assessment of a person's fall risk is important to mitigate potential falls. Measuring a person's balance and gait with inertial sensors offers a more accurate to way quantify mobility than commonly used clinical assessments. We are measuring balance and gait in a group of elderly men who are part of the Osteoporotic Fractures in Men (MrOS) longitudinal study; in total we will collect data on over 300 men to develop a Fall Risk Score. Here we present results from the first subjects tested using our instrumented Stand and Walk (ISAW) Test. AIM. Identify objective balance and gait measures related to falls. Methods. During routine MrOS study visits, subjects also completed the ISAW test (30 seconds quiet standing, walk 7 meters, turn around, walk back). The test was repeated with a cognitive dual-task of reciting serial subtractions by threes. Fall history was quantified from quarterly postcards (past 16 months). Subjects were categorized as "fallers" if they had one or more self-reported falls and "non-fallers" otherwise. We focused analysis on six important sway, gait, and turning metrics found in a previous factor analysis of subjects across a wide age range: sway ML and AP dispersion (RMS ML and RMS AP), sway frequency, gait velocity, stride length, turning peak velocity; and also calculated the dual task cost [(dual task ISAW-ISAW)/ISAW*100)]. RESULTS. We have tested 53 elderly men (age = 83.6 ± 3.7 yrs). The subjects were grouped as fallers (N=23) and non-fallers (N=30). There was separation between fallers and non-fallers in several metrics: gait speed (fallers: median 1.11, IQR [1.01,1.22]; non-fallers: median 1.24, IQR [1.11,1.32] m/s), stride length (fallers: median 1.23, IQR [1.18,1.32]; non-fallers: median 1.32, IQR [1.23,1.45] m), peak turn velocity (fallers: median 147.6, IQR [128.3,164.1]; non-fallers: median 163.8, IQR [133.1,198.1] deg/s), and RMS ML sway (fallers: median 0.080, IQR [0.066,0.103]; non-fallers: median 0.071, IQR [0.057,0.086]; m/s2). Subjects with 2 falls (N=7) had even more pronounced changes in gait and balance measurements, e.g., gait speed: median 0.99, IQR (0.96,1.13) m/s. The addition of a cognitive task, measured as dual task cost, resulted in worsening of metrics in both fallers and non-fallers, with no apparent difference between groups. CONCLUSIONS. Both gait and balance measures tended to become worse with increasing number of falls experienced by these elderly mean. Dual tasking affected gait and balance measures in both fallers and non-fallers. Additional

subjects will allow a more complete discrimination of most sensitive gait and balance metrics to identify fallers and development of a fall risk score. Acknowledgements: 2R42 HD071760, R01 AG00645, UL1 RR02414, U01 AG027810, U01 AG042124, U01 AG042139, U01 AG042140, U01AG042143, U01AG042145, U01AG042168, U01AR066160, ULTR000128

P3-O-72 Spatiotemporal Gait parameters in Elderly are unaffected by internal or external attention

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BACKGROUND AND AIM: It has been suggested that individuals with increased fear of falling have heightened conscious attention to their own movements. The process of switching from a more automated implicit form to a more conscious form of motor control has been termed reinvestment [1]. Using the Movement Specific Reinvestment Scale (MSRS), Wong et al. have found higher reinvestment scores in elderly with a history of falling compared to elderly non-fallers [1]. Related to reinvestment, one might distinguish between external and internal focus of attention during motor performance. Based on a growing body of literature [2], external focus of attention appears to facilitate performance on challenging motor tasks. We studied whether external focus of attention leads to a temporary less variable gait pattern (indicative of greater stability) than internal attention. Effects of gait perturbations, fall history and falls efficacy on spatiotemporal gait parameters and fear of falling were studied as well. METHODS: 28 healthy older adults (8 males, 20 females, age: ≥65) were recruited. Participants walked on a split belt treadmill in combination with a virtual environment (VE) projected on a 180° semi-cylindrical screen (see figure). Temporary unilateral treadmill decelerations at random time intervals were used to perturb gait and full body kinematics was collected. Participants filled out the Falls Efficacy Scale International (FES-I), the Movement Specific Reinvestment Scale (MSRS) and fall history details. 5 Minutes of unperturbed and two 5-minute trials of perturbed gait were recorded, one internal and one external attention condition. For both conditions participants received verbal instructions. Internal attention: "Look ahead at the screen and concentrate on the movement of your legs". External: "Look ahead at the screen and concentrate on the movement of the treadmill". We calculated variability (coefficient of variation [CV]; SD / mean X 100) for: step width, step length, swing time and stance time. RESULTS: 12 out of 28 participants had experienced a fall within the last 12 months and were labeled as fallers; remaining subjects were labeled as non-fallers. No difference between fallers and non-fallers was found for MSRS scores, $F(1,25) = 0.74$, $p = 0.40$ (MSRS part 1) and $F(1,25) = 0.61$, $p = 0.44$ (MSRS part 2). For the CVs of the 4 spatiotemporal gait parameters no significant difference was found between conditions for fallers and non-fallers. CONCLUSION: Variability of our selected gait parameters did not show a difference between internal and external attention. Our results of spatiotemporal gait parameters indicate that effects of internal and external attention on motor control, as observed in

other studies with challenging motor tasks, are not found in healthy elderly gait. LITERATURE: [1] Wong, W.L., et al., Neurorehabil Neural Repair, 22(4) 410-4, 2008. [2] Wulf, G., Int Rev Sport Exerc Psychol, 6, 77-104, 2013.

P3-O-73 Development and evaluation of Kinect-based tests for clinical and in-home assessment of fall risk in older people

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BACKGROUND AND AIM: Fall risk assessments have been developed to determine the individual likelihood to fall and to select an appropriate prevention or treatment strategy. Because of limited health care resources, objective test equipment (e.g. force platforms or electronic walkways) and expertise to perform these technical assessments are not always available. Furthermore, the results of tests performed in a laboratory setting under ideal circumstances might be dissimilar to those in an older person's daily environment. The aim of this study was to develop and evaluate novel Kinect-based tests for clinical and in-home assessment of fall risk in older people. METHODS: The assessment tests were conducted with 94 older people (79.7±6.4 years) in the laboratory and with 20 participants at home. Three tests were developed including a sit-to-stand, reaching reaction time and stepping reaction time test. Participants were standing or sitting in front of a television and saw themselves represented as an avatar in a virtual environment. In the sit-to-stand test participants were asked to stand up and sit down five times as quickly as possible. In the reaction time tests participants saw two lights, one to the left and one to the right side of the avatar, which flashed in random order. Participants had to lift their arm to the flashing light or to take a step onto the flashing light as quickly as possible. Participants' movements were recorded and measurements from the sensor signals of the Microsoft Kinect were algorithmically obtained. It has been determined whether these measurements could identify people at increased risk of falling and the feasibility of conducting the tests in a home setting. RESULTS: Twenty-nine participants reported a fall in the 12 months prior to the assessment. Fallers were significantly slower than non-fallers in all three Kinect-based tests. Non-fallers completed the five-times-sit-to-stand test in 14.33±4.53s compared to the fallers who required 16.80±5.68s (p=0.03). The mean reaching reaction time according to a cue signal on the television was 788±162ms in the group of fallers and 724±99ms in the group of non-fallers (p=0.02). It took fallers 968±235ms compared to the non-fallers 830±130ms to initiate a step (p<0.01). The correlations between the laboratory and in-home assessments were 0.83 (p<0.01) for the five-times-sit-to-stand test, 0.69 (p<0.01) for the reaching reaction time test and 0.86 (p<0.01) for the stepping reaction time test. CONCLUSIONS: The study findings indicate that the Kinect-based assessment tests are able to identify fallers and are feasible to administer in clinical and in-home settings. Consequently, this work represents an important first step towards the development of sensor-based home assessments. With further validation, the assessment

tests may prove useful as a fall risk screen and home-based assessment measures for monitoring changes over time and effects of fall prevention interventions.

P3-O-74 The Narrow Path Walking Test - a new tool to identify elderly fallers

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Background and aim: Falling during walking is a common problem among the older population. Hence, the challenge facing clinicians is identifying who is at risk of falling during walking, for providing an effective intervention to reduce that risk. We aimed to assess whether the clinical version of the Narrow Path Walking Test (NPWT) could identify older adults who are reported falls. Methods: A total of 160 older adults were recruited and asked to recall fall events during the past year. Subjects were instructed to walk in the laboratory at a comfortable pace within a 6 meter long narrow path, 3 trials under single task (ST) and 3 trials dual task (DT) conditions without stepping outside the path (i.e., step errors). The average trial time, number of steps, trial velocity, number of step errors, and number of cognitive task errors were calculated for SD and DT. Fear of falling, Performance oriented mobility assessment (POMA) and mini-metal state examination (MMSE) was measured as well. Results: Sixty-one subjects reported that they had fallen during the past year and 99 did not. Fallers performed more steps, and were slower than non-fallers. There were no significant differences however in the number of steps errors, the cognitive task errors in ST and DT in POMA and MMSE. Conclusions: Our data demonstrates decreases in gait speed and the number of steps during the NPWT in ST and DT in fallers. There is no added value of DT over the ST for identification of faller's older adults

P3-O-75 Falls and fear of falling in dizzy patients

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Background: Vertigo and dizziness have substantial impact on functioning and quality of life. However, there is only limited information on the incidence and severity of falls in the affected patients. Methods: We conducted a controlled cross-sectional study at the tertiary care outpatient clinic of the German Center for Vertigo and Balance Disorders using a self-administered questionnaire for the assessment of falls, fall related injuries, and fear of falling. A total of 862 patients (mean age 59.6±17.1 years, 55% female) and 114 healthy subjects were recruited over a 6 months period (response rate >90%). Results: Dizzy patients with central balance disorders (Parkinsonian, cerebellar and brainstem ocular-motor

syndromes) had the highest fall rates (>50% recurrent fallers, odds ratio >10). The rate of recurrent fallers was 30% in bilateral vestibular failure and peripheral neuropathy (odds ration >5). Patients with functional dizziness (somatoform or phobic vertigo) did not fall more often than healthy controls (odds ratio 0.87). Fear of falling, however, was higher in this group than in bilateral vestibular failure. Conclusion: Falls are common in patients presenting to a dizziness unit. Patients presenting with central syndromes are at risk to fall recurrently and severely. Fall rates should be assessed in balance disorders and should guide the regimen of rehabilitation therapy.

P3-O-76 Real-time smartphone based fall detection platform for at-risk populations

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BACKGROUND AND AIM: There is currently much interest in identifying and detecting fall events using a single inertial measurement unit (IMU) consisting of accelerometers, gyroscopes, and magnetometers. Multiple studies have shown that the IMU based wearable systems effectively identify fall incidents by measuring the impact of the body on the ground and monitoring body orientation during and after falling. However, many fall detection systems cannot support ubiquitous fall detection because their specific hardware and software increase cost and limit commercial viability. Programmable, customizable smartphone technology is a promising alternative, due to embedded motion sensors, advanced microprocessors and memory capacity, and open source operating systems. This study develops a smartphone based fall detection system and analyzes its ability to differentiate falls occurring during activities of daily living (ADLs), other types of falls, and fall-like activities. METHODS: An Apple iPhone 4S (Apple Inc.) smartphone having a powerful central processing unit, adequate memory capacity, adaptable software development environment, and built-in motion sensors was developed. The prototype sampled values of accelerometer, gyroscope, and attitude information at a rate of 50 Hz. Accelerometer and gyroscope measures were low-pass filtered in real-time with a cutoff frequency of 5 Hz to account for signal noise. To demonstrate a proof-of-concept, the prototype quantitatively assessed five representational ADLs by measuring real-time acceleration, gyroscope, and attitude values. The five ADLs were: 1) comfortable walking, 2) standing-to-seated posture, 3) seated-to-standing posture, 4) pivoting at the waist to pick up an object, and 5) standing-to-seated-to-laying transition. In all trials, the smartphone was placed in the left front-pocket (inferior to left anterior superior illiac spine) with the screen directed towards the participant's body. RESULTS: Preliminary observations of ADLs using the proposed system yielded clear and discrete movement patterns. A comfortable walking speed showed traditional gait characteristics of consistent and repetitive rotational velocities and movement angles. In addition, the proposed system measured other activities typically associated with false positives, such as the seated-to-standing and standing-to-seated transitions, object pick-up, and the standing-to-seated-to-laying transition. These postures and postural transitions also yielded the clear patterns necessary for threshold identification techniques and pattern recognition algorithms required to differentiate discrete events in real-time. CONCLUSIONS: The real-time smartphone based fall detection system prototype provided superior differentiation. Future studies will develop the real-time fall detection algorithm including machine learning.

P3-O-77 An adverse interaction between joint pain and habitual walking on incidence of falls among community-dwelling older adults

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Background and aim: Joint pain is a risk factor for falls (Leveille et al., 2009) and related to decreased physical activity (Stubbs et al., 2013) among older adults. However, question exists as to whether older adults with joint pain should simply increase their physical activity, particularly by walking. Therefore, the purpose of this longitudinal study was to examine the association between joint pain, habitual walking, and incidence of falls among community-dwelling older adults. Methods: A cohort of Japanese community-dwelling older adults (n = 535) aged 60-91 years (73.1 ± 6.6 yr, 157 men and 378 women) who underwent community-based health checkups from 2008 to 2012 were followed until 2013. Number of pain sites (head, neck, shoulder, elbow, chest, abdomen, back, hip, knee, and foot) and presence of habitual walking (≥ 30 minutes/day, ≥ 2 days/week, ≥ 1 year) were ascertained at baseline. The "fallers" were defined as participants who suffered multiple falls or a fall with an injury within one year during the follow-up period. Incidence rate of falls between walkers and non-walkers was compared stratified by the number of pain sites (0, 1, 2, 3, and ≥4). The Cox proportional hazard model was used to assess the association between habitual walking and falls, stratified by the number of pain sties (0-1 and ≥2), adjusted for covariates (age, sex, depressive symptom, poor balance, polypharmacy, use of assistive devices, knee pain, mobility limitation, and previous fall history). An interaction between pain and habitual walking on falls was assessed with the Cox proportional hazard model adjusted for the above covariates. Results: During a mean period of 1.7 (1-5) years, a total of 916 person-years and 112 falls were observed. The incidence of falls among the walkers was higher than that of the non-walkers, particularly among those with 2, 3, and ≥4 sites of pain (Figure 1). The Cox proportional hazard model showed that habitual walking was not significantly associated with falls among those with 0-1 site of pain (hazard ratio (HR): 1.01, 95% confidence interval (CI): 0.50-2.22). However, habitual walking was significantly associated with increased falls among those with ≥2 sites of pain (HR: 3.58, 95% CI: 1.66-7.73). A significant interaction between habitual walking and pain on falls was observed (P for interaction = 0.027). Conclusions: The results suggest the adverse interaction between joint pain and habitual walking on incidence of falls among community-dwelling older adults. When individuals have two or more sites of pain, habitual walking increases their risk of multiple or injurious falls. Therefore, an appropriate pain-management strategy is warranted when conducting a walking intervention to increase the level of physical activity.

P3-O-78 Qualitative Evaluation of the Stay Well At Home Multifactorial Fall Risk Reduction Program

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BACKGROUND AND AIM: Multifactorial fall risk reduction programs have been effective in reducing fall rates and/or fall risk. One challenge of these interventions is participant adherence post program. Theory- driven interventions have been suggested to address this issue (Brawley & Culos---Reed, 2000). The development of the Stay Well At Home (SWAH) fall risk reduction program was guided by the Health Action Planning Approach; a theoretical framework that has shown some recent success in behavior change interventions (Gaston & Prapavessis, 2012). METHODS: Older adults identified at moderate-to-high risk for falls received an in-home program and follow-up phone coaching over a 4-month period. Trained facilitators guided recipients through a progressive home exercise program and interactive discussions addressing important fall-related topics (e.g., home safety, medication management, vision), goal-setting, overcoming barriers to taking action, and building social support. At the completion of the in-home program, participants completed a 45-60 minute semi-structured interview. Interviews were recorded, transcribed verbatim, and thematically analyzed. RESULTS: Three overarching themes emerged based on interviews conducted with 9 participants: cognitive changes, physical changes, and changes in fall protective behaviors. Within physical changes, changes in balance were reported by 8 of the 9 participants and mentioned 16 times; an example change in balance was " . . . I don't necessarily have to lean on the wall or hold the wall with one hand while I get my pants on." Other physical changes mentioned were physical changes in gait (n=5 respondents; 11 responses) and physical performance (n=5 respondents; 8 responses). All participants reported changes in fall protective behaviors (n=9; 21 responses). An example change in fall protective behaviors was ". . . now . . . I stand up and I don't take that first step, you know - the split second that I get up . . ." For the theme of cognitive changes, participants reported feeling more confident and comfortable (n=5; 17 responses) as well as having an increase in knowledge of the consequences of falls (n=4; 6 responses). CONCLUSIONS: These preliminary results suggest that the SWAH program is effective in changing the perceptions, attitudes, and behaviors of program recipients immediately following the in-home phase of the program. Subsequent follow-up interviews scheduled for 12-months post-completion of SWAH will provide further evidence for long-term adherence to fall protective behaviors.

P3-O-79 Accelerometer based detection of rising from the floor to describe recovery

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Accelerometer based detection of rising from the floor to describe recovery Schwickert L1,Boos R1, Becker C1, Lindemann U1,Schwenk M1, Klenk J1,2 1 Department of Clinical Gerontology, Robert-Bosch Hospital, Stuttgart, Germany. 2 Institute of Epidemiology and Medical Biometry, Ulm University, Germany. Background Long lying periods after a fall are a major problem for older persons. It is essential that automated support systems can detect if a successful recovery follows after a fall or a long lie to initiate a call for help. In a previous study, movement strategies and key components dur-ing rising from the floor were determined from video analysis (Schwickert 2014, submitted). As a first step an algorithm for automatic detection of rising from the floor from different ly-ing positions is being developed from inertial sensor signals. Stereotypic movement patterns are being classified and described by kinematic parameters. Methods Accelerometer data of fourteen younger subjects between 20 and 50 years of age and 10 healthy older subjects (60+ years) were recorded for different rising sequences with a multi-sensor-system (APDM, Portland, Oregon). The duration of transfers as well as maximal verti-cal velocity within the motion sequences of different rising sequences recorded at sternum position were analysed. Results An algorithmic approach (threshold based detection of standard deviation from inactivity motion level) for automatic detection of start and end points for different rising sequences was developed. Comparing lie-to-stand transfer duration (paired t-test) based on video vs. automated sensor signal analysis showed a mean difference of .39s (SD=0.67, mean video 5.19s vs. sensor signal 5.58s; p=0.008). A stereotyped pattern for elevation movements was observed for rising from supine lying. Maximum vertical velocity ranged from 1.8 to 10.3 m/s^2 (SD=2.1). Conclusions An algorithmic approach for automatic detection of start and end points for different rising sequences was developed. The algorithm performance was confirmed by comparison of sen-sor signal and video analysis. A stereotyped pattern for elevation movement could be de-fined for rising from supine. Next steps should include further characterisation of movement patterns and analysis of vertical velocity profiles within the elevation phases.

P3-O-80 Differences in elderly balance recovery response by stepping: effect of faller past and perturbation duration

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BACKGROUND AND AIM: Falls are a major health problem. A critical parameter for older adults is their ability to elaborate an adapted balance recovery response. Particularly, recover from an involuntary perturbation by stepping is a natural protective option to maintain balance that detects elderly fallers from non-fallers. However, it is still difficult to interpret balance recovery behavior by stepping because of the variety of paradigms and perturbations used. We wanted to see if a balance recovery task better detect fall risk than clinical measures or a voluntary initiated step and discuss the effects of perturbation duration. METHODS: 24 elderly healthy subjects (14 women, 10 men, 75 ±4,6 years old) in 2 groups of 12 fallers (F) and 12 non-fallers (NF) performed 4 balance tasks: 1) a Brief BESTest, 2) two posturographic tasks (eyes open and closed), 3) a "as fast as possible" forward step voluntary initiated on 1 of 4 large targets and 4) a balance recovery "on the shortest possible distance", without specific instruction about possible recovery steps, from 2 waist-pull perturbations: P1 (28% of subject's body weight (SBW), 0.2 s) and P2 (15% of SBW, 1 s). Both perturbations were chosen to be hardly recoverable with one protective step. Due to given instructions, tasks 3 and 4 were assumed as maximal performance. Marker trajectories and ground reaction forces were collected. RESULTS: Only stepping tasks (3 and 4) discriminate between F and NF: in both voluntary and protective steps, step preparation time SPT (time between the onset of the reaction and lift-off) are longer for F than NF. For voluntary steps, F compensate with a shorter swing phase to have similar total step duration than NF. Also, neither Brief BESTest nor posturography were discriminant. Regarding the two perturbations, P1 involved more often a 0-step strategy than P2 and, if a step was taken, shorter SPT and step length. CONCLUSIONS: We found that only stepping tasks, particularly SPT, differentiate F from NF. Longer time for F may come from difficulty to take the appropriate strategy decision. Difficulties to correctly perform the anticipated postural adjustments could also be involved, but F swing phase performances were as good as NF. Nonetheless, SPT could be an interesting candidate to early detect an increased risk of fall. Another interesting point regards the perturbation descriptors: although P2 has a lower magnitude than P1, it represents a higher perturbation for subjects. As such, perturbing force magnitude alone is not sufficient to describe the perturbation. In this case, one should also consider the duration, for example through the impulse (the time integral of the perturbation force), which is about three times higher for P2 than for P1. More generally, researchers working on balance recovery from an external perturbation should carefully consider the perturbation characteristics and provide a complete description of it when reporting results.

P3-P-81 Sensitivity of different combinations of locomotor-cognitive tasks to assess adolescents following concussion

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BACKGROUND AND AIM: Mild traumatic brain injuries (mTBI) frequently occur during youth and represents the great majority of TBI's. Despite an increased interest within the research and public domains, the impact and consequences of mTBI are still underestimated. Evidence suggests that isolated physical or cognitive testing is not sensitive enough to assess the residual effects of mTBI. Deficits in the control of forward momentum and equilibrium, in dual-task situations, have been shown months after an mTBI in both adults and adolescents. Dual-task paradigms during gait appear to offer functional

challenges naturally integrating cognitive and sensorimotor domains following mTBI. However, specific locomotor and cognitive tasks vary widely. Preliminary results in adults are showing that measuring gait speed during obstacle avoidance appears to be sensitive to executive dysfunctions following mTBI. The aim of this study is to identify the sensitive combinations of locomotor and cognitive tasks as well as variables differentiating adolescents with an mTBI from those without. METHODS: 17 adolescents (13.8 years old) with an mTBI have been compared to 10 adolescents without an mTBI (13.2 years old) to date. Subjects walked in different conditions related to environmental contexts (unobstructed walking, stepping over a 15 cm high by 2 cm deep obstacle and stepping over a 15 cm high by 15 cm deep obstacle) and simultaneous cognitive tasks (no dual task, Stroop task (St), verbal fluency task (VFt) and arithmetic task (At)). 3-D motion data were collected with a Vicon system (100 Hz). Dependent variables included, mean gait speed and fluidity (number of acceleration zero crossings in the antero-posterior direction) and their respective dual-task costs (DTC). ANOVA's for repeated measures were used to compare the different conditions between groups. RESULTS: No group effects were found for either mean or DTC in gait speed, but cognitive tasks showed a significant effect ($p<0.001$). The interaction between the physical and cognitive tasks also showed significant effects ($p=0.01$). Across both groups, subjects slowed their gait speed, particularly with VFt. There were significant group ($p=0.011$) and physical task effects found for fluidity ($p=0.003$). The DTC for fluidity showed a significant cognitive task effect ($p=0.014$) and a significant interaction was found for physical tasks by cognitive tasks by groups ($p=0.005$). In general, subjects with mTBI were less fluid than controls. CONCLUSION: These preliminary results suggest that gait fluidity could be a sensitive variable to detect residual deficits in adolescents following an mTBI depending on different combinations of tasks. Gait speed and its DTC did not seem to differentiate groups as was found for adults suggesting that adolescents may react and recuperate differently from an mTBI. Identifying a sensitive combination of tasks would be of great help for clinicians for return to function decisions.

P3-P-82 Community ambulation in the first six months after stroke

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BACKGROUND AND AIMS: Community ambulation, or walking outside the home and yard, is regarded an important goal by most stroke survivors [1]. However, they report low levels of community ambulation and high dissatisfaction with outcomes [1, 2]. Thus far, community ambulation after stroke has been measured through self-report, but now a variety of devices are available to measure ambulation [3]. This study aimed to characterise community ambulation at one, three and six months after hospital discharge following stroke. METHODS: 34 stroke survivors (aged 72±14 years, 71% male) were recruited at hospital discharge and assessed at 1,3 and 6-months. Community ambulation was measured over four days using the ActivPALTM accelerometer, Garmin Forerunner GPS watch and a diary. Characteristics of ambulation in the community per day were calculated, including: volume (time spent sitting/lying, standing, walking and steps taken); frequency (number of trips, number of bouts and time spent in short: < 40 steps, medium: 40-300 steps and long: >300 step bouts); and intensity (number of ambulation bouts and time spent at low: < 30 steps/minute, moderate: 30-80 steps/minute and high intensity: >80 steps/minute bouts). The purpose of the trip was also recorded. Linear mixed effects modelling determined if community ambulation changed over time, with adjustment for age and discharge gait speed. Cross-tabulation determined changes in trip purpose over time. RESULTS: Participants took on average one trip and spent two to three hours per day in their community at 1, 3 and 6 months after discharge following stroke. They took an average of 1700 to 2298 steps per day in the community, walking on average 20.1 to 25.5 minutes per day at all three time points. Most community ambulation was spread across long (11.3 to 14.1 minutes per day) and moderate intensity (14.0 to 16.1 minutes per day) ambulation bouts. Least time was spent in short and low intensity bouts, although they were the most frequent of bouts performed. There was no change in community ambulation until six months, where stroke survivors spent more time in long ambulation bouts ($p < 0.027$). Most trips into the community were for essential roles and errands, followed by recreation (travel and exercise). There were no changes in trip type across 1, 3 and 6-months ($p > 0.734$). CONCLUSIONS: Stroke survivors regularly access the community after hospital discharge. However, no change in community ambulation is observed until six months later, when stroke survivors spend more time in longer bouts of walking outside the home and yard. Total volume and intensity of community ambulation, and purpose of trips do not change over the first six months after hospital discharge. 1 Lord SE et al. Arch Phys Med Rehabil. 85(2):234-9, 2004 2 Robinson CA et al., Phys Ther. 91(12):1865-76. 2010 3 Lord SE et al. Age Ageing. 40(2):205-210. 2011.

P3-Q-83 Investigating adaptation in hindlimb split-belt treadmill walking by rats using kinematic measurement and a neuromusculoskeletal model

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BACKGROUND AND AIM: Animals produce adaptive locomotion in diverse environments by controlling their limbs cooperatively. Investigating interlimb coordination is important to understand the mechanism. In the previous works, split-belt treadmills have been used for that purpose [Forssberg et al. 1980; Frigon et al. 2013; Morton & Bastian 2006; Reisman et al. 2005; Yanagihara & Kondo 1996; Yanagihara & Udo 1994]. The treadmill has two parallel belts controlled independently, and artificially produces left-right symmetric (tied configuration) and asymmetric (split-belt configuration) environments for walking. When the speed condition switches from tied to split-belt configuration, locomotion parameters, such as duty factor and relative phase between the limbs, change to adapt to the environment. Although the previous works [Frigon et al. 2013; Morton & Bastian 2006; Yanagihara & Kondo 1996; Yanagihara & Udo 1994] suggest that the spinal cord and cerebellum contribute to such adaptation, the underlying mechanism remains unclear. In this study, as a first step to investigate the functional role of the nervous system in motor control, we investigated the kinematics during split-belt treadmill walking by hindlimbs of intact rats. In addition, we developed a neuromusculoskeletal model of a rat walking on a split-belt treadmill by the hindlimbs and compared the results with the measured data. METHODS: We measured the kinematics of five intact Wister rats walking by their hindlimbs under symmetric and asymmetric belt conditions of a split-belt treadmill using a 3D motion capture system. Using the measured data, we investigated locomotion parameters, such as duty factor, relative phase, stride length, and step length. Furthermore, we developed a two-dimensional neuromusculoskeletal model, where the musculoskeletal model was based on anatomical data and the neural model was based on the physiological concept of central pattern generator, muscle synergy, and phase resetting [Aoi et al. 2013]. RESULTS: During the tied configuration of the measured data, left and right limb movements were almost symmetrical and the locomotion parameters were almost identical between the left and right limbs. However, during the split-belt configuration, the locomotion parameters changed to adapt to the environment and they differed between the left and right limbs (see Figure). The adaptation trends were similar to those of humans and cats [Forssberg et al. 1980; Frigon et al. 2013; Morton & Bastian 2006; Reisman et al. 2005]. Moreover, our simulation results showed similar trends in the locomotion parameters to those of measured data. CONCLUSIONS: This study showed adaptive changes in locomotion parameters from measured data during split-belt treadmill walking of rats by their hindlimbs and showed these adaptation properties using a neuromusculoskeletal model. This paper is supported in part by JSPS Fellows 26-2718 and KAKENHI(26120006, 23360111， 26289063) from MEXT, Jap

P3-Q-84 Limit cycle oscillations in upright human posture of individuals with neurological impairments

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BACKGROUND AND AIM Understanding the mechanisms associated with postural instability is of great importance for rehabilitation and fall-prevention in older adults as well as neurologically impaired individuals. Traditionally, postural research has examined fluctuations about a static upright equilibrium. Although this approach is intuitively appealing, it neglects the fact that multiple or dynamic equlilibria such as limit cycle oscillations (LCOs) often exist in nonlinear, time-delayed systems. LCOs are self-excited periodic motions that mark the onset of dynamic instability in systems such as biological oscillators. It is interesting to consider if LCOs can occur in the natural fluctuations of humans standing upright, and what their mechanisms and implications might be. METHODS In order to answer this question, we adapted an inverted pendulum model (Peterka 2002) to examine whether LCOs exist in bipedal stance, $I\theta''-mgh\theta=Mp+Ma+Mext$. We find LCOs exist when there is an excessive combination of neuromuscular time-delay and sensory feedback gain. These LCOs can be intermittent and noisy when control parameters slowly change and external noise is present. We next examine if LCOs are present in the sway of individuals with longer time-delays. Twelve individuals with MS, 12 age-matched healthy controls, 12 older adults, 9 concussed athletes, and 9 age- and position-matched control athletes stood, for 30 s with feet together, on a BertecTM force platform. Data were sampled at 50 Hz for 3 trials with eyes open and 3 trials with eyes closed. The condition order was randomized. The concussed athletes were tested when first diagnosed and after being cleared to return-to-play. We developed methodology based on a continuous wavelet transform to identify intermittent, noisy LCOs. This method identifies correlations of the signal that occur at a consistent timescale. LCOs are identified when these correlations repeat at an interval equivalent to the timescales captured. RESULTS/CONCLUSIONS LCOs were found in 5 of 12 individuals with MS and 3 of 9 athletes with concussion. LCOs were not identified in MS-matched control individuals or older adults and were only identified in 1 of 9 control athletes. Thus, we suggest LCOs are related to disorders with longer neuromuscular time-delays and not simply a consequence of aging. Interestingly, LCOs were identified in 3 of the 4 concussed athletes with the highest symptom scores and only identified in 1 athlete when they were cleared to return-to-play. Coincidently, the only athlete still showing LCOs was returned-to-play in less than half the time as players with similar symptom scores; possibly suggesting that they were still experiencing cognitive impairments. These findings demonstrate that the identification of LCOs can serve as a simple and quick measurement of the severity of neuromuscular impairment, and in the future, may assist as a method for early detection of neuromuscular health and insufficient balance.

P3-R-85 Smaller obstacle height increases variability of spatial parameters compared to bigger obstacle height

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BACKGROUND AND AIM: Obstacle crossing has been considered one of the major causes of falls in people with Parkinson's disease (PD) [1-3]. In addition, variability of spatial parameters during unobstructed walking is considered a neurodegenerative symptom and could be useful to identify fallers [3]. So, during obstacle crossing, a less variable approaching to obstacle may guarantee a safe crossing. However, it is little known about the effects of obstacle height on variability of spatial parameters in approach phase to obstacle. Therefore, the aim of this study was to investigate the effects of obstacle height on variability in approach phase of people with PD. METHODS: Fifteen people with PD (70.61±9.82 years) and 13 neurological healthy elderly (70.5±15.4 years) participated in this study. All subjects performed ten trials for each condition: gait without obstacle, gait with small obstacle, gait with intermediate obstacle and gait with big obstacle. The participants performed the gait without obstacle, after they performed the others conditions, which were randomized by block. The obstacle heights were customized according to leg length (small, intermediate and big obstacle). The obstacle was positioned in the middle of a pathway (8 meters). A carpet with sensors of pressure (GAITRite® - CIR System, Clifton, NJ, USA) was used for acquisition of gait parameters. Variability (standard deviation) of stride length, stride width and stride velocity were analyzed for the approaching to obstacle. MANOVA (group x condition) with repeated measures was used to analyze the variability during approaching to obstacle. Bonferroni post hoc tests were used to localize the differences between experimental conditions ($p<0.05$).. RESULTS: MANOVA indicated group*condition interaction. People with PD showed greater variability of stride length ($p<0.01$), stride width ($p<0.01$) and stride velocity ($p<0.01$) than control group in all conditions. In a general way, people with DP and healthy group increased variability of these parameters in the approach obstacle, independent of obstacle height. In addition, people with PD were more variable than control group in all conditions. Finally, the smaller obstacle increased the variability of spatial parameters, mainly for people with PD. CONCLUSIONS: We concluded that smaller obstacle increased the variability of gait parameters during approach obstacle compared to big obstacles. This conclusion seems to be explained due to less attention driven to the small obstacle during approach obstacle, which seems to indicate that the individuals, mainly people with PD, adjusted the spatial parameters during the last stride before obstacle crossing, increasing the risk of trip. Therefore, the obstacle height is an important factor that can influence the negotiation with the obstacle. REFERENCES 1-ORCIOLI-SILVA, D. et al. Int J Alz Dis 2012:1-6. 2-SIMIELI, L. et al. J Alz Dis, 2015, 43:435-441. 3-VITÓRIO, R et al. Gait Post 2010; 31:1

P3-R-86 Pattern recognition of gait parameters - a 16 weeks cross-sectional study in a Neurology University Department

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BACKGROUND AND AIM: Deficits of gait and balance are common among inpatients of Hospitals for Neurology. However, the underlying mechanisms of these deficits are not well understood. Quantitative assessment with wearable sensor systems may add to a better understanding of specific deficits, and may improve diagnosis and treatment. Using a quantitative wearable sensor system, our aim here is to define patterns of gait and balance deficits of different "typical" neurological diseases, observed in the Neurological department of our University Hospital. METHODS: The cross-sectional study will last 16 weeks, and is currently in its 6th week. All inpatients of the Center for Neurology who are 40 to 89 years old and have gait and balance deficits undergo a clinical and quantitative balance and gait assessment. Tri-axial gyroscopes and accelerometers attached to the lower back and both ankles (Rehawatch®, Hasomed, Magdeburg, Germany) are used. We anticipate including approx. 400 patients and 200 controls until end of study. For this first analysis, number of steps, step duration, step velocity, and standard deviation of step duration from the 20m fast walk from patients with idiopathic Parkinson`s disease (N=23), atypical Parkinson`s disease (N=22), neurovascular diseases (N=11), polyneuropathy (N=16), headache/epilepsy (N=13), lumbar spinal stenosis (N=4) and cerebellar ataxia (N=4) obtained during the first 5 are presented. The four above-mentioned gait parameters were ranked based on the mean value, and ranking patterns for each diagnosis developed. RESULTS: Although number of steps, step duration and step velocity showed -as expected -moderate to high correlations, the rank order of these gait measures often differed relevantly within a diagnosis (Figure 1). Standard deviation of step duration added relevantly to the diversity of the ranking patterns of specific diagnoses. CONCLUSIONS: We conclude that quantitative assessment of gait and balance in inpatients of Hospitals for Neurology may provide relevant new data, and may have great potential to improve understanding, diagnosis, and treatment of respective deficits. The visualization and analysis of gait patterns including a number of quantitative parameters seems to be a particularly promising approach.

P3-R-87 Are muscle synergies used for balance recovery impaired after stroke?

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BACKGROUND AND AIM: Postural instability is a major risk factor for falls in people after stroke. Lack of selective muscle control might impair the fast and coordinated muscle responses that are required to prevent a loss of balance from becoming a fall. Previous work showed that people after stroke use fewer motor modules (i.e. have lower dimensional motor output) to control gait [1]. Here, we aimed to identify stroke related impairments in muscle control during balance recovery. METHODS: Five people after unilateral stroke (> 6 months) and four healthy controls were subjected to translational balance perturbations in 12 directions. Activity of eight muscles (erector spinae, gluteus medius, biceps femoris, semitendinosis, soleus, rectus femoris, peroneus and tibialis anterior) was recorded bilaterally. Muscle synergies were extracted for each leg separately using non-negative matrix factorization [2]. To evaluate symmetry in muscle coordination, we used synergies of the left leg to reproduce muscle activity of the right leg and vice versa. Total variability accounted for was calculated for each leg when using iplilateral (VAFipsi) and contralateral (VAFcon) synergies. We used an ANOVA with GROUP and SIDE (ipsi- or contralateral) to compare VAFs between the two groups and between VAFipsi and VAFcon. RESULTS:

The number of synergies was not different between people after stroke (3-5) and controls (3-4), nor between the affected and unaffected leg (p>0.05). For the VAF there were significant GROUP, SIDE and GROUP*SIDE effects (p<0.01). Post-hoc testing indicated that in the stroke group reconstruction of contralateral muscle activity was poorer than in controls (VAFcon=84.8±5.6% vs 92.3±1.0%, p<0.01). This reduced VAFcon was mostly due to a poor reconstruction of hamstring and peroneus activity. In 5 legs reconstruction of these muscles improved by adding more contralateral synergies, but the number of synergies needed (6-7) was such that the reconstruction approached individual muscle control. Five different synergies were observed in controls, of which three were consistently present in all subjects. One or more of these control synergies were lacking in 3 of the affected legs and in 2 unaffected legs of people with stroke. The missing synergy was either replaced by synergy 5 of the control subjects (1 affected and both unaffected legs) or by a synergy that was not present in controls. CONCLUSION: People after stroke do not use fewer muscle synergies during balance recovery. However, they perform different from controls in terms of symmetry of muscle synergies. Furthermore, muscle synergies in both the affected and unaffected leg seem to be different from controls. Future studies are needed to identify if these differences in muscle synergies are related to poorer balance capacity after stroke. REFERENCES: 1. Clark 2010, 2. Torres-Oviedo 2007.

P3-R-88 Secondary Tasks' Nature Determines Prioritisation Strategies in PD Patients during Dual Tasking

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Background and Aim: The interaction between motor and cognitive functions has an important impact on daily activities and is particularly affected in age-associated chronic diseases such as Parkinson's disease (PD). It has been hypothesized that PD patients use a "Posture Second" strategy for dual tasking situations, which would increase their risk for gait disturbances and falls. In this study, we therefore aimed at investigating whether different cognitive tasks (checking boxes and serial subtraction) had a different effect on the prioritization in PD. Methods: Fourty-four PD patients in Off medication condition, and 44 age- and gender-matched healthy controls were included. Dual tasking effects on gait velocity, stride duration, double limb support (DLS), gait variability, stride asymmetry and double limb support variability of the primary task as well as velocity of the secondary tasks (subtracting serial sevens and checking boxes) during a 1 minute "as fast as possible" walk were investigated. Participants wore a portable gait analysis assessment system with six sensors (Mobility Lab®, APDM, Oregon, USA). Dual task costs (DTC) were calculated for both groups, and compared using Student t-test and Wilcoxon test. Results: In PD patients, DTC on checking boxes velocity (28%) were higher than on the three main

gait parameters (gait velocity, 13%; stride duration, 9%; DLS, 22%). In contrast, DTC on serial subtraction (3%) were lower than on the three main gait parameters (gait velocity, 10%; stride duration, 11%; DLS, 24%). In controls, DTC on checking boxes (34%) and on serial subtraction (5%) were consistently higher than DTC on the three main gait parameters (gait velocity, -2% and -2%; stride duration, -5% and -3%; DLS, -7% and -3% for checking boxes and serial subtraction, respectively). Conclusions: Our study shows that PD patients can use different dual tasking strategies (Posture First and Posture Second) depending on the secondary tasks actually performed. PD patients with gait disturbances/falls should therefore be assessed specifically in regard to the nature of dangerous dual task situations, and these deficits should be specifically trained or omitted. However, a general avoidance of dual tasking situations (which is not possible anyway) cannot be recommended.

P3-R-89 Gait-related postural control and asymmetry are early discriminant markers of Parkinson's disease

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BACKGROUND AND AIM: Parkinson's disease (PD) is a chronic neurodegenerative condition whose symptoms can develop years before clinical diagnosis. Gait characteristics are sensitive to early and pre-manifest neurodegenerative disease yielding data undetectable on clinical examination and show specificity for different disease profiles [1-3]. There has been relatively comprehensive evaluation of gait in very early PD to understand the specific profile of change prior to confounding from secondary deconditioning as the disease progresses [4]. Better understanding of specific signatures of gait impairment in early, mild PD may advance early discrimination and aid differential diagnosis. Therefore, the aim of this analysis was to describe a profile of gait impairment which discriminates early, mild PD from age-matched controls. METHODS: Gait was assessed in 28 people with newly diagnosed PD presenting with mild symptoms (63±10 years, 10 females, MDS-UPDRS III: 17±6, <4 months post diagnosis, Hoehn & Yahr stage I) and 184 controls (69±8 years, 106 females). Two minutes of preferred pace walking was measured using an instrumented walkway (GAITRite). Sixteen gait variables were calculated, the selection of which was based on a validated model of gait [5]. ROC curve analysis was used to assess discriminatory characteristics of individual gait variables. Discriminant tree analysis was used to determine which combination of gait characteristics best discriminate early, mild PD from controls (CHAID model; 10-fold validation). RESULTS: ROC curves showed increased temporal (step, swing and stance time) asymmetry and reduced step width variability could discriminate between PD and control groups (AUC .675-.697; p < .01). Discriminant tree analysis revealed the combination of a low step width variability (<15.3mm) and greater swing time asymmetry (>6.75ms) best discriminated the two groups (accuracy: 90%; sensitivity: 82%; specificity: 91%). DISCUSSION: People with early, mild PD present with a subtle yet distinct gait profile of impaired postural control (step width variability) and temporal asymmetry. These findings are important because they: i) identify asymmetry and gait-related postural control as early targets for clinical intervention; and ii) speculatively, this combination of gait variables may aid earlier discrimination and differential diagnosis although this requires further validation in a large heterogeneous clinical cohorts with longitudinal assessment. REFERENCES: [1] Mirelman et al. Ann Neurol, 2011; 69. [2] Rochester et al. Mov Disord, 2014; 29(2). [3] Galna et al. J Neurol, 2014; 261(1). [4] Galna et al. Mov Disord, In press; doi:10.1002/mds26110. [5] Lord S et al. J Gerontol A Biol Sci Med Sci, 2013; 68(7).

P3-R-90 Enhancing foot clearance in people with Parkinson's disease

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BACKGROUND AND AIM: People with Parkinson's disease (PD) have an increased risk of falling with tripping as the most common cause for falls outdoors. This might be due to a gait pattern with a decreased foot clearance, which also leads to the typical shuffling gait pattern in PD. The aim of the present study was to investigate 1) the differences in foot clearance between PD patients and age-matched controls (CTRL) in single and dual task walking, and 2) the impact on foot clearance of the instruction to focus at each step on striking the heel first while walking. METHODS: 10 people with PD (mean [SD] age: 60.00 [6.40] years; disease duration: 11.90 [7.57] years) were tested in the on-phase of their medication cycle and compared to 10 age-matched controls (age: 59.90 [6.09] years). Participants were requested to walk for 2 minutes during the following conditions 1) at comfortable speed; 2) while performing a dual task; and 3) with the instruction to strike the heel first while walking. Conditions were offered in random order and feet kinematics were recorded by a 10 camera Vicon system (Oxford Metrics, UK). Main variables calculated were: i) the minimal foot clearance during the swing phase; ii) the maximal toe clearance achieved during the second half of the swing phase and iii) the angle between the sole of the foot and the ground at the foot-strike moment. Non-parametric Mann Whitney U test was used to analyze group differences and Friedman's test with Wilcoxon signed rank test as post-hoc was used to determine condition effects for each group independently. RESULTS: Minimal foot clearance did not differ between PD and control participants during comfortable walking (PD: 16.99 [1.98]; CTRL: 15.51 [1.69] mm), dual task walking (PD: 17.54 [2.23]; CTRL: 14.66 [1.66] mm), and while focusing on heel-strike (PD: 22.94 [2.24]; CTRL: 22.59 [3.03] mm). Nevertheless, the instruction to focus on heel strike significantly increased minimal foot clearance in both groups ($p < 0.001$). When using the heel strike strategy, people with PD significantly increased maximal toe clearance during the second half of the swing phase (96.8 [6.7] mm) compared to comfortable walking (79.4 [5.6] mm) ($p = .005$). At the moment of foot-strike PD participants showed a significant increase in angle between the sole of the foot and the ground when using the heel strike strategy (16.3 [1.4] degrees) compared to normal walking (13.4 [0.8] degrees) (p = .017). By using the heel strike strategy, PD participants achieved similar values of toe clearance in late swing phase and foot-strike angle as controls during comfortable walking. CONCLUSIONS: The instruction to focus on striking the heel first has a positive effect on foot clearance in people with PD. Implementing this aspect in an online wearable feedback application may help people with PD improve gait performance and reduce the risk of falls.

P3-R-91 Does anxiety compete for processing resources during walking and a dual-task in Parkinson's disease?

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Background and Aim: Anxiety has been shown to influence gait when individuals with Parkinson's disease walk in threatening situations, including slower velocity, smaller step length, and increased variability. These gait changes are remarkably similar to changes seen when performing a dual-task (DT), and are exacerbated in highly anxious PD (HA-PD) group compared to healthy controls and low anxious PD (LA-PD). Stability measures such as step width variability are most sensitive to DT interference and is the primary measure that displays DT cost in PD. Although there are similarities between gait changes seen in anxiety-provoking environments and while performing a DT, it is unclear if anxiety acts as an additional "load" reducing processing capacity. If this was the case, it might be expected that HA-PD would show exacerbated DT effects compared to LA-PD. The aim of the current study was to investigate whether gait is different between HA-PD and LA-PD and if gait was exacerbated while performing a cognitive DT. Methods: 36 participants with idiopathic PD were subdivided into low or high anxiety groups based on State and Trait Anxiety Inventory scores. All participants were required to complete a total of six walking trials on a 10 m long Protokinetics Zeno Walkway. Participants completed in random order three trials of single task (ST) walking where they simply walked along the mat at a normal pace, and three trials of DT walking where they were required to walk as well as count two digits in a string of digits and report the number of times each digit was heard once the walking trial was completed. Gait parameters and DT performance were compared between groups. Results: An interaction between group, condition, and trial was found for step width variability ($F(2,64)=3.32$ $p=0.043$) which showed that HA-PD were more variable while walking and performing the DT compared to ST specifically on the third trial. Additionally, a main effect of group for step time ($F(1, 32)=4.21$ $p=0.048$) showed that HA-PD had greater step times compared to LA-PD. A trial by group interaction for the variability of time spent in double support (%) ($F(2,64)=3.75$ $p=0.029$) revealed that HA-PD were more variable in the amount of time spent in double support on the first trial regardless of condition. Importantly, performance on the secondary task (counting) was not different between groups. A condition by trial interaction ($F(2,66)=3.33$ $p=0.042$) revealed that both groups spent more time in double support (%) during the DT compared to ST. Conclusions: Overall, these results support the hypothesis that anxiety may act similarly to a DT by consuming and potentially overloading processing resources in individuals with PD, thereby interfering with gait in a similar way that has been shown with DT interference. Supported by CFI.

P3-R-92 The necessity of smooth weight transfer for the restoration of independent walking in hemiplegic patients after CVA

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BACKGROUND AND AIM: In the human walking, it is necessary to transfer the weight from support leg to next one leg for swinging leg. In some hemiplegic patients after CVA (Cerebro-Vascular Accident), the insufficiency of foot clearance causes the difficulty of independent walking. This results from the insufficiency or the delay of the weight transfer from paretic side to non-paretic side before the swinging of paretic leg. The purpose of this study is to indicate the necessity of smooth weight transfer, especially from paretic side to non-paretic side, for the restoration of independent walking in hemiplegic patients. METHODS: Two ambulatory CVA patients were analyzed at about 100 days post-onset. One patient could walk independently, and the other could not. Additionally, one female CVA patient was analyzed longitudinally every other month from the time when she was able to walk without assistance (40 days post-onset). All three patients had moderate hemiplegia because of the first episode of CVA (Brunnstrom Recovery Stage: IV). For gait analysis, Three-dimensional motion analysis system and force plates were used. To evaluate the similarity (or symmetry) of the ground reaction force (GRF) profiles between the paretic and non-paretic legs, left-right correlations of the three components of GRF were calculated. RESULTS: Our analysis demonstrated that the correlation of the mediolateral GRF between the paretic and non-paretic legs was higher in the independent walker. It was also observed that the value of the correlation coefficient increased with the increase of the gait speed, particularly during the double-support phase following the foot-ground contact of the paretic leg. These results suggest that the symmetry of the mediolatral GRF hence the ability to appropriately transfer the center of body mass in the mediolateral direction is important for improving gait performance. However, such increase in the correlation coefficients were not observed in the vertical and anteroposterior component of the GRF, indicating that the mediolateral weight transfer is the initial key for the restoration of independent walking. CONCLUSIONS: In the present study, it was found that the smooth weight transfer in the mediolateral direction was primarily necessary to re-acquire independent walking for hemiplegic patients after CVA. In the walking movements of hemiplegic patients, the weight transfer from paretic side to non-paretic side is more difficult than that from non-paretic side to paretic side, but is crucial for swinging the paretic leg.

P3-R-93 Comparing single and dual-task gait as predictors of decline in attention in people with Parkinson's disease

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Background Impaired cognitive function is associated with gait impairment in Parkinson's disease (PD)©ö. Preliminary work shows that gait velocity under single task (ST) conditions predicts change in attention over 18 months; providing emerging evidence for the role of gait as a sensitive marker of disease progression©÷. Evidence suggests that under dual task (DT) walking conditions the relationship between gait and cognition strengthens©ø, however, this seems to be DT protocol dependent4. Our work uses a DT paradigm controlling for baseline cognitive capacity4, therefore other protocols may potentially bias the relative sensitivity of DT gait as a predictor of cognition. We were therefore interested to compare ST and DT gait when controlling cognitive capacity. Aim The aim of this interim analysis on 50 people with incident PD was to establish whether ST or DT gait can best predict change in attention over 3 years. Methods 50 participants with idiopathic PD completed assessments for gait and attention within 4 months of diagnosis and again 3 years later. Participants walked continuously for two minutes under both ST (walking alone) and DT (repeating maximum digit span) conditions. Individual capacity was controlled for by standardising tasks with respect to each individual's baseline4. Step velocity and step length were collected using a 7m instrumented walkway (GaitRite?). Attention (power of attention and fluctuating attention) was measured using the computerized drug research (CDR) computer battery. Partial correlations were completed controlling for age and task order (ST or DT condition first). Significant correlations for step velocity and step length were entered into separate linear multiple regression models controlling for age and task order. Results Those whose fluctuating attention got worse over 3 years tended to walk more slowly (ST $p<0.01$; DT $p=.015$) and had a shorter step length (ST $p<.01$; DT $p<.01$) at baseline. For step length both conditions were found to be independent predictors for change in fluctuating attention with minimal differences evident between ST (F (2, 50) = 4.748, r= .482, adjusted r©÷ = .184, ¥â= -.405, $p<.01$) and DT (F (2, 50) = 4.466, r= .471, adjusted r©÷ = .172, ¥â= -.403, $p<.01$) gait. Similar findings were observed for step velocity for both ST and DT conditions. Conclusions Both ST and DT gait equally predict cognitive decline in PD over 3 years. In the absence of a robust standardised dual-task paradigm, our findings suggest that assessment of ST gait can be used as a simple alternative to predict cognitive decline in early PD. References ©öLord, S et al. Front. Aging Neurosci 2014 ,6: 249. ©÷Lord, S. et al. Movement Disorders 2013;28 Suppl 1 :361 ©øYogev, G. et al. Eurpean Journal of Neuroscience 2005; 22 4Rochester et al. Neuroscience 2014; 265

P3-R-94 Cortical Motor Planning for Initiating Stepping After Stroke: A case study

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BACKGROUND AND AIM: After stroke, motor planning in the brain can be altered and may impact performance of balance and gait, possibly leading to increased falls risk. Using electroencephalography (EEG), motor planning leading up to stepping can be evaluated and linked with clinical performance of balance. Cortical effort involved with motor planning is reflected in the amplitude of the movement related cortical potential (MRCP). This case study aimed to assess the feasibility for 1) evaluating the MRCP for stepping with the paretic and nonparetic limbs, 2) examining whether the amplitude differed after outpatient physiotherapy treatment, and 3) whether these changes accompany changes in clinical measures of balance such as the Berg Balance Scale (BBS). METHODS: One individual was assessed before and after outpatient physiotherapy, following inpatient stroke rehabilitation discharge. EEG assessment of motor planning during stepping was conducted using a 64-channel cap and involved 3 sets of 20 steps per leg to an elevated platform with rest given as needed. A goniometer was attached to the lateral knee where angular deflection defined movement onset in the EEG data. Steps were performed in a self-initiated manner at approximately 6-10 s intervals with no cueing during testing given. A physiotherapist assessed the BBS. During EEG analysis, trials were visually inspected and those with signal artifact were excluded. The EEG signal over known motor planning regions (supplementary motor area: Fz electrode; premotor cortex: Cz electrode) was averaged for 4 seconds prior to the onset of stepping for each leg and the MRCP measured. RESULTS: An 84 year old participant sustained a right corona radiata infarct approximately 4 months prior to the baseline assessment and presented with left leg paresis. Follow-up testing occurred 2 months later, following 12 outpatient physiotherapy treatments. The BBS score was 43 out of a possible 56 at the baseline test session and increased to 48/56, indicating better balance after treatment. At baseline, stepping planning appeared to be different between the limbs. When stepping with the paretic leg, the MRCP was -18.34µV over Cz and -24.32µV over Fz, and for the nonparetic leg -10.56µV over Cz and -8.01µV over Fz. After physiotherapy, the MRCP at Cz did not appear to differ from baseline values with the paretic leg (-16.82µV) or the nonparetic leg (-10.79µV). The MRCP at Fz, however, appeared to increase compared with baseline values for stepping with the nonparetic only (nonparetic - 22.82µV, paretic -23.29µV). CONCLUSIONS: This case study is the first to determine the feasibility of assessing motor planning for stepping movements in an older adult after stroke. Clinical improvements in balance may accompany alterations in the cortical effort for planning stepping movements; however, future studies are needed to determine whether this pattern is similar for other individuals poststroke.

P3-R-95 Effects of dual-task walking on different motor and cognitive complexities in pre-clinical stages of degenerative cerebellar ataxia

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Background It is well-known from many neurodegenerative movement disorders that subtle movement changes occur often years before clinical manifestation. Effectiveness of future interventions and their evaluation will largely depend on (i) detecting these diseases as early as possible, and (ii) a more detailed understanding of earliest dysfunctional motor (and cognitive) mechanisms within the pre-clinical stage. Dual tasks may serve as an efficient tool to uncover movement abnormalities already at this stage, as suggested e.g. in prior studies fromPD2 or sub-clinical ataxia patients after cerebellar tumor resection 3. Here, we examined interaction effects between working memory tasks (n-back1) and gait tasks with different complexities in a dual-task paradigm for subjects in pre-clinical and early stages of cerebellar ataxia. We hypothesized that an increasing load of dual-task burden might lead to a surfacing of otherwise concealed ataxia-related dysfunctions. Methods: We examined n-back tasks (2back, 3back) while (i) sitting, (ii) treadmill walking at 1m/s and (iii) tandem walk at 0.3m/s. Assessments were performed in three groups: 1.) Group EARLY: N=15 patients with early stage degenerative ataxia [SARA4 score: 3-7 points]; 2.) Group PRE: N=10 subjects with premanifest ataxia [SARA score <3 points, 7 of 10 mutation carriers for spinocerebellar ataxia (SCA) types 1,2,3 or 6]; 3.) Group CON: N=20 age-matched healthy controls. Results: Group level performance in the n-back task in sitting position differed only between EARLY and CON (2-back: p<0.03), whereas PRE and CON differed in the walking conditions (walk 2-back: p<0.01, tandem 2-back: p<0.02, tandem 3-back: p<0.04). Gait analysis revealed a significant increase of variability in step length and step cycle time for tandem dual task walking in the PRE group compared to CON group (p< 0.03). Changes of variability increased with complexity of the n-back task. Analysis of the interaction effects revealed that preclinical subjects showed a most pronounced decrease in cognitive and motor performance in complex dual task conditions (3-back tandem). Discussion: In dual task conditions healthy controls differentiate not only from early ataxia subjects, but also from pre-clinical ataxia subjects. Furthermore, these features show a correlation to the time of estimated disease onset for SCA mutation carriers5, thus describing a continuum of change within pre-clinical phase. These findings increase our understanding of cognitive-motor changes in preclinical stages of ataxia and will also influence therapeutic trials aiming to delay disease onset and progression in premanifest gene carriers of SCA. References 1. Dobbs AR, and Rule BG. Psychology and aging 4: 500-503, 1989. 2. Mirelman A et al., Ann Neurol 2011;69(1):193-197. 3. Ilg W et al., J Neurophysiol 2013;110(10):2337-2349. 4. Schmitz-Hübsch T et al., Neurology 2006;66(11):1717-1720 5. Tezenas du Montcel S et al. J. of medical genetics 20

P3-R-96 Does post-stroke lower limb spasticity influence the recovery of standing balance control? A multilevel growth model of stability control measures over two years

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BACKGROUND AND AIM:Lower limb spasticity (LLS)-a velocity-dependent increase in tonic stretch reflexes-is a sensorimotor consequence of stroke. Stroke survivors with LLS may face additional balance control challenges due to impairments in spatial symmetry (SS) and temporal synchrony (TS) between individual limb COP displacements - two important indices of standing balance control (Mansfield et al.,2012;Singer et al.,2013). The present work examined: (a) whether the recovery of SS and TS differed among individuals with and without LLS; (b) the influence of time-varying changes in post-stroke LLS on the recovery trajectories of SS and TS. We hypothesized we would observe an initial improvement in both SS and TS, followed by a deceleration in the rate of recovery. We expected stroke survivors who experienced LLS to exhibit a reduced rate and extent of standing balance control recovery, relative to those without LLS. We also believed the time-varying level of LLS would account for a significant proportion of the within-subject variance in SS and TS. METHODS:This retrospective longitudinal analysis included 92 stroke survivors (45 LLS; 47 no-LLS). Participants were assessed at baseline and at 6, 12 and 24 months post-stroke. Measurements of LLS (Modified Ashworth Scale (MAS)), motor impairment (foot component of the Chedoke-McMaster Stroke Assessment), and stroke severity (NIH Stroke Scale) were used as covariates. Two force platforms were used to obtain individual-limb anteroposterior COP displacements during 30 seconds of quiet-standing; indices of interlimb SS and TS were calculated using the ratio of between-limb root-mean-square (RMS) displacements and the cross-correlation coefficient at zero phase-lag (Rxy(0)), respectively. A 2-level hierarchical growth curve model, with linear and quadratic effects of time, was used for longitudinal analysis SS and TS trajectories. RESULTS:Individuals with LLS exhibited lower SS than those without LLS (RMS ratio=0.75 v. 1.03). There was no relationship between the MAS and SS, nor were there linear or quadratic effects of time. Individuals with LLS exhibited lower TS than those with LLS (Rxy=0.78 v. 0.86). A time-varying change of one level on the MAS corresponded with a 0.05 unit change in Rxy(0). All participants exhibited a linear improvement in TS of 0.007 units/month; a negative quadratic slope parameter of -0.004 units/month2, indicated a diminishing improvement with time. CONCLUSION:Balance control challenges among stroke-survivors with LLS may stem from reductions in both SS and TS of COP displacements. While the recovery trajectories were similar for both groups, the absolute extent of balance control recovery among stroke-survivors with LLS was reduced. Given the association between time-varying MAS scores and TS, interventions to reduce the level of post-stroke LLS may also improve balance, by improving the timing of individual limb COP displacements necessary for stability control.

P3-R-97 Functional and perceptual limitations in motor ability following a stroke

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Background and aim: One of the most common neurological issues in the elderly is a stroke event, affecting nearly 800,000 adults in the U.S. alone every year. Since falls occur at a rate of 73% per year

with people who are more than six months past the stroke event compared to a 30% fall rate in aged-matched healthy elderly, the potential consequences for injury are devastating. Current literature does not completely address the specific functional and perceived deficits in gait and posture after a stroke. To resolve this problem, this investigation used clinical assessments of both motor ability and patient reported outcomes to more holistically document changes to gait and posture following a stroke. Methods: Twenty-seven participants (20 healthy elderly adults [63.4±8.9 years] and 7 non-cerebellar/non-brain stem stroke survivors [57.6±7.7 years]) were recruited. The participants were community dwelling, able to walk without an assistive device, cleared for dementia with the Mini Mental Status Exam, and the stroke survivor population had sustained only one stroke event. The Timed Up and Go (TUG), Berg balance assessment (Berg), Functional Gait Assessment (FGA), Activities-Specific Balance Confidence Scale (ABC), lower extremity strength (hip extension, hip abduction, knee extension, knee flexion and plantarflexion) and lower extremity flexibility (hip extension and dorsiflexion) were recorded to document functional and perceived gait and posture ability. A MANOVA was used to test for significant differences, with group (stroke or healthy) as the independent variable and the clinical metrics (TUG, Berg balance, FGA, ABC, affected side strength, unaffected side strength, affected side flexibility and unaffected side flexibility) as the dependent variables. Results: The TUG, Berg, FGA, and ABC showed group differences (all $p<.002$). Significant differences were also observed in strength and flexibility between the affected and matched limbs between groups (both $p<.008$). Interestingly, no differences in strength ($p=.074$) or flexibility ($p=.197$) were observed between the unaffected limbs of the stroke survivor group and matched limbs of the healthy elderly group. Discussion: The clinical measurements that assessed motor ability showed group differences in the expected direction (stroke survivors had a higher TUG, lower Berg, and lower FGA). Cut-off values for increased fall-rate have been developed for these tests and the stroke survivors had values indicating they were at an increased risk for falling. These data provide a motor ability explanation for the higher fall rate observed in stroke survivor populations. Further, differences in strength and flexibility in the affected limb likely contributed to the lower motor ability scores in the clinical tests. Lastly, it is important to note that not only did the stroke survivors exhibit biomechanical differences relative to healthy elderly, they also perceived their functional limitations.

P3-R-98 Dominance of the right cerebral hemisphere for balance control: evidence from unilateral cerebral stroke

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BACKGROUND AND AIM: In the lateral dimension of motor behavior, cerebral hemisphere dominance for postural control has been a theme of debate. This issue has been approached through investigation of patients with unilateral lesions to the brain, in the search for understanding the specialized role of each cerebral hemisphere in balance control. In this investigation we aimed at comparing the effects of lesions to the right versus left cerebral hemisphere on stance control, having as reference balance in age-matched normal individuals. METHODS: Participants were 22 chronic post-stroke individuals (n=11 for each hemisphere lesion) and 24 neurologic intact controls. Balance control was evaluated in quiet stance, supported on a rigid or on a malleable surface, and in reactive responses to a mechanical perturbation through unexpectedly releasing a load attached to the participant's trunk. Evaluation was made under full vision or visual occlusion. Performance was evaluated through reactive forces applied to the ground, joint kinematics, and electromyography of posterior legs muscles. RESULTS: Analysis revealed greater postural sway in post-stroke individuals as compared to controls in quiet stance, and increased effect of sensory manipulation either through a supporting malleable surface or visual occlusion. Whereas insult to either cerebral hemisphere induced poorer performance in comparison with neurologic intact individuals, stroke to the right cerebral hemisphere led to inferior balance performance as compared to both stroke to the left hemisphere and controls. That relationship became evident from analyses of different parameters. In the analysis of quiet stance, stroke to the right hemisphere led to increased excursion area and velocity of center of pressure sway, in addition to higher dependence on visual information for balance stability. In the analysis of perturbed posture, stroke to the right hemisphere led to lower velocity of center of pressure sway, increased amplitude of hip mobilization, delayed response latency and decreased power of muscular activation of the paretic leg. CONCLUSIONS: These results conduct to the conclusion that lesions to either cerebral hemisphere induces decline of balance control, while insult to the right in comparison to the left cerebral hemisphere leads to increased deterioration of control both of quiet stance and of large-scale reactive responses to extrinsic perturbations threatening upright body equilibrium. Therefore, our results support the notion of dominance of the right cerebral hemisphere for postural control.

P3-R-99 The relationship between quantitative parameters of the Timed-up-and-Go phases, and health-related quality of life in Parkinson's disease

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INTRODUCTION AND AIM:Health-related quality of life (HRQoL) is often used to evaluate (success of) treatment of chronic diseases such as Parkinson's disease (PD). Objective assessment tools may be useful and have potential to serve as a kind of 'surrogate marker' for HRQoL. The Timed-Up-and-Go-Test (TUG) is a short test that provides information about important movement patterns, i.e. transfer (sit-to-walk (SIWA), walk-to-sit (WASI)), walking and turning. In PD, the total TUG time showed to be associated with HRQoL. Our aim was (i) to test whether also sub-phases of the TUG performed during different conditions (convenient speed, CS; fast speed, FS; to the less affected side, LAS; to the more affected side, MAS) are associated with HRQoL, and (ii) whether these results were related to differences observed between PD and controls. METHODS:Seventeen PD participants (65.1 (±7.1) years, 11 females, H&Y stage I-III, 'off' state) and 20 controls (66.1 (±7.5) years, 8 females) performed an instrumented TUG (Dynaport®, McRoberts BV, The Netherlands) under 4 conditions. Unpaired t-test was used to compare combined CS and FS TUG values between controls and PD patients. A paired t-test was used for comparison of lateralization aspects among PD patients. Pearson's correlation analyses were used to identify correlations between TUG sub-phases and HRQoL, measured with the PD Questionnaire 39 (PDQ-39). RESULTS:Total TUG time (CS, p=0.035; FS, p=0.004), transfer durations (CS SIWA, p=0.009; FS SIWA, p=0.005; FS WASI, p<0.037) and the turning durations (CS, p<0.000; FS, p<0.001) differentiated significantly between controls and PD patients, but not the walking durations. Moreover, PD patients showed a different movement pattern during the transfers (lower mean and maximum flexion and extension velocities). In PD patients, turning velocity of the CS TUG was significantly different between LAS and MAS, but also the maximum flexion velocity during the SIWA phase. Total TUG time correlated significantly with the PDQ-39, independent of different assessment conditions (CS, R=0.63; HS, R=0.58). From all sub-phases, the walking forth time in the CS condition (R=0.44) and walking back in the FS condition (R=0.52) showed the strongest association with the PDQ-39. CONCLUSION:Our data confirm previous findings of differences of total TUG time and TUG sub-phases between PD patients and controls. Particularly interesting is the observation that a very early marker of the SIWA phase differentiated LAS from MAS in PD patients. Moreover, a relatively strong association of total TUG time with HRQoL in PD was observed. Durations of sub-phases did not relevantly add to this finding. Interestingly, transfer durations, which differentiated best between controls and PD patients, correlated least with HRQoL. This lack of association needs further investigation, as the deficit obviously reflects daily-relevant symptomatology such as rigidity, hypokinesia and reduced muscle strength.

P3-S-100 Static single-leg standing balance performance is impaired in individuals with patellofemoral pain

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BACKGROUND AND AIM: Patellofemoral pain (PFP) is a multifactorial condition resulting in knee pain during daily and exercise activities, such as stairs and squatting. Studies have shown impaired balance performance in those with knee ligament injuries and osteoarthritis, yet little is known about static balance in PFP. This cross-sectional study investigated whether people with PFP demonstrate altered centre of pressure (CoP) movement during static, unilateral tasks compared to healthy adults. Associations between balance variables, patient-reported outcomes and physiological measures of the hip and trunk in PFP, were also explored. METHODS: 46 adults with PFP (30 women, mean[SD] age 35.5[7] yrs) and 30 healthy controls (8 women, age 33.8[7] yrs) performed two repetitions (30 s) of barefoot single-leg standing under two conditions: eyes open (StandEO) and eyes closed (StandEC). The test limb was the symptomatic leg (unilateral PFP), most symptomatic leg (bilateral PFP), or a randomly allocated leg (controls). CoP total velocity, range and standard deviation of CoP movement in mediolateral (ML range, MLSD) and anterior-posterior directions (AP range, APSD) were extracted from a force platform. Patient-reported outcomes of knee pain severity (visual analogue scale, Anterior Knee Pain Scale) and kinesiophobia (Tampa Scale) were collected, as well as physiological measures of hip muscle strength (dynamometer), hip joint range of motion (ROM) (inclinometer) and maximum time of side bridge hold. Data were analysed using one-way ANCOVA and stepwise multiple regression ($P<0.05$). RESULTS: During both tasks, CoP movement was significantly greater in the PFP group compared to the healthy controls. For StandEO there was a significant main effect of group (mean diff. [95% CI]) on AP Range (13.3 [8.5-18.9]mm), APSD (2.4 [1.7-3.2]mm), ML Range (10.6 [2.8-18.4]mm), MLSD (1.7 [1.0-2.5]mm) and CoP velocity (7.0 [0.6-13.4]mm) after controlling for gender, age, height and weight. During StandEC, significant between-group differences were observed for AP Range (21.2 [4.6-37.9]mm) and APSD (2.9 [0.8-4.9]mm). Higher Tampa score and greater hip internal rotation ROM accounted for 34% ($P<0.001$) of the variance in AP Range when performing StandEO. Greater kinesiophobia was a significant predictor of greater APSD ($R^2=0.102$, $P=0.032$), while less severe pain in the last week predicted greater CoP velocity ($R^2=0.124$, $P=0.018$). No variables predicted any CoP measures during StandEC. CONCLUSIONS: Individuals with PFP demonstrated increased CoP movement during static single-leg balance compared to controls. In PFP, greater kinesiophobia and hip internal rotation ROM and lower severity of pain were predictors of worse balance performance. PFP may alter neuromuscular and psychosocial factors that contribute to CoP movement control during unilateral tasks. Further exploration of predictors of balance impairments in PFP is required to establish early identification strategies.

P3-S-101 Neuromuscular response to unexpected single-planar versus multi-planar support perturbations.

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Background and aim: Non-contact anterior cruciate ligament (ACL) injuries mostly occur during unexpected and multi-planar movements in the deceleration phase of landing or pivoting manoeuvers. In contrast, screening tasks that are used in clinical settings to assess injury risk, contain mostly expected and single planar movements. It has been suggested to develop more unexpected screening methods that challenge the athletes' neuromuscular control in a similar way as in real sports situations. The aim of this study was to compare the biomechanical and neuromuscular responses to unexpected single-planar (SPP) and multi-planar perturbation (MPP) conditions and this at different amplitudes and

velocities. Methods: Thirteen young adults performed a single leg stepping-down task in eight perturbation conditions (four MPP and four SPP with a specified amplitude and velocity). The perturbations occured in one out of four stepping trials in a random order. The amplitudes of vastus lateralis (VL), vastus medialis (VM), hamstrings lateralis (HL), hamstrings medialis (HM) EMG activity, medio-lateral and antero-posterior centre of mass (COM) displacements and the peak knee flexion and abduction angles were compared between conditions using an one-way ANOVA. Stepping responses were monitored during all conditions. Results: Significantly greater muscle activity levels were found in response to the more challenging (larger conditions) MPP and SPP compared to the less challenging conditions ($p<0.05$). No differences in neuromuscular activity were found comparing the different conditions in the MPP versus their equivalents in the SPP. Eighteen stepping responses were monitored in the SPP compared to nine in the MPP indicating that the postural control was more challenged during the SPP conditions which was supported by greater COM displacements in the SPP. Conclusion: The more intense MPP and SPP evoked different neuromuscular responses resulting in greater muscle activity levels compared to small perturbations. Based on the COM displacements and on the amount of stepping responses, we concluded that balance was less challenged during the MPP. Therefore, future work should investigate the capability of unexpected MPP (i.e. the more intense MPP) to differentiate between athletes who are at risk of sustaining an ACL injury and athletes who are not.

P3-T-102 Interaction between Multisensory and Plantar Mediation Stimulation on Postural Gain

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Introduction: In clinical podiatry, we dispose of two types of insoles, flat (F) or thermomoulded (T) to stimulate foot soles. The difference between F and T is an enrichment of plantar sensory information through medial arch contact by moulding. We can associate these with a plantar stimulation such as anterior bar (BA). BA is a specific pressure-relief insole which induces plantar mechanoreceptor stimulation and influences postural control. Podal system impact on postural control, performance, and stability can be evaluated by ground reaction force displacement (GRF). Our intent was to investigate postural gain (total, stability and performance) in the presence or absence of additional plantar somatosensory information supplied by medial arch contact (F to T) and in the presence or absence of specific upgrading plantar somatosensory stimulation (BA). Method: 10 subjects' GRF was collected by baro-stabilo-podometry platform (Fusyo3, Medicapteurs, France, 40 Hz, 30 s, subject shod, with 4 cm into heel). Four sensory variation conditions: flat without BA (F), flat with BA (FBA), thermomoulded without BA (T), and thermomoulded with BA (TBA) were compared to the control condition (C). Gain postural performance (GPP) was calculated using (GRF sway, longer, speed, and variation of speed) and gain postural stability (GPS) using GRF displacement (x, y) Results: All sensory variations change postural gain. A more significant variation was observed with T (T, TBA) than F (F, FBA) for GPP, GPS, and totality: GPP+GPS. Specific plantar stimulation adjunction (BA) enhances the gain for F and T. For GPP and GPS, a considerable difference was observed between F (F, FBA) and T (T, TBA) due to moulding. BA stimulation shows some opposing results by actually increasing gain between F to FBA and reducing gain T to TBA. Discussion: Those specific stimulations induce a variation of pressure which improves postural gain. For F, the upgrading of sensory information with BA, low-threshold mechanoreceptors stimulation, is always integrated and improves postural control. Conversely, for T, this upgrading produces the opposite reaction: only postural performances are improved. Totality gain and also postural stability are decreased because this specific sensory stimulation (BA) induces a saturation of plantar mechanoreceptors therefore afferent information become noxious. Consequently, postural control is altered. The best result is obtained by T. This condition is better than FBA (for all gains). The enrichment sensory information (skin arch contact) enhances the proper functioning of receptors and this feedback is used for postural control. Conclusions: The change in plantar sensory information incurred through insole types and specific stimulations revealed different postural gain results. Arch contact is better than specific stimulation and additionally these two conditions must be clinically evaluated and adjusted for their influence on postural responses.

P3-T-103 Gender differences in the shoulder joint position sense acuity

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BACKGROUND AND AIM: work-related musculoskeletal disease (WMSD) is the most expensive form of work disability. Female gender has been considered as an individual risk factor for the development of WMSD, specifically in the neck and shoulder region. The higher prevalence of neck/shoulder WMSD in women can generally be attributed either to sex/gender (s/g) differences related to anthropometry and strength, or s/g differences in aspects related to motor control. Although anthropometry and strength differences may mostly account for the higher rate of WMSD in women, motor control differences may also play a role. An important part of the motor control system is position sense, which has received little attention in the s/g studies. Accordingly the purpose of this study was to estimate the effect of s/g on shoulder joint position sense acuity in healthy individuals. METHODS: 28 healthy participants, 14 females and 14 males were recruited for this study. To test position sense acuity, subjects were asked to flex their dominant shoulder to one of the three pre-defined angle ranges (low, mid and high-ranges) with eyes closed, while keeping their elbow extended and their forearm and wrist in neutral position. They then had to reproduce the same joint angle from memory while the difference between the reproduced and original angle was taken as the measure of position sense error. The errors were measured only for the shoulder flexion in the sagittal plane, with the help of Vicon motion capture system. Three types of errors were calculated to estimate position sense: absolute (magnitude of error), constant (direction of error) and variable (consistency in performance). Subjects reproduced nine positions in total (3 ranges × 3 trials each). RESULTS: calculation of absolute repositioning error showed no significant difference between men and women (p-value ≥ 0.05). However, the analysis of the direction of error (constant error) showed a significant difference between the genders as women tended to mostly overestimate the target, whereas men tended to both overestimate and underestimate the target (p-value ≤ 0.05, effect size = 0.8, observed power = 0.66). The results also showed that men had a significantly more variable error, indicating more variability in their position sense, compared to women (p-value ≤ 0.05, effect size = 0.84, observed power = 0.7). CONCLUSIONS: the findings of this study showed no significant difference in the absolute position sense error between men and women during shoulder flexion. However, the results showed that the direction of error is significantly different and that men's repositioning performance is more variable compared to women. Understanding the position sense and neuromuscular control differences between men and women can help to prevent the higher rate of WMSD in women.

P3-U-105 Sensorimotor coupling adaptation to environmental changes in postural control is compromised by sleep deprivation in young adults

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BACKGROUND AND AIM: Sleep deprivation is a common consequence of the contemporary days and might cause impact on many of our daily activities. The aim of this study was to investigate the effects of sleep deprivation in adaptation of the coupling between visual information and body sway in young adults' postural control due to changes in optic flow characteristics. METHODS: Thirty healthy young adults participated as volunteers in the study. Fifteen participants performed postural tasks after remaining approximately 25 hours awake (sleep-deprived group) and 15 subjects performed the same postural tasks after sleeping normally the night before the experiment (control group). Postural tasks for both groups were performed in the morning, between 8 and 11 am. Participants were asked to stand as still as possible, inside of a moving room, looking at a target 1 m in front of them at eye level. Seven 60-second trials were performed. In the first three trials, named "pre-change", the room oscillated at a 0.2 Hz frequency, peak velocity of 0.6 cm/s, and peak-to-peak amplitude of 0.9 cm. In the fourth trial, named "change", peak velocity of room movement was increased to 3.5 cm/s and peak-to-peak amplitude to 5.1 cm. In the last three trials, named "post-change", room movement parameters were the same as the "pre-change" trials. Body sway and the room movement were obtained through two IRED markers (OPTOTRAK system) positioned on the participants' back and on the frontal wall of the room. RESULTS: Mean sway amplitude was greater for the sleep-deprived group compared to control group in pre- and post-change trials and decreased in post- compared to pre-change trials only for the control group. Gain between room movement and body sway decreased in post- compared to pre-

change trials for both groups but this decrease was higher for the control group compared to the sleep-deprived group. Position and velocity variability tended to be higher for the sleep-deprived group compared to control group both before and after the change trial. Overall, results demonstrated that after an abrupt change in optic flow characteristics, i.e., higher velocity and amplitude of room movement, sleep-deprived adults were able to decrease the influence of visual information on body sway. Nevertheless, they were not as efficient as well rested adults in doing so, since this decrease was less pronounced in sleep-deprived individuals. In addition, sleep-deprived adults swayed more and were more variable than those in the control group, which shows their tendency to oscillate in a wider range of frequencies, being unable to uncouple body sway to irrelevant sensory cues. CONCLUSIONS: Sleep deprivation impairs young adults' ability to adapt sensorimotor coupling in postural control after a perturbation occurring due to environmental changes.

P3-U-106 Validating the use of a smartphone to measure postural control of healthy subjects during standing

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BACKGROUND AND AIM: Postural control is frequently assessed in healthy and pathological populations using force platforms to measure center of pressure during standing. Wearable inertial sensors containing an accelerometer recently have been used to assess sway during standing and walking in research and clinical environments. Widely accessible consumer smartphones containing built-in accelerometers may be capable of measuring postural sway in any setting. The goal of this study was to examine the relationship between smartphone sway measures and gold-standard force platform center of pressure measures. A significant relationship between these outcome measures would indicate that smartphone based sway measures are a valid tool to assess postural control. METHODS: Fourteen healthy subjects (age range 24-55) simultaneously stood on a force platform and held a smartphone against their sternum. The standing protocol included 5 standing positions - feet together, tandem left foot in front, tandem right foot in front, standing on left foot only, and standing on right foot only. Subjects stood in each position for 15 seconds and completed the protocol a total of three times. Center of pressure measurements from the force platform (100 Hz) were used to calculate sway Range and mean sway Velocity. Acceleration time series from the smartphone (10 Hz) were used to calculate a Sway Score based on jerk across all trials. One value per subject was obtained for sway Range and sway Velocity by taking their average across all completed trials. The relationships between measures (Sway Score v. Range; Sway Score v. Velocity) were assessed with Spearman correlations. RESULTS: There were significant correlations between Sway Score and sway Range ($\rho = -0.568$, $p=0.034$) and between Sway Score and mean sway Velocity ($\rho = -0.701$, $p<0.01$). CONCLUSIONS: The results show that the Sway Score calculated from the smartphone acceleration data is in agreement with gold standard measurements from a force platform. A lower Sway Score was associated with larger values for both range and mean velocity of sway, hence the negative rho values. The strength of the correlations were moderate but significant across only 14 subjects. The lack of strong agreement may be due in part to the fact that the smartphone measures sway from the sternum while the force platform measures sway under the feet. Our findings indicate that smartphones may be useful as a low-cost tool for balance assessment, but further study is needed on the validity of this technology in measuring sway across larger sample sizes and pathological populations. The portability and availability of devices such as smartphones creates a potential for individuals to quantitatively assess balance in a wide range of environments.

P3-U-107 Tremor and sway in Parkinson's disease subtypes as detected using a single body-fixed sensor: A Romberg-like test for parkinsonian tremor?

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BACKGROUND AND AIM: Sensory deprivation (e.g., eyes closed) and changes in the base of support (e.g., semi-tandem) may challenge postural control and increase quiet standing sway. Anecdotally, we observed that in patients with Parkinson's disease (PD), tremor may also be exaggerated in response to these postural challenges. PD is often divided into tremor dominant (TD) and postural instability gait difficulty (PIGD) subtypes. We aimed to evaluate the effects of vision and base of support on tremor and sway in these subtypes using a single sensor. METHODS: Participants stood quietly for one minute under four conditions: 1.eyes open feet together 2.eyes open semi-tandem 3.eyes closed feet together 4.eyes closed semi-tandem. Testing was performed "off" medication while wearing a body-fixed sensor on the lower back. The anterior-posterior (AP) and medio-lateral (ML) acceleration axes were analyzed. Parameters extracted included tremor-related measures, tremor-free postural acceleration and displacement measures i.e., velocity and direction of sway. We compared the tremor and sway measures between the two groups, and also evaluated the effects of the different conditions within the groups. RESULTS: The PIGD (n=62) and TD (n=42) groups were similar with respect to age, gender, and basic disease characteristics (disease duration, $p=0.69$, "off" motor UPDRS, $p=0.07$, LED= 0.29). As expected, the TD patients had more tremor compared to the PIGD in all four conditions ($p<0.0001$). Within the TD group, a marked higher tremor amplitude was observed in both the AP and ML axes ($p<0.034$) (tremor power ML condition 1: 0.014±0.021psd, condition 4: 0.029±0.049psd, $p=0.017$). In the PIGD group, tremor power increased only in the AP axis ($p<0.001$), but not in the ML axis ($p=0.475$). The PIGD group exhibited decreased AP and ML acceleration frequency measures ($p<0.045$) (e.g., condition 1, ML centroid frequency: PIGD: 0.561±0.182hz, TD: 0.698±0.265hz, $p=0.007$) and decreased AP and ML displacement measures compared to the TD group ($p<0.039$) (e.g., condition 1, acceleration AP range: PIGD: 0.053±0.0303g, TD=0.063±0.041g, $p=0.035$). CONCLUSIONS: The present findings demonstrate that tremor can be detected even by a single central sensor, which is sensitive to distal hand

movements, and may be used in the future to track disease progression. Interestingly, tremor becomes exacerbated during conditions that challenge postural control. The PIGD patients are less capable to perform correction movements and perhaps exhibit a worse response-time to changes in the natural center-of-mass motion during standing compare to TD patients. This reduced sway may imply that the PIGD are more rigid, than the TD patients during quiet standing, even though the classification is not based on rigidity. Objective markers of postural control and tremor are consistent with the clinical impression and the visual observation of balance deficits and tremor seen in PD subtypes.

P3-U-108 Processing time of addition or withdrawal of single or combined posture-stabilizing visual and haptic information.

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Background and aim Maintaining equilibrium is basically a sensorimotor integration task. Due to changes of sensory inflow in the environment, the central nervous system continually and selectively weights and integrates afferent inputs from multiple sources to properly orchestrate postural muscles' activity. Determining the time-interval necessary for the brain to process changes in the sensory inflow is one way of investigating sensory reweighing during quiet stance. Sozzi et al. (2011, 2012) had estimated the latency of onset and the time-course of the changes in postural control mode following addition or withdrawal of vision or haptic information. The aim of this study was to measure the latencies necessary to integrate the addition or withdrawal of vision and touch simultaneously or when vision is substituted with touch and vice versa. Methods Seven healthy young adults performed the Romberg Tandem Stance in 4 conditions: 1) vision was added and withdrawn via LCD goggles, 2) touch (<1N) was added and withdrawn by a mobile touch-pad while eyes closed, 3) vision and touch were added and withdrawn simultaneously, 4) vision was replaced with touch and vice versa. A force platform was used to measure centre of pressure (CoP) position. EMG of soleus, tibialis anterior and peroneus longus of both legs was also acquired. Results Under steady-state conditions, the amount of the reduction in CoP mean oscillation level was not equal to the algebraic sum of the reduction due to vision alone and touch alone. In response to sensory shifts, as a general rule latencies in the change in CoP oscillation were just shorter on withdrawal than on addition of the stabilizing inputs. The latency was the shortest for the withdrawal of vision or of vision + touch. The longest latency was observed on addition of touch. Addition or vision + touch reduced the latency in the oscillation with about the same latency as addition of vision only. The CoP oscillation changed little when vision and touch were substituted with one another. In these cases, latency was shorter when touch substituted vision than viceversa. Corresponding changes in EMG activity always preceded those of CoP oscillation by a hundredth of ms. Conclusions The findings hint at a complex organisation connecting the centres integrating touch and those processing visual information. The two stabilizing inputs sum their effects

when both are steadily present. Regardless of the concurrent tactile information, the latency to the CoP changes were mainly dependent on the effect of adding or withdrawing vision, relegating touch in a secondary position as to the promptness of its action. However, the slight reduction in latency provided by the addition of both stabilizing information suggests a facilitatory interaction on the speed of the process of integration of both stabilizing inflows.

P3-U-109 Effects of a sensorimotor training on postural control and pain in patients with non-specific low back pain: Study protocol of a parallel, single-blinded RCT

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BACKGROUND: Sensorimotor training (ST) is popularly applied as preventive or rehabilitative exercise method in various sports and rehabilitation settings. As shown in a recent systematic review, its effect on pain and function is only poorly evaluated. No recommendations on quality and quantity of ST exist. This randomised controlled trial intends to investigate the effects of a theory-based ST in rehabilitation of chronic (>3 months) non-specific low back pain (LBP) patients. METHODS: A pilot study with a parallel, single-blinded, randomised controlled design conducted in a rehabilitation clinic in Switzerland. Central randomisation will use a computer generated table for 1:1 group allocation. 20 adult patients referred to the clinic for LBP treatment will be included and allocated. Each group will receive 9x30 min. standard physiotherapy (PT) treatments, as prescribed by the referring physician. After each PT session, the experimental group will receive added ten min. of postural proprioceptive training (PPT), a specific and standardised form of ST. For PPT, a postural movement task is performed on a labile platform with adjustable oscillation to provoke training effects on different entry levels. The active comparator group will perform 10 minutes of added low-intensity treadmill training instead of PPT. Outcomes will be assessed on 4 time-points by a treatment blinded tester: eligibility assessment (BL) at 2-4 days prior to intervention, pre-intervention assessment (T0), post-intervention assessment (T1), and at four weeks follow-up (FU). At BL, an additional healthy control group (n=20) will be assessed to record normative data and allow cross-sectional comparison with symptom-free participants. The main outcomes are self-reported pain (visual analogue scale) and functional status (Oswestry Disability Index). For a secondary analysis, sagittal joint-angle variation and centre of pressure (COP) deflection during externally perturbed stance on a labile platform will be recorded using a video-based marker tracking system and a pressure plate. Movement variability will be assessed using the uncontrolled manifold approach. Joint repositioning error after perturbation will be analysed. Confidence ellipse of COP sway will be reported. For statistical analysis, effect sizes and mixed-model MANOVA (2 groups x 4 measurements for 5 dependent variables) will be performed. DISCUSSION: This is the first attempt to systematically investigate effects of sensorimotor training in patients with LBP using non-linear methods. It will provide analysis of the involvement of several postural segments during a dynamic task which allows

quantitative analysis of the actual quality and change of the task performance. The intensity and frequency at which an effect is detectable will be proposed based on these outcomes, which have been shown to be highly sensitive to change. Trial registry number on cliniclatrials.gov is NCT02304120. Recruiting is underway. No funding.

P3-U-110 The effect of light touch on balance control during over ground walking in healthy young adults

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BACKGROUND AND AIM: Balance control requires integrating sensory inputs to produce appropriate motor output. Lightly touching a stable surface is suggested to augment the sensory information used to maintain stability and improve balance control[1]. The effect of light touch on standing balance control is well established[2] and shows promise for improving rehabilitation strategies focused on balance; however the ability of light touch to improve stability in walking is not as clear. The aim of this study is to investigate the effect of light touch on balance control during walking in healthy young adults. We hypothesized that lightly touching a railing would not alter locomotor progression (reflected in the walking velocity) but would improve medial-lateral stability through reductions in step width variability and medial-lateral centre of mass (COM) velocity. METHODS: Sixteen young healthy adults (8 male, mean age = 25.8 years, 3.5 years SD) participated in this study after providing informed consent. Participants walked for 10m normally (NW) or in tandem (TW) while lightly touching or not touching a railing set at a standard height with the index finger of their dominant hand. 3D kinematic data was captured (Vicon Motion Systems Ltd. UK) and used to calculate gait velocity, step-width co-efficient of variation (CV), and medial-lateral COM[3] velocity. Paired t-tests (IBM SPSS, V22.0, USA) were used to detect the effect of touch within each walking condition. RESULTS: Preliminary analysis shows that touch had a significant effect on walking velocity in the normal walking condition only: Participants walked 22.5% slower when walking normally and touching the railing (p=.005) but only slowed down 3.6% when touching the railing in tandem walking (p=.452). Touching the railing had no effect on the step width CV (NW p=.464; TW p=.139) but did lead to a reduced medial-lateral COM velocity (NW p=.001; TW p=.032). CONCLUSIONS: For healthy young adults, lightly touching a railing may influence forward progression in locomotion as shown by the decreased velocity in the normal walking condition whereas adding light touch during tandem walking has little or no effect on gait velocity. Light touch does not seem to have an effect on step width variability as evidenced by no changes in step width CV but may improve stability by reducing the medial-lateral velocity of the COM. This suggests that the stabilizing effect of light touch established in standing carries forward to balance during overground walking which may have important locomotor rehabilitative implications. Further analysis is ongoing to confirm these

findings. References: 1.Boonsinsukh et al. (2009) Arch Phys Med Rehabil: 90(6):919. 2.Jeka & Lackner. (1994). Exp Brain Res;100:495. 3.Yang & Yi-Chung. (2014). J Biomech; 47(16): 3807.

P3-U-111 Sway-dependent changes in standing ankle stiffness caused by muscle thixotropy

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Balance in human standing is achieved via a combination of active and passive mechanisms (Morasso & Schieppati 1999, Loram & Lakie 2002, Casadio et al. 2005). The active mechanism is the neural control of muscle activity. The passive mechanism is the inherent stabilization of the body obtained through ankle stiffness. Despite its fundamental role in maintaining balance, intrinsic ankle stiffness (K) varies considerably. The purpose of this study was to determine how K may change within a standing subject, caused by changes in ankle joint motion due to sway history. 10 participants were instructed to stand on two footplates in an upright relaxed position. Ankle position and torque response to small (<1degree) and brief (<140ms) perturbations were used to determine K. K was then expressed as a percentage of the gravitational toppling torque (mgh) i.e. the minimum stiffness theoretically necessary to stabilise the body solely through passive mechanisms. Since joint stiffness increases with muscle activation, we also normalized K with respect to baseline torque levels. Baseline ankle motion was manipulated in the following 3 conditions: 1) normal standing; 2) body strapped to a fixed board; 3) standing with a superimposed low-frequency 'wobble' of the ankle joint (0.6±0.02 deg RMS). In addition, we used 4 different amplitudes of perturbation to measure K (0.1, 0.2, 0.4 and 0.6 deg), leading to a total of 12 conditions. Estimates of K varied between 31 and 78% of mgh, agreeing with previous research showing that passive stiffness alone is insufficient for balance. K was greatest during the Board condition, decreased for Normal stance, and decreased further for Wobble ($F_{2,18}=14.7$; $p<0.001$). There was also a significant reduction in K with increasing stimulus amplitude ($F_{3,27}=39.2$; $p<0.001$). We attribute this changing stiffness of the ankle joint to the mechanical properties of muscle tissue. At small displacements, previously still muscle is initially very stiff (i.e. within the short-range elastic component; SREC). Hence, we observed the largest K with the smallest perturbation (0.1 deg). Once the muscle is stretched beyond the SREC, stiffness decreases; hence K became lower with increasing amplitude (minimal K at 0.6 deg). Increasing baseline ankle motion caused the muscle to become less stiff across all stimulus amplitudes. This is because, once stretched, the muscle takes time to restore its resting stiffness, a phenomenon known as thixotropy. The present study shows that intrinsic ankle stiffness is less in people who have recently been swaying more. For control of limb movement, a reduction in stiffness as movement occurs is favorable because it allows muscles to economically control both posture and movement. For standing it may be less beneficial, because an increased sway will lead to a reduction in ankle stiffness and stability and thus, potentially, to collapse unless there is corrective neural intervention.

P3-U-112 Visual and Somatosensory Deficit Patterns on the Sensory Organization Test: Comparison of Five Diagnostic Groups

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BACKGROUND AND AIMS: The Sensory Organization Test (SOT) was developed before two common neurotologic diagnoses, vestibular migraine (VM) and persistent postural-perceptual dizziness (PPPD), were defined by international consensus. VM is a migraine variant that manifests with recurrent episodes of vertigo, unsteadiness, or dizziness and nausea accompanied by migrainous symptoms. PPPD is a new term for the condition previously known as phobic postural vertigo or chronic subjective dizziness. It presents with chronic unsteadiness or dizziness lasting >3 months that may be exacerbated by upright posture or exposure to complex visual stimuli. Recently, we found that patients with PPPD had lower scores than normal individuals on SOT conditions 2-6 and lower scores than patients recovered from acute vestibular syndromes on conditions 2-3. Poor performance across multiple SOT conditions or relatively poor performance on lower numbered conditions have been called "aphysiologic" patterns, but fit emerging data on the physiology of PPPD, namely stiffened ankle mechanics and visual dependence, which may adversely affect postural control when somatosensory and visual feedback are altered. This study extended our previous work by comparing SOT performance of patients with PPPD and VM, alone and in combination, to patients with Meniere's disease (MD) and benign paroxysmal positional vertigo (BPPV). METHODS: We examined group differences in mean scores from SOT conditions 1-6 in 236 adults (147 F, 89 M) aged 57±16 years with PPPD (n=56), VM (n=33), PPPD+VM (n=22), MD (n=50), or BPPV (n=75). We repeated the analysis including 117 patients without clinically significant anxiety or depression to eliminate psychiatric confounds. Diagnoses were based on multidisciplinary evaluations (neurology, otology, psychiatry), vestibular laboratory testing, and neuroimaging, as indicated. The SOT was performed in standard fashion. RESULTS: Patients with PPPD tended toward lower scores than patients with MD on condition 2 and MD or VM on condition 3 ($p<0.10$). These differences reached statistical significance ($p<0.05$) when patients with anxiety or depression were excluded, thus were not explained by psychological factors. Patients with PPPD+VM had the lowest scores on conditions 1-5, significantly worse than patients with VM ($p<0.01$), MD ($p<0.01$), or BPPV ($p<0.05$) on condition 3, and worse than patients with VM alone on conditions 4 & 5 ($p<0.05$). As expected, patients with MD had the lowest scores among those with a single diagnosis on condition 5 (MD vs. VM, $p<0.05$, MD vs. PPPD, $p<0.10$, MD vs. BPPV, p=n.s.). CONCLUSIONS: Patients with PPPD had lower scores on SOT conditions 2 & 3 than those with VM, MD, or BPPV. Patients with PPPD+VM had difficulties across multiple conditions. These patterns are not robust enough to be diagnostic of PPPD, but are consistent with its physiology (i.e., somatosensory and visual deficits). Patients with VM alone showed little SOT impairment.

P3-U-113 PREDICTIVE POSTURAL CONTROL DRIVES THE ONLINE CORRECTION OF ARM MOVEMENTS DURING STANCE REGARDLESS OF DIRECTION AND EXTENT OF VISUOMOTOR PERTURBATION.

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PREDICTIVE POSTURAL CONTROL DRIVES THE ONLINE CORRECTION OF ARM MOVEMENTS DURING STANCE REGARDLESS OF DIRECTION AND EXTENT OF VISUOMOTOR PERTURBATION. Background and aim: We have shown that, when an ongoing voluntary movement executed towards a visual target is perturbed by a sudden change in target position, postural adjustments accompanying the change in arm trajectory precede the muscle activity involved in trajectory correction. This study investigated if such a predictive mode of postural control generalises to visuomotor perturbations across changing; 1) direction (ipsi- vs. contralateral to the moving arm; IPSI and CONTRA), and 2) extent (increasing eccentricity from the body midline). Methods: Nine healthy, right-handed humans (mean age: 22.9 ± 3.1 years) participated in this study. They stood behind a semi-circular array of 7 light targets. Three targets were spaced at successive 15º intervals to the right and left of a central target aligned with their sternum, at shoulder height and at a distance of 130% arm length. Participants performed self-paced reach movements to the central target with their right arm when the target illuminated. Trials were also given during which, at a random time of between 150-785 ms, the central target would extinguish and 1 of the 6 others (light 2, L2) would illuminate. Participants were required to perform an online correction to the new target while standing. Bilateral kinematics, 14 selected muscles of the right arm and bilateral lower limbs and ground reaction forces in 3 axes were recorded. Results: In comparison to unperturbed reaches, online corrections were accompanied by distinct differences in arm and lower limb muscle activity during the period between L2 onset and finger trajectory correction. For IPSI corrections, right posterior deltoid and triceps activated with right tensor facia latae (TFL) and left biceps femoris (BF), soleus (SOL) and peroneous longus (PerL). For CONTRA corrections, right anterior deltoid and biceps activated with left TFL, right BF, SOL and PerL. For IPSI targets all leg muscles activated on average 65-123 ms after L2, and arm muscles 114-157 ms. For CONTRA targets, leg muscles activated 80-112 ms after L2, and arm muscles, 132-173 ms. A clear leg-arm activation pattern emerged for all online corrections and was unaffected by direction or extent. Conclusions: When faced with an unexpected change in final target position after the onset of a planned voluntary movement, humans consistently produce changes in the postural muscles before those of the moving arm regardless of target direction or extent with respect to the body. The CNS predicts the postural dynamics required to correct voluntary movement.

P3-U-114 Effect of visual dependence on postural responses to visual perturbation in spastic cerebral palsy

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BACKGROUND AND AIMS: Instability of postural control in Cerebral palsy (CP) is commonly considered to be due to deficits in neuromuscular control. However, the influence of the sensory components of postural control in this population is understudied. Primary sensory contributions to postural control include visual, somatosensory, and vestibular information. This study examined the postural behavior of visual dependent and visual non-dependent individuals with spastic CP (sensory-reweighting) during continuous visual flow in a virtual environment (external noise). METHODS: Twenty-three subjects with CP (32.3 ± 11.4 yrs) and 23 typical subjects (TY, 29.6 ± 11.0 yrs) were tested with a Rod and Frame Test for visual dependence. Criterion of a mean visual vertical error > 5° indicated 13 subjects with CP were visually dependent (CPVD) and 10 were not (CPVI). No TY subjects were visually dependent. All subjects stood quietly on a force platform in the center of a 3-wall virtual environment. The visual scene was either kept static or continuously rotated upward or downward in pitch at 30°/s. To characterize postural responses, variability (RMS) and complexity (multiscale entropy) were calculated for center of pressure (COP, Neurocom Inc) and center of mass (COM, Motion Analysis Inc) data. Deviation from the starting position was measured with the slope of the trend lines calculated separately for COP and COM. A 3 (group: TY, CPVI, CPVD) x 3 (condition: static, up, down) RMANOVA was used to test significance (α=.05). RESULTS: There were significant effects of condition in the AP direction. Greater variability of COM (p=.002) and COP (p<.001) and complexity of COP (p=.001) were found in the moving visual scene conditions compared to the static condition. Deviations from the starting position of subjects shifted in the direction of the rotating visual scene (COM: p=.002; COP: p<.001). Main effects of group also emerged. In the sagittal plane as depicted in COM, visual dependent subjects with CP moved more variably (p=.042) and deviated farther from their starting position (p=.046). In contrast, in the frontal plane (orthogonal to the visual perturbation), TY subjects tended to move less variably than either CP group. CONCLUSIONS: Visual perturbation, as a means of external sensory noise, induces instability of standing posture in all subjects. In contrast, visual dependence makes them more sensitive to external visual perturbation, which then introduces more variability and complexity into the postural behavior. For individuals with CP, maintaining balance in an unstable environment takes more attention than for typical subjects. Therefore, ensuring stability in the plane of the visual perturbation may require that individuals with CP surrender precision of postural control in the orthogonal axis. Our results suggest that different interventional strategies may be needed with respect to the presence of visual dependence for individuals with CP.

P3-U-115 Dynamical auditory information can influence body sway of standing subjects

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Background and aim: Vestibular, proprioceptive and mainly visual information are known to be the principal afferent inputs involved in postural regulation. Surprisingly, only a few studies have addressed the effect of auditory information in postural regulation, and no clear consensus has emerged, because of slightness of effects and different experimental contexts. Here, our goal is to develop a methodology to systematically explore the effects of dynamic auditory information on static balance. Methods: An innovative 3D sound spatialization system was developed for sound stimuli generation, with 42 loudspeakers equally distributed around the subject. This system allows to create virtual sound sources and to displace it in the whole 3D space. Then, three experiments were conducted on young and healthy standing subjects. Subjects were blindfolded; their body sway was measured with a force platform. The first experiment aimed to investigate the role of a rotating sound source around subjects compared to no sound or a static sound source. Subjects were asked to stand still and focus on sound stimuli. The second experiment addressed the importance of attentional focus in the integration of sound into postural process. Subjects were presented with the same sound stimuli as in experiment 2, but their attention was manipulated in 3 different tasks, where they were asked to: 1 - focus on sound, 2 - focus on their posture and 3 - focus on a secondary mental arithmetic task. In the third experiment, the sound stimuli were designed to compare effect of sound movement evoked by manipulations of its morphology (rendered on one loudspeaker) to real sound source displacement around subject (rendered with sound spatialization). Results: In the first experiment, body sway of subjects was reduced in presence of a rotating sound stimulus, compared to no sound or static sound conditions. In the second experiment, the same stabilizing effect of rotating sound stimuli was observed but only when subjects' focus was directed on sound stimuli. Then, in the third experiment, subject body sway was greater in conditions where sound movement was evoked by morphology than in real sound source movement conditions. Conclusion: Data from the three experiments suggest that auditory information can be integrated in postural control process of blindfolded subjects, to reduce their body sway, provided: 1- subjects' attentional focus is on sound, and 2 - sound source are moving around subjects, varying auditory cues. In other situations, sound information does not seem to be crucial as proprioceptive and vestibular modalities are available to manage posture.

P3-U-116 An experimental test of hypothesized sensory fusion mechanisms contributing to sensory reweighting in human balance control.

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Background and Aims: Human sway responses to support surface tilts show a non-linear increase with increasing stimulus amplitude attributed to sensory reweighting [1]. Little is known about the mechanisms that produce reweighting. One hypothesis, embodied in the Disturbance Estimation and Compensation model (DEC; [2]), assumes that reweighting is achieved through sensory fusion mechanisms that estimate the destabilizing effects of gravity and surface tilts. This model postulates the existence of central threshold elements that act separately on position- and velocity-related signals. The aim of our study was to test the sensory fusion concepts of the DEC model by comparing sway responses to stimuli with different position and velocity characteristics that the model predicts will have different specific effects on sway responses and on sensory reweighting. Methods: Sway responses of 14 subjects standing with eyes closed on a motion platform were compared with results from DEC model simulations (Matlab Simulink). Sagittal plane sway was evoked by tilting the platform about an axis aligned with the subject's ankle joints. Two pairs of tilt stimuli were presented with each stimulus consisting of a pseudorandom series of velocity steps. The first stimulus pair had different velocity step amplitudes (±0.7°/s and ±1.3°/s), but nearly equal 2° peak-peak position amplitudes and equal position-amplitude spectral characteristics below ~1 Hz. The second pair had the same velocity step amplitudes (±0.7°/s), but differed in peak-peak position amplitudes (1.3° and 2°). Frequency response functions (FRFs), characterizing the sensitivity (gain) and timing (phase) of sway responses relative to the stimulus, were calculated for both simulated and experimental results. FRFs were compared to assess the extent to which model predictions accounted for the experimental results. Results: Comparisons of human and model FRFs showed good agreement for both stimulus pairs. Both experimental and model results showed smaller FRF gains to the stimulus with the higher step velocity (but equal position amplitude, first pair) and to the stimulus with the larger position amplitude (but equal velocity amplitude, second pair). However, the two pairs showed different frequency-dependent patterns of gain changes with the first pair showing gain reductions with increasing velocity amplitude across a broad range of frequencies (below ~1 Hz) while the second pair's gain reductions with increasing position amplitude occurred over a narrower frequency range (below ~0.5 Hz). FRF phase was unaffected by all stimulus conditions. Conclusions: The agreement between experimental and model results supports the concepts embodied in the DEC model that sensory fusion is achieved through a mechanism involving central thresholds in sensory estimators of external disturbances. [1] Peterka, J Neurophysiol, 2002. [2] Mergner, Annual Reviews in Control, 2010.

P3-V-117 Defining postural control over first time trials of Nintendo Wii game play

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Background and Aim: Interactive gaming systems, such as the Nintendo Wii, are seeing increased use as a tool for providing objective measures of balance. The National Collegiate Athletic Association (NCAA)

of the United States supports Wii Fit games as an alternative tool to assess and rehabilitate athletes who have suffered concussion injuries. However, the validity and reliability of using Wii Fit games as an assessment tool remains unknown. The Nintendo Wii is an attractive option for the assessment of concussion injuries because, unlike other balance assessment tools used in concussion assessment, it requires both motor and cognitive performance. When using the Wii it is clear that learning the human-machine interface can produce large variability in measures, which could confound assessment of balance abilities in injured and non-injured athletes. Therefore, the purpose of this study was to assess changes in postural control during Nintendo Wii game play over a series of first-time trials among uninjured athletes. Methods: Thirty university athletes (age 18-25 years) were included in our clinical research cohort to measure baseline postural control measurements during Wii game play. Each participant completed four trials of the Nintendo Wii Fit Soccer Heading Game. For measurement of postural kinetics, the Wii Balance Board (WBB) was placed on top of a force platform (TrueImpulse, Northern Digital Inc., Waterloo). Centre of pressure (COP) was calculated in the anterior-posterior (AP) and medial-lateral direction (ML) for each 70-second time trail at 1000 Hz. Magnitude of COP displacement was measured through standard deviation of COP in each direction (AP and ML). Mean velocity of COP displacements was also calculated for each direction. Repeat measures ANOVA compared COP measures over the four trials. Results: Significant increases were found between trials 1 and trials 2-4 in COP ML magnitude ($p = 0.002$). Following trial 2, the magnitude of COP ML was found to plateau. No significant differences in COP magnitude across the trials were found in the AP direction. A significant increase in COP ML velocity was also found between trial 1 and trials 2-4 ($p = 0.026$). ML velocity was also observed to continue to increase between trials 2 and 3, however was not statistically significant. No significant changes in velocity were found in the AP direction. Conclusions: These data suggest that COP control stabilizes after the first trial of the Nintendo Wii Soccer Heading Game, an important consideration in reliability of assessment. Stabilization of the magnitude of COP seems to occur first, followed by velocity that may in fact continue to fluctuate over repeated trials. Differences in these measures may indicate two different factors in postural control during game play that may be useful in the assessment of postural control following concussion injury. Further analyses using non-linear methods may provide greater insight into these trends.

P3-V-118 Characteristics of gait during long-duration walking in people with multiple sclerosis

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BACKGROUND AND AIM. Multiple Sclerosis (MS) is a progressive degenerative neurological disease resulting in sensory and motor dysfunction. Gait impairments are one of the most frequent complaints in MS, increasing the risk of falls. To date, characteristic of gait in people with MS have not been well defined and clinical walking tests are limited to maximum walking speed and maximum distance covered. With the use of inertial sensors it is possible to study continuous over-ground walking, thereby detecting even subtle manifestations of gait deficits. We hypothesized people with MS to show a greater 'slowing' of gait characteristics over the long walk than healthy controls. METHODS. Eleven subjects with MS (age 49.2±15.5 years; 10M, 1F) and seven age matched healthy control participants (age 50.1±13.4 years; 7F) have been tested so far. The subjects with MS had a disease duration of 5-25 years and disease severity of 2.5-4 (EDSS). Subjects performed a 6-min walk test. They were instructed to walk at a comfortable walking speed up and down a 20-meter dead-end hallway. The APDM Mobility Lab system was used for data collection. The subjects wore 6 inertial sensors (Opals, APDM) at the ankles, feet, sternum and lumbar attached by Velcro straps. The 3D accelerometer and gyroscope data from the synchronized inertial sensors was sampled at a rate of 128Hz. Ten reliable and valid gait and turning metrics were directly computed though Mobility Lab. Mean and coefficient of variation (CV) of each of the metrics were determined for the complete 6-min walking trial, as well as for the first and last third. Non-parametric statistics were applied to test between group differences (Mann-Whitney Test) and changes over time (Wilcoxon signed-rank test). RESULTS. Differences between people with MS and control group were found for range of motion (RoM) of the trunk in the horizontal plane in the first (p=.02) and last 2-min segment (p=.03), stride length was significantly different in the first 2-min segment only (p=.03). Healthy controls but not persons with MS altered their cadence, gait cycle time and RoM trunk frontal over the 6-min walk. Both groups prolonged their double-support over time (Figure 1). CONCLUSIONS. Unexpectedly, there were only few marked differences between people with MS and control subjects. Even more surprising was that the healthy control subjects showed more gait adjustments over time than the subjects with MS. Absence of a clear trend in gait adjustments may be attributed to the fact that the subjects were asked to walk at a comfortable walking speed. Additional analyses will be performed to further investigate heteroskedasticity, i.e. change in variability over time. ACKNOWLEDGMENTS. This work was supported by the National Multiple Sclerosis Society. Figure 1. Prolonged double-support as a function of time in a subject with MS.

P3-V-119 Measuring Step Width During Gait Using Inertial and Ranging Sensors

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Background: Characteristics of leg movements can be quantified using spatio-temporal gait metrics, such as stride time/length, stance and support time, and step width. Step width is related to balance and stability. Average step width and its variability have been shown to indicate fall risk in older individuals and in those with neurological disorders. The spatio-temporal characteristics during gait have traditionally required video-based motion analysis or gait mats. However, these systems are costly, time consuming, and can only be used in a laboratory environment. Inertial measurement units (IMUs) overcome these shortcomings, and can provide the same gait metrics. Stride width, however, cannot be directly estimated by IMU's. The objective of this study is to evaluate the feasibility of integrating time-of-flight ranging sensors with IMU's to quantify step width during gait. Method: Three healthy adults performed a 7-meter walk with movement monitors attached to each foot. Each monitor integrated ultra-wideband ranging sensor with Opal inertial sensors (APDM Inc.), including triaxial accelerometers and gyroscopes. Subjects followed lines and marks that indicate where to place their fee. Each subject performed three repetitions at each step width of 0.1, 0.2, and 0.3 meters. The repetitions were designed to have the subject place the left foot at different step lengths. Each of the total 9 walks started and ended with about 3 seconds of standing still to estimate and remove sensor bias. Periods of walking were identified and used to calculate gait metrics including stride length (m), foot clearance (m), step lateral deviation (m), stride velocity (s), step duration (s), stance time (s), and their variability. We used the step lateral deviation, and the range between measurement units on the feet to calculate each step width. We define the step width as the distance between the feet at the time of mid-swing, when the accelerating limb is aligned with the stance limb. Results: The average calculated step width was 0.15 ± 0.06 m, for gait data collected at the prescribed step width of 0.1 m. Similarly, the average calculated step width was 0.23 ± 0.05 m, and 0.31 ± 0.04 m, respectively at the prescribed width of 0.2 and 0.3 m. The estimation error was consistently below 0.1 m for all prescribed walks at different step lengths. Larger errors were obtained, however, during terminal stance and pre-swing phase due to occlusion. Conclusions: It is feasible to integrate inertial sensors with ranging sensors to measure step width during gait. Combined with the inertial data, range information can continuously characterize gait in and outside the laboratory settings, during unconstrained activities, with reasonable accuracy during long-term monitoring. Ranging sensor data can be distorted by multipath propagation. Further studies are required to mitigate these effects and algorithms to rely less heavily on ranging data when when occlusion occurs.

P3-V-120 Test-retest reliability and concurrent validity of a fMRI-compatible pneumatic vibrator to stimulate muscle proprioceptors during upright standing

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BACKGROUND AND AIM: Optimal postural control requires the brain to process proprioceptive signals. To study this central processing, functional magnetic resonance imaging (fMRI) combined with local muscle vibration, a strong stimulus for muscle spindles, is of great value. Due to the high-strength magnetic field of fMRI, the use of electromotor driven muscle vibrators is problematic in this environment. Pneumatic muscle vibrators provide a fMRI-compatible alternative. However, their ability to produce reliable and valid proprioceptive stimuli has not been investigated yet. This study aimed to determine test-retest reliability and concurrent validity of the postural response of pneumatic vibration on ankle and back muscles. METHODS: Mean center of pressure (CoP) displacement in response to respectively ankle and back muscle vibration (45-60 Hz, 0.5 mm, 15 sec) during standing on stable and unstable support surface were determined in ten healthy subjects (aged 23±3 years). This test procedure was performed first with electromagnetic vibrators, and was repeated after a 5 minute break with MRI-compatible, custom-made pneumatic vibrators. The entire test was repeated within one week. Intraclass correlation coefficients (ICC) were calculated to determine (1) intraday and interday reliability for CoP displacement during both electromagnetic vibration and pneumatic vibration, and (2) concurrent validity of CoP displacement during pneumatic compared to electromagnetic vibration. The classification of Fleiss was used to interpret the ICC findings: ICC< 0.40 represents poor reliability, ICC 0.40-0.75 fair to good reliability and ICC> 0.75 excellent reliability. RESULTS: Intraday and interday ICC values for CoP displacement in response to ankle muscle and back muscle vibration during stable and unstable standing ranged from 0.64-0.94 for electromagnetic vibration and from 0.64-0.90 for pneumatic vibration, respectively. Concurrent validity ICC values for CoP displacement during ankle muscle vibration ranged from 0.67-0.95 during stable standing and from 0.69-0.87 during unstable standing. For back muscle vibration, concurrent validity ICC values ranged from 0.63-0.65 during stable standing, whilst the ICC values during unstable standing were not statistically significant (p≥ 0.034). CONCLUSIONS: Test-retest reliability for CoP displacement during pneumatic vibration was good to excellent and resembled the test-retest reliability of CoP displacement during electromagnetic vibration. The concurrent validity of pneumatic compared to electromagnetic vibration was good to excellent on ankle muscles in stable and unstable standing, and on back muscles in stable standing. This study shows that the custom-made, MRI-compatible pneumatic vibrator is able to stimulate muscle spindles during postural control reliably and validly. Consequently, this device can be used to study the central processing of proprioceptive signals in an fMRI environment.

P3-V-121 A Multi-Kinect system for the quantitative analysis of spatial- temporal gait measures in neurological movement disorders

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Background: Given the low cost and widespread availability of the Kinect sensors, this tool may provide a means for conducting large scale clinical assessments of physical function. Earlier valuation studies focused predominantly on single Kinect systems, which are limited in workspace. In the presented project, we develop a multi-kinect system for the analysis of gait and other whole-body movements in neurological movement like cerebellar ataxia 1. Methods: We developed a multi-kinect system including six Kinect? v2 sensors, six mini- PCs directly attached to the Kinect sensors and one host computer. The mini-PCs are time synchronized with the host PC and are communicating via WLAN. Using this architecture we can scale up to as many sensors as necessary to cover a given volume. For the gait analysis, we used six Kinect sensors covering a walking corridor of 6-7 meters. After calibrating the

Kinect by using the depth images, we recorded in parallel to a VICON? system 6 healthy subjects performing 24 walking trials. After recording, we used the Kinect SDK v2 for skeleton fitting and customized matlab routines for merging the six skeletons. Foot events were determined semi-automatic using foot markers and angle trajectories from the skeleton. Results: In this first pilot study we determined spatial and temporal gait measures like step length and stride time by the Kinect system and our Vicon system in parallel in order to evaluate the measure gained from the Kinect system. In both, stride time and step length the comparison revealed highly significant correlations (step length: rho = 0.8625, p=1.0013*10^-6, rho=0.9217, p=7.9008*10^-9), indicating a very close relationship between the measures determined by both systems. Further analyses will include the comparison of spatio-temporal variability measures, which have shown to be important measures to quantify neurological gait disorders like cerebellar ataxia and PD1,2. Conclusion: Our first pilot studies have indicated that our approach to develop a multi-kinect movement analysis system is very promising. In future, the system could allow cost-effective movement analysis also in non-dedicated clinics enabling multi-centre studies. This might be in particular interesting in combination with exergaming studies, in order to quantify the motor improvements in gait as well as in other whole-body movements. References 1. Ilg W, Timmann D. Gait ataxia-specific cerebellar influences and their rehabilitation. Mov Disord 2013;28(11):1566-1575. 2. Hausdorff JM. Gait variability: methods, modeling and meaning. J Neuroengineering Rehabil 2005;2(1):19.

P3-V-122 Influence of balance disturbance method on the timing and accuracy of reach-to-grasp balance recovery reactions during level ground walking

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BACKGROUND AND AIM: Well-designed handrails can significantly improve a person's ability to recover from balance loss and avoid a fall[1], but the consequences to balance recovery when rails are poorly-designed are not well-understood. To study how rail design affects reach-to-grasp balance recovery, we can perturb balance safely and repeatably with support-surface movements. However, high-acceleration perturbations may be needed to evoke compensatory reach-to-grasp reactions, particularly in healthy young adults. This can increase measurement errors arising from vibration of instrumentation on the motion platform. This study evaluates an alternative to high-magnitude perturbations for investigating reach-to-grasp responses during level gait: a lower-magnitude perturbation combined with reduced-traction shoes. The shoes are designed to limit the effectiveness of compensatory stepping, thereby reducing the perturbation magnitudes needed to evoke reactive grasping in young adults. METHODS: Data were collected in the Challenging Environment Assessment Laboratory at Toronto Rehab: a 5mx5m lab mounted on a robotic platform that can deliver perturbations. 8 of 11 young adults (21-30y; 3M) are

analyzed. Harnessed subjects walked beside a handrail set to 57% of subject height. The walkway consisted of fiberboard panels. Unexpected backward translations were used to induce balance loss and evoke reach-to-grasp reactions. Two perturbations were tested: a high perturbation magnitude (acceleration $4.75 m/s^2$) (REGULAR), and a lower perturbation magnitude (acceleration $3.75 m/s^2$) (SLIPPERY). Square-wave acceleration profiles were used in both cases. Subjects wore standardized, unaltered athletic shoes for REGULAR trials, and the same model of shoe with fabric attached to the sole for SLIPPERY trials to reduce foot-floor friction. Each subject completed four trials per condition. Reaching reaction onset latencies were estimated from EMG sensors on the right middle deltoid. Rail overshoot and hand speed were estimated from a motion capture marker on the base of the second metacarpal; rail contact time was estimated with an optical system on the rail. Timing variables were defined with respect to perturbation onset (platform acceleration>$0.1 m/s^2$)[2]. Statistical analysis was performed with paired t-tests (significant $p<0.05$). RESULTS: Descriptive statistics are presented in Table 1. Despite the major differences in how subjects were destabilized, no significant differences were observed in key reactive grasping timing and kinematic metrics for REGULAR and SLIPPERY. CONCLUSIONS: Key reaction time and kinematic metrics of reach-to-grasp reactions did not differ significantly between the two perturbation methods. This suggests that the slippery method will produce comparable results to high-acceleration perturbations for studying how handrail design influences these balance recovery metrics during level walking. REFERENCES: [1]Maki et al, 1998 [2]King et al, 2011

P3-V-123 Reliability of Multifractal Detrended Fluctuation Analysis using Smartphone Technology

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BACKGROUND AND AIM: Numerous studies have indicated that fluctuations in human locomotion are complex and self-similar over various scales. The fractal nature of walking appears to be an important indicator of neurophysiological complexity and health status. Most research to date has assessed the fracticality of walking using monofractal techniques. Monofractal techniques capture only a single, time independent scaling relation. Alternatively, multifractal techniques assess scaling relations across timescales, and may therefore capture feedback-driven alterations to locomotor patterns that occur in response to changes in environmental and task constraints. Until recently, a major limitation in adaptive gait assessment has been the inability to collect measures outside of the laboratory. However, the advancement of smartphone technology has allowed devices to be adapted to capture spatial and temporal gait parameters. Multifractal techniques are well suited for adaptive gait analysis since individuals must integrate feedback as they navigate cluttered environments. As gait assessment in natural environments becomes possible, it is important to examine the applicability of multifractal techniques. Therefore, the purpose of this work was to assess the reliability of the multifractal spectrum during free-walking in healthy adults utilizing smartphone technology. METHODS: Ten healthy adults participated in free-walking around a 200m track. Subjects performed three trials, consisting of six laps, at preferred speed. Subjects were instrumented with an iPhone that was mounted to their waist. The cell phone camera was used to track the position of the feet using a custom written app (SmartGait). Visual Analog Scales for Fatigue (VASF) were used to assess fatigue over trials. Multifractal detrended fluctuation analysis (MFDFA) was used to assess long range correlations in the step length time series. Surrogate data sets with the same Fourier spectrum as the original time series were created to confirm statistically significant differences from a random process. RESULTS: Multifractal spectrum including the mode Hurst exponent, spectrum width, and the width of each tail of the spectrum (see figure) were calculated. A mixed, model repeated measures ANOVA confirmed no main effect of time on the assessed MFDFA parameters or VASF scores. Intraclass correlations were calculated for absolute agreement. Mode values demonstrated excellent agreement (0.932). Spectrum width showed good reliability (0.722). Right and left tail widths showed poor reliability (0.518 & 0.203 respectively). CONCLUSION: In summary, care must be taken when averaging features of the multifractal spectrum. Even in healthy adults spectrum variability is observed in consecutive trials of preferred speed walking. As such, comprehensive examinations into time dependent changes of the spectrum are necessary before multifractal techniques can be accurately interpreted in adaptive gait.

P3-V-124 Video-based body shape capture for movement study - Application to a walking sequence.

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BACKGROUND and AIM: To analyze the whole-body movements, accurate anatomic landmarks must be extracted, usually using optical marker-based capture methods to provide 3D movement coordinates. It requires expensive equipment and time to setting-up subjects and provides an incomplete description of the whole body motion. We present here a motion capture method based on multiple video camera system to acquire 2D body shapes data that allows to rebuild the entire body surface of the subject during the image sequence. The main ambition of this method is to eliminate markers for human motion analyses. For comparison with optical motion analysis results, we set up an experiment integrating video recordings from 8 video cameras and a marker-based motion capture system. METHODS: The subject and experimental room (Figure 1.A.) was set up to allow the automatic image segmentation. Subjects were asked to walk naturally along a walking track. The Vicon system consists of 12 cameras recording at 250Hz the 3D position of 39 markers, using the Conventional Gait Model (Figure 1.B.). The video system consists of 8 Basler? (acA1300-30g) cameras, synchronized with the Vicon. Cameras were recording the same volume at 25Hz. The Vicon area and the field of view of cameras were automatically calibrated.

Given the distance between the cameras and the acquisition volume, the resolution was 5mm/pix. From the Vicon data, 3D co-ordinates of each marker, and. the video data, 8 silhouettes of the subject, for each frame of the sequence, we obtained a mesh using a visual hull approach (Laurentini, 1994). The Vicon and Video 3D data sets were merged using 3D reconstruction software (Figure 1.C.). RESULTS: The coupling of Vicon and Video data acquisition allows extracting two synchronized sets of 3D movement coordinates, illustrated Figure 1. Our data provided distances between the 3D trajectories from the Vicon system and the 3D mesh extracted from the video cameras. The mean distance between the mesh and the marker has been calculated through a walking sequence. The lowest distance corresponds to a marker on the shoulder (0.45±0.32cm) the highest to a marker on the hip (2.3±1.3cm). Considering that the diameter of the markers is 1cm, our method can be considered as relatively accurate. CONCLUSION: Our method preserve acceptable 3D data accuracy required to access to the inner mechanism of human movement, and to analyze the implicit neuromechanical processes. It shows promising application for a simplification of movement analysis procedures. Although our method depends on the segmentation quality, we believe that the video-based human motion analysis opens great possibilities in fundamental and applied human gait, posture and movement analyses. [This research was supported by the ANR grant MORPHO and the Equipex Robotex Gipsa-lab.] Laurentini, A. (1994).IEEE Transactions on Pattern Analysis and Machine Intelligence, 16(2), 150-162.

P3-V-125 Crowdsourced annotation of EMG onset times in healthy individuals and Parkinson disease

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BACKGROUND AND AIM. Annotation of onset times in electromyogram (EMG) signals is time-consuming, difficult to automate, and may be subject to low inter-rater reliability. As a result, many EMG recordings are recorded but never analyzed. Annotation of EMG signals from individuals from clinical populations, like those with Parkinson disease (PD) or dystonia may be particularly difficult due to artifacts from tremor or other pathological movements in EMG signals. Crowdsourcing through platforms like Amazon Mechanical Turk may offer an alternative solution to provide reliable annotations. Here, we tested whether this approach could be used to annotate EMG signals recorded during balance tasks in healthy young individuals (HY) and individuals with PD. METHODS. 1,175 EMG medial gastrocnemius recordings of automatic postural responses to forward and backward ramp-and-hold translation perturbations of the support surface were collected from two research participant groups (HY=9 and PD=9). Responses to perturbations were used because typically EMG recordings of lower limb muscles transition from quiescence to activity at approximately 100 ms after perturbation onset. All individuals in the PD group were taking antiparkinsonian medications: 4/9 exhibited dyskinesia scores ≥2, and 3/9 exhibited notable tremor artifact in EMG and Unified Parkinson Disease Rating Scale

items. EMG records were processed at 1080 Hz, high-pass filtered (35 Hz), demeaned, and rectified. The experiment was conducted through the Amazon platform with an interactive link to CrowdLabel, an online annotation system for electrophysiological signals. A minimum of 5 workers was requested to submit onset labels for each signal. In each assigned task, workers were provided examples of onsets, and given simple instructions to locate onset times by dragging a cursor across the EMG in order to identify the onset of activation in the CrowdLabel interface. Initially, workers were compensated $0.01 per EMG signal annotated, followed by $0.02 and $0.03 to evaluate wage sensitivity. RESULTS. A total of 69 workers contributed to the data collection process, with at least 8 workers each labelling a minimum of 400 EMG signals. Over eight days 6,469 annotations were collected costing $106. The averaged time to complete a task was 48.5 seconds. When payment to workers increased from 1 to 3 cents, we noticed a drastic change in accruing annotations, with daily rate rising from 14 annotations by 2 workers to a maximum of 2,218 annotations from 20 workers. CONCLUSIONS. Crowdsourced annotation of EMG signal onset times using Amazon Mechanical Turk is feasible and produces a large number of annotation records in a relatively short time. This suggests that this platform may represent a useful component of the analysis workflow in many studies. The accuracy of annotations produced by workers with those produced by expert raters remains to be validated.

P3-V-126 Methods for assessing Achilles T-reflex during stance

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BACKGROUND AND AIM: The tendon tap reflex (T-reflex) can be measured in a range of muscles and is typically elicited while subjects are seated or prone. The amplitude of this reflex is influenced by the excitability of the pathway through the spinal cord and the sensitivity of muscle spindle receptors; both of which are modulated in a task specific manner (Sinkjaer et al 1996). Because the triceps surae muscles play an important role in maintaining balance, it is important to be able to assess the Achilles T-reflex in a standing posture. However, natural fluctuations in body sway make it difficult to elicit consistent T-reflexes. Previous work has used linear motors to elicit Achilles T-reflexes (Woollacott & Nashner 1982; Horslen et al 2013); however, these devices are costly and precautions must be taken to immobilize the ankle or strictly monitor body sway in order to limit variability in tap forces. A simple uniaxial pendulum reflex hammer may be capable of applying reproducible tap forces without having to take such precautions. Thus, the aim of this study was to investigate the validity and reliability of a recently developed pendulum reflex hammer designed to elicit Achilles T-reflexes during stance and determine appropriate tapping parameters for experimental use. METHODS: Fifteen healthy young adults stood on a forceplate while taps were applied to the right Achilles tendon using the custom made reflex hammer. T-reflex amplitude was measured from the soleus using electromyography and peak tap force was measured with a dynamic force sensor. Two blocks of 10 Achilles T-reflexes were evoked from

a release angle of 50° (relative to equilibrium) under conditions in which body sway was constrained or unconstrained. Under constrained conditions, participants received feedback to ensure their centre of pressure was maintained within a set range; no feedback was received under unconstrained conditions. Intraclass correlation coefficients (ICCs) between blocks were calculated for T-reflex amplitude and peak tap force. A recruitment curve was then constructed by varying the release angle of the hammer between 20-90° in 10° increments. Release angles were randomized and 5 taps were applied for each angle. RESULTS: Peak tap force was found to be highly reproducible between blocks regardless of whether postural sway was constrained (ICC=.964) or unconstrained (ICC=.937). T-reflex amplitude was reasonably reproducible when sway was constrained (ICC=.591) and unconstrained (ICC=.789). Peak tap force and reflex amplitude were found to increase linearly with increases in release angle up to 70°, with 40-50° (tap force: ~25-30N) eliciting medium range reflexes. CONCLUSIONS: These preliminary results suggest the pendulum reflex hammer may offer a simple and reliable means to assess Achilles T-reflex during normal stance. A tap force of approximately 25-30N is recommended to elicit medium range reflexes susceptible to facilitation or inhibition.

P3-V-127 Novel approaches to clinical walking assessment in pediatric populations

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BACKGROUND AND AIM: Walking is a focus of rehabilitation for many children with cerebral palsy (CP) or spina bifida (SB). Thus, clinicians and researchers need valid and reliable measures to assess walking in these children. The 10-meter walk test (10mWT) is commonly used in adult populations, but its test-retest reliability was found inadequate in children with CP[1]. The aim of this pilot study was to assess the test-retest reliability and discriminative validity of two new walking tests, the Obstacles and Curb tests, in ambulatory children with CP or SB. We hypothesized that these tests would have greater test-retest reliability than the 10mWT, and good discriminative validity. METHODS: Children with SB or CP who were 2-13 years old, and able to ambulate 14m were recruited. Age- and gender-matched typically-developing (TD) children also participated. The 10mWT, Obstacles test, and Curb test were performed at self-selected and fast speeds. Gait aids/braces were permitted. The Obstacles and Curb tests are timed tests modified from the Spinal Cord Injury Functional Ambulation Profile.[2] The Obstacles test involves walking on a 7m walkway, stepping over two obstacles (height and width normalized to child's leg length), and walking around a bin. The Curb test involves walking toward an 8-inch high platform, stepping onto it, walking across it (1.2m), and stepping down to the floor. Tests were performed twice, with ≥15 minutes separating each administration. Data are reported as mean ± 1 SD. Intraclass correlation coefficients (ICC) (95%CI) were used to evaluate the within-session, test-retest reliability of each test. To assess discriminative validity, mean test scores were compared between TD children and children with CP or SB (independent t-tests, $\alpha=0.05$). RESULTS: Seven children with CP (5 spastic diplegia, 2 hemiplegia) and 9 with SB participated (9 males, mean age 7.6±3.3 years). All were rated as Normal or Community Ambulators on the Hoffer Scale (SB), or levels I-III on the Gross Motor Function Classification System (CP). Sixteen TD children also participated. When performed at a self-selected speed, the Curb test had the greatest test-retest reliability (ICC=0.94 (0.81-0.98)), followed by the Obstacles (ICC=0.87 (0.58-0.96)) and the 10mWT (ICC=0.81 (0.48-0.93)). The test-retest reliability of all tests increased when performed at a fast speed (Curb ICC=0.95 (0.85-0.99); Obstacles ICC=0.94 (0.79-0.98); 10mWT ICC=0.89 (0.67-0.96)). With respect to discriminative validity, TD children scored higher than the children with CP or SB on all tests ($p<0.05$), with the exception of the 10MWT at a self-selected speed ($p>0.05$). CONCLUSIONS: The Obstacles and Curb tests are promising walking measures for children with CP or SB. Both tests had good to excellent test-retest reliability and discriminative validity, and their psychometric properties were superior to those of the 10mWT. [1]Thompson et al. 2008 Dev Med Child Neurol [2]Musselman et al. 20

P3-V-128 Feasibility and Validity of Functional Movement Screen in Assessing Postural Control of Operative Firefighters Aged 22-59

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BACKGROUND AND AIM: Roof work, working in moving emergency vehicles and rescuing victims in changeable environments are typical tasks in fire and rescue work, in which good postural and movement control are critical for safe and efficient work performance. We examined the feasibility and work- and health-related validity of the functional movement screen (FMS) assessing postural and movement control as part of the evaluation of the work ability of operative firefighters. METHODS: The participants comprised 97 male firefighters in the age groups of 20-29, 30-39, 40-49 and 50-59 years (mean±SD 39.9±10.6). The FMS included seven tests with different movement patterns: deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability push-up and rotary stability. The participants performed each test one to three times, and scored 0-3. The final score was the sum of the seven items. Work-related dynamic balance was measured by a functional test in which the participants wore fire-protective clothing and equipment. The participants also performed the modified agility T-test. A questionnaire elicited perceived work ability, balance and musculoskeletal pain (MSP) in the last year. Age-adjusted Spearman's correlation analysis was also used. RESULTS: The FMS was feasible for the different age groups and fitness levels of the firefighters, and took about 30 minutes. Its mean (range) was 14.2 (7.0-21.0) and it was significantly related to age ($r=-.64$, $p<.0001$). Good FMS results were connected with efficient performance in the dynamic balance test ($r=-.19$, $p=.064$) and associated significantly with fast performance in the agility T-test ($r=-.23$, $p=.023$). Good perceived work ability in relation to the physical demands of fire and rescue work, as well as perceived balance in relation to the balance demands of work were significantly associated ($r=.26$, $p=.009$, $r=.28$,

p=.005, respectively) with better FMS results. Poor FMS results were related to previous MSP (r=-.26, p=.011) in several body sites. CONCLUSIONS: The FMS score was strongly related to age, perceived and measured work-related balance, agility, work ability and the number of MSP sites among operative firefighters. The test was suitable for firefighters of different ages, and took a reasonable amount of time when performed by a well-qualified tester. Our results support the work- and health-related validity of the use of FMS among operative firefighters. Peate et al. (2007) have shown a correlation between past musculoskeletal injury and FMS score among firefighters. However, a longitudinal study is needed to evaluate the predicted value of FMS in respect to work ability and MSP. Our results also support the feasibility of FMS as a part of the evaluation of the physical work performance of operative firefighters. For early prevention of decreased work ability, we recommend that a qualified tester perform FMS during firefighters´ periodic health examinations.

P3-V-129 Reliability of clinical and instrumented balance assessments in patients with Parkinson`s Disease.

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BACKGROUND AND AIM: Postural instability, one of the cardinal motor symptoms in Parkinson's disease (PD), affects gait and increases risk of falling (Bloem et al., 2001). Since balance performance deteriorates during disease progression, its measurement plays a critical role in clinical decision-making (Horak & Mancini, 2013). However, commonly used clinical balance tests (e.g. the pull test) are subjective and have limited reliability. The aim of this study is to examine and compare the interrater and test-retest reliability of clinical and instrumented tools to assess balance performance in PD. METHODS: Seventeen PD patients (Hoehn & Yahr stages I-III; 12♂, 5♀; age=65±9years; UPDRS-III=19±6) were independently assessed by two experienced raters. Measurements were conducted within two weeks and performed on medication. Balance was assessed using 1) the Mini-BESTest (Franchignoni et al., 2010) and 2) an instrumented static posturography (pressure platform, zebris Medical GmbH). Posturography data were collected at 100 Hz in two test conditions: double-legged quiet standing with eyes opened (EO), and eyes closed (EC). Center of pressure (COP) sway path (mm), velocity (mm/s) and area (95% confidence ellipse, mm^2) were calculated, and the average of three 30-second trials was analyzed. Concordance between the two measurements (raters/ time points) was assessed by paired t-tests and intraclass correlation coefficients (ICC). RESULTS: Agreement in the Mini-BESTest total score was moderate between the two raters (ICC(2,1)=.63, 95%CI .22-.85). Scores of rater #2 were significantly higher (3.18, p=.000) compared to rater #1. Subscore ICCs ranged from .33 (dynamic gait) to .47 (anticipatory postural adjustments). Rater agreement for the individual items ranged from 41,2% (pivot turns) to 100% (stance eyes open). Test-retest reliability was high for all postural sway measures in both test conditions (ICC(2,k)=0.91-0.97, 95%CI .62 -.99). Two out of six measures were consistently higher for

the second appointment: sway path EO (85.08mm, p=.001), and sway velocity EO (2.82mm/s, p=.002). CONCLUSIONS: Reliability was moderate for the clinical test and high for the instrumented posturography. These findings support the importance of instrumented balance assessments in PD. The improved performance during the second appointment indicates a test-learning effect. REFERENCES: Bloem, B. R., Grimbergen, Y. A., Cramer, M., Willemsen, M., & Zwinderman, A. H. (2001). Prospective assessment of falls in Parkinson's disease. Journal of neurology, 248(11), 950-958. Franchignoni, F., Horak, F., Godi, M., Nardone, A., & Giordano, A. (2010). Using psychometric techniques to improve the Balance Evaluation Systems Test: the mini-BESTest. Journal of rehabilitation medicine, 42(4), 323-331. Horak, F. B., & Mancini, M. (2013). Objective biomarkers of balance and gait for Parkinson's disease using body-worn sensors. Movement disorders, 28(11), 1544-1551.

P3-V-130 Distribution of traction coefficient in the contact area between shoe sole and floor during straight walking

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BACKGROUND AND AIM: Slip will not occur if the shear force (fh) applied to the floor during walking does not exceed the friction force at the shoe-floor interface. Thus, to prevent slips, traction coefficient, i.e. the ratio of fh to the vertical force (fv) applied to the floor must be lower than the coefficient of friction at the shoe-floor interface. The traction coefficient has been used to identify the gait cycle point where a slip onset is most likely. fh and fv are usually measured with force plate as horizontal and vertical ground reaction forces (GRFs); however, GRFs are resultant forces in the whole contact area. Thus, it is difficult to know the local GRFs distribution in the contact area between shoe sole and floor. In this study, we developed a shoe device mounted with miniature tri-axial force sensors and investigated the distribution of traction coefficient in the shoe-floor contact area during straight walking. METHODS: To measure the local GRFs distribution, four miniature force sensors (ShokacChip, Touchence Inc.) were mounted on the shoe outsole. The size of the sensor is 11.1 mm×11.1 mm×2.5 mm and its rate capacities are 10 N, 10 N, 40 N in x, y, z directions, respectively. The force sensors were mounted at 52 local positions in total, as shown in Figure 1. Four healthy young adult males with an average age of 22.1 yrs. participated in this study. The subjects were asked to walk, wearing the developed shoe on the right foot, in a straight line on dry level floor surface. GRF data at each sensor location for ten steps were obtained from each subject. The traction coefficient Øi (i = 1-52) at each sensor position was calculated. RESULTS: The temporal profile of local GRFs indicated the timing of contact and take-off of each sensor position. The maximum peak value of the traction coefficient at each sensor position indicated the required coefficient of friction (RCOF) to prevent a local slip at the position. Distribution of the local RCOF demonstrated that the heel, toe, and the ball of the thumb area needs the coefficient of friction greater than 1.0, which is greater than the RCOF calculated from resultant GRFs obtained with a force plate. Distribution of the direction in the traction force (horizontal GRF) was also clarified. CONCLUSIONS: In the current study, we investigated the distribution of traction coefficient in 52 local position of the shoe sole by means of the shoe device mounted with miniature tri-axial force sensors. We demonstrated that coefficient of friction greater than 1.0 is needed to prevent local slip in the contact area between shoe and floor during straight walking. The findings may ultimately be used to design a high grip shoe sole.

P3-V-131 Between-subjects differences in CoP measures on stable and unstable spring-supported platform

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BACKGROUND AND AIM: The International Standardization Committee for Clinical Stabilometry of the ISPGR recommended for the CoP measurements an accuracy of 0.1 mm and a precision of 0.05 mm [1]. This means the error about 0.2 mm (0.1 mm%2B1.96*0.05 mm). However, the movement of the CoP can be less than 2 mm and the change of less than 20% (i.e. 0.4 mm) can be significant. Thus, each CoP point should be determined with an error of less than 0.2 mm. However, posturography systems based on force plate have errors from almost 1 mm (accuracy of 0.5 mm, precision of 0.2 mm) to over 4 mm (accuracy of 2.0 mm, precision of 1.2 mm). When dealing with humans, the error for the most reliable parameter, mean CoP velocity, is 10.4% [2]. For value of 10 mm/s it means the error of 1 mm/s. If changes after the training or differences between subjects are less than 1 mm/s, which is often in the case of static posturography, this could simply be the error. Providing that reliability of CoP measures is similar under stable and unstable conditions, in the later these changes or differences are supposed to be behind the margin of the error. Verification of this assumption was accomplished by comparison between-subjects differences in CoP measures while standing on stable and unstable spring-supported platform. METHODS: A group of 42 fit subjects (age 22.6±3.8 y, height 173.6±7.1 cm, weight 69.7±10.5 kg) underwent a series of two 30-second trials of bipedal stance on either 3 strain gauges force plate or platform supported by 3 springs, both with eyes open and eyes closed. The CoP measures were registered by using the FiTRO Sway Check system. RESULTS: There were significant between-subjects differences in favour of standing on spring-supported vs. stable platform with eyes closed in mean CoP X-length of 176.3 mm (95% CI 170.0, 183.1), P=.001, mean CoP Y-length of 312.9 mm (95% CI 303.7, 323.2), P=.001, mean CoP velocity of 12.5 mm/s (95% CI 12.1, 13.0), P=.003, and mean CoP distance of 3.7 mm (95% CI 3.4, 4.0), P=.007. Significantly greater differences under unstable than stable conditions were also found with eyes open in mean CoP X-length of 46.8 mm (95% CI 43.6, 50.1), P=.041 and mean CoP Y-length of 99.7 mm (95% CI 96.5, 103.8), P=.036. However, these were no significant in mean CoP velocity of 2.0 mm/s (95% CI 1.7, 2.3), P=.107 and mean CoP distance of 0.6 mm (95% CI 0.4, 0.8), P=.119. Taking into account the error of measurement in range of 10-14%, it may be possible to detect

small differences between subjects when testing balance under unstable conditions. CONCLUSIONS: Significant between-subjects differences in CoP measures, mainly during stance on spring-supported platform with eyes closed, greater than the margin of previously established errors of the measurement, may be considered real with a certain confidence. REFERENCES: 1. Scoppa F et al. Gait Posture, 2013;37(2):290-2. 2. Zemková E, Hamar D. National Congress of Sports Medicine,1998

P3-W-132 Perceived Timing of Auditory and Inertial Cues During a Fall

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Background & Aim: It is relatively unknown how conscious awareness of sensory processing changes during a fall. Common anecdotal reports suggest that people often report distortions in their perception of time with little to no recollection of what occurred during the fall. It has been shown that the vestibular system is perceptually slow compared to the other senses (45-160ms delay), indicating that vestibular stimuli must be presented prior to other sensory stimuli in order for it to be perceived as synchronous. To date, no research has examined this perceptual delay during a fall. Establishing a link between delayed perception of vestibular stimulation with falling could be used to develop preventative strategies to reduce the incidence of falls. It is hypothesized that the onset of a fall will be perceptually delayed relative to an auditory stimulus due to slow vestibular perception. Alternatively, the onset of a fall may elicit no lead time relative to auditory stimulus, suggesting that slow vestibular perception reported in the literature is restricted to direct vestibular stimulation and movements of the head. Methods: We tested 8 healthy subjects and exposed them to unpredictable falls using a lean-and-release perturbation system where fall onset varied in time relative to the onset of an auditory sound. Subjects made temporal order judgments (TOJ) on whether the onset of the sound or their fall came first to measure the point of subjective simultaneity (PSS) between sensory cues. Results: Comparable with previous research identifying delayed perceptual responses to vestibular stimulation, the present results show that onset of a fall has to precede an auditory stimulus by approximately 45ms to appear coincident with the fall. Conclusions: We conclude that young, healthy individuals are no more cognisant of indirect vestibular stimulation during fall onset than during a simple head movement. Future experiments will look to establish whether additional lead times for fall onset are required for those susceptible to increased fall behaviour. This research has potential implications for monitoring increased likelihood for fall incidence and for identifying and alerting those more likely to fall, such as the elderly, of imminent lapses in balance.

P3-W-133 Reliability of the instrumented Timed Up and Go and Postural Sway tests in Patients with Vestibular Disorders

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Background and Aim The instrumented Timed Up and Go (iTUG) and Postural Sway (iSway) tests are simple and practical tools to reliably assess balance and gait ability in a clinical context. Whereas these test have been already used and validated for patients with other pathologies (e.g. Multiple Sclerosis and Parkinson's disease) to the best of our knowledge, they have not been validated for individuals suffering with vestibular disorders. The aim of this paper is to assess the reliability of a number of iTUG and iSway parameters computed using the commercially available Mobility Lab system (OPAL?-Apdm Inc.) in a group of patients with vestibular disorders. Methods Data were collected from 47 volunteers, including twenty healthy young adults and twenty-seven patients with vestibular disorders. The study was approved by the local National Research Ethics committee and informed consent was established prior to participation. All the participants performed the iTUG and the iSway while wearing inertial sensors on their wrists, chest, L5 and shanks. Two sessions of each test were performed one week apart. Three repetitions of each test were performed in random order within each session. Within and between sessions' reliability of the parameters extracted by the Mobility Lab were calculated and the ability of the reliable parameters to discriminate patients with vestibular disorders from healthy volunteers was then tested. Reliability was quantified with an Intra-Class Correlation Coefficient (ICC) and a t-test along with Cohen's d was used to assess the discrimination ability of the parameters. To identify a subset of reliable and valid parameters a criteria of ICC values ≥0.6 and Cohen's d value ≥0.8 was set. Significance level was set at $p=0.05$ for all tests. Results Thirty-two parameters were extracted from the iTUG and forty-seven from the iSway test, respectively. For the iTUG, mean±standard deviation of the between sessions ICC values were 0.68±0.22 and 0.69±0.15 for the healthy and the patient group, respectively. Gait was the most reliable component of the iTUG, while sit to stand was the least reliable. A subset of thirteen parameters of iTUG showing good reliability with ICC≥0.6 and excellent discrimination strength with Cohen's d ≥0.8 were detected. For the iSway, between sessions ICC values were much lower in the control group (0.38±0.16) than in the patient group (0.71±0.14). The time domain parameters of iSway were the most reliable in both groups. However, none of the iSway parameters simultaneously satisfied the requirements of good reliability and excellent discrimination strength. Conclusion Only the iTUG test satisfied the requirements set for reliability and validity and appeared to be suitable and reliable for patients with vestibular disorders. The identified subset of iTUG parameters can be used in the clinics with the potential to objectively monitor functional status in patients with vestibular disorders.

P3-W-134 Functional Interactions of vestibular and cortico- spinal networks in the control of neck musculature

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Abstract body Background We have recently developed a technique to induce neck stretch reflexes in the sternocleidomastoid (SCM) muscle by tendon tapping. We have used this to probe the spinal excitability of the neck muscles during caloric vestibular stimulation. In addition, we have probed corticospinal excitability to SCM during caloric irrigation using transcranial magnetic stimulation (TMS). We wanted to examine the underlying mechanisms mediating vestibular modulation of cortico-spinal neck muscle excitability (Guzman-Lopez et al. 2011). Methods Experiments were conducted on two groups of healthy subjects (n=11 for TMS testing, n=10 for stretch reflex testing). Subjects were seated in a semi-reclined position with forehead head restraint and eyes open. Electromyographic (EMG) activity was recorded bilaterally from the sternal heads of SCM whilst maintaining low level isometric neck flexion (approximately 20% of maximum voluntary contraction). Experiment 1: TMS was applied to the SCM area of the right motor cortex before and during 40s cold caloric irrigation to the right ear (on confirmation of the induced nystagmus). After a 10 minute rest period, the process was repeated with stimuli delivered to the left motor cortex. Ten stimuli were given, one every 10s in each condition. Experiment 2: the left SCM tendon was tapped using a hand held mechanical device before and during 40s cold caloric irrigation to the right ear. Twenty five taps were applied, one every 5 seconds. EMG data were averaged (both unrectified and rectified) and amplitudes, areas and latencies of evoked responses were calculated. Results TMS Motor Evoked Potentials (MEPs) in the SCM opposite the irrigated ear were increased with respect to baseline (129.39±7.22%); this was significantly different (P<0.001) to the normalised MEP amplitude on the same side as the irrigated ear (103.87±10.36%). Tapping of the left SCM tendon evoked reflex EMG responses in the left SCM, the latencies of which were not different between the two conditions (tap only 32.00±9.00ms; tap%2Bcaloric 29.84±5.92ms; t=-1.05, P=0.32). The areas of the responses were also not different (tap only 0.15±0.11 %MVC; tap%2Bcaloric 0.16±0.11 %MVC; t=-0.06, P=0.95). Conclusion These data indicate that the caloric (vestibular) increase in the SCM MEPs is more likely to be due to cortical modulation rather than changes in local (spinal) excitability. Further clarification of the underlying mechanisms responsible for the alteration in excitability (using paired pulse TMS) is underway.

P3-W-135 To compensate or not to compensate: that is the question in vestibular failure

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BACKGROUND AND AIM: Acute unilateral vestibular loss leads to vertigo sensation, nystagmus and postural imbalance. As a rule, a behavioral recovery of the signs and symptoms follows over days to months due to central vestibular compensation (VC). The cerebral plasticity on which VC is based is a fragile process. The present study aimed to investigate the determining factors for impaired VC by following a large cohort of patients after vestibular neuritis. METHODS: 710 patients (mean age: 54.2±15.2, 53.4% men) with the clinical picture or history of vestibular neuritis, who were seen at the

Department of Neurology and the German Center for Vertigo and Balance Disorders over the last 10 years, were included in the study. All patients underwent a detailed neuro-ophthalmological and neurological examination, including measures of the subjective visual vertical (SVV), ocular torsion (OT), head impulse test (HIT), provocation nystagmus (PN), visual acuity and postural control. 375 patients were followed along their course of VC (mean number of visits 3.5±1.2, mean time of follow-up 217±625 days). In 235 patients a cranial MRI was available at onset of vestibular failure. The MRI was assessed by a senior neuro-radiologist. Extent of white matter lesions was classified by the ARWMC scale. Patients were indicated as poorly compensated, if deviation of SVV (>2.5°), PN and postural asymmetry persisted for longer than 3 months after vestibular failure. RESULTS: 13.3% of patients were classified as poorly compensated at 3 months (PN: 55%, SVV deviation: 36%, postural asymmetry: 22%), 12.8% at 6 months and 10.6% at 12 months after vestibular failure. These patients had a significantly higher age (mean: 59.8 vs. 52.3 years, $p<0.003$), poorer visual acuity ($p<0.002$), higher rate of polyneuropathy ($p<0.001$) and higher ARWMC scales as compared to patients with regular VC. There was a non-significant tendency of poorer compensation in women. In the entire group of patients mean time of SVV normalization almost doubled with every 20 years of aging. CONCLUSIONS: About 10% of patients have an impeded course of VC after vestibular failure. The most important risk factors are age, visual or somatosensory deficits and cerebral white matter lesions. On the basis of these data a risk score may be developed to predict the individual course of VC and define the necessity of intensified physical treatment and aftercare.

P3-W-136 Effect of postural control in frontal plane by virtual reality

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[Background and aim] Postural balance in healthy individuals involves sight, vestibular sensation, and somatosensory information. Modification of visual information is known to affect postural balance. We examined the effect of visual information on postural balance stability using virtual reality by Head Mount Display (HMD). [Methods] Subjects comprised 9 healthy adults (mean age 21.0 yrs male 6 female) with no history of orthopedic malady from whom informed written consent was obtained. We created images as though viewed from an upright posture (0°), and one tilted 60° to the right. Subjects were instructed to maintain a static upright posture while postural balance was measured by Gravicorder GS-31P stabilometer (Anima Co.) for 15-s, under two conditions of the HMD presented images. The data sampling frequency was 20Hz. To create the virtual reality, examiner tapped the subject' s back with a cane at a rate of 1Hz. Measurements were analyzed using Wilcoxon rank sum test, SPSS ver21. Differences with $P<.05$ were considered significant. [Results] When shown images 60° tilted to the right (X) and upright posture (Y) lateral postural sway trajectory length(LNG) was X

140.8(56.8)cm[mean(SD)], Y 156.4(45.8)cm; rectilinear area(REC.AREA) X 116.3(72.1)cm2,Y 235.9(92.0)cm2; LNG/time X 9.4(3.8)mm/sec, Y 10.4(3.0)mm/sec; maximum frontal amplitude X 8.2(4.2)mm, Y 12.9(3.7)mm; respectively ($p<0.05$). [Conclusion] Lateral postural instability increased when subjects mistook their stance as tilted rightwards. As stability was affected by postural change in the frontal plane not the sagittal plane, the instability was due to visual modification in the frontal plane. It is suggested that virtual reality may be a useful method to improve patients improve standing balance because vision had a great influence on postural stability.

P3-W-137 Long-term balance training with vibrotactile biofeedback: Two case reports

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BACKGROUND AND AIM: Evidence supports that vestibular physical therapy (VPT) is effective in improving functional outcomes for patients with vestibular loss. However, full recovery of function is often incomplete in persons with bilateral vestibular loss (BVL). Prior research has shown real-time improvements in balance performance when subjects with vestibular deficits used trunk-based vibrotactile biofeedback during quiet and perturbed stance. The goal of this research is to assess the persistence of balance improvement for persons with bilateral vestibular loss who participated in VPT with vibrotactile biofeedback. METHODS: Two subjects with BVL, who previously completed a course of standard VPT, participated in supervised VPT combined with vibrotactile biofeedback in an outpatient clinic setting. Kinematic and functional assessments were performed at baseline, midway through training, one week post training, and one month post training. During assessments, subjects performed two static standing exercises (feet apart with eyes closed on firm surface and feet together with eyes open on foam surface) and the computerized dynamic posturography Sensory Organization Test (SOT) while trunk sway data were recorded. Root-mean-square (RMS) trunk tilt, elliptical fits to the trunk sway trajectory and percentage time spent inside a no feedback zone were computed. Functional outcome measures included the functional reach test, mini-Best test, gait speed, and Functional Gait Assessment (FGA). Additionally, the Dizziness Handicap Inventory (DHI) self-report was recorded. Subjects performed various static and dynamic balance exercises with feedback for approximately 30 minutes, three times per week, for six weeks. RESULTS: Short-term significant improvements in kinematic metrics were observed for both subjects post training. Additionally, both subjects showed significant improvements in SOT composite scores (35 to 40, and 30 to 43, respectively) and functional reach scores (7.19 cm and 1.60 cm, respectively) one-week post training. Modest improvements in the mini-Best scores (6 and 1 point increase, respectively), FGA (2 and 1 point increase, respectively), and gait speed (0.06 and 0.15 m/s improvement, respectively) were also observed. The DHI score decreased 12 points for the first subject, but increased 12 points for the second subject. The first subject also mentioned a great improvement in her quality of life after completing the training program. After one month, both

subjects maintained or continued improvement in their balance performance based on five functional outcomes. CONCLUSIONS: Improvements in balance performance were observed after one week and one month for both subjects with chronic BVL following the six-week training session with trunk-based vibrotactile feedback. Future work will include comparable training without feedback to quantify the effects of VPT with and without feedback.

P3-W-138 The interplay of eye movements and gait in patients with downbeat nystagmus syndrome

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Background: Downbeat nystagmus (DBN) is the most common form of acquired fixation nystagmus. The key symptom is vertical oscillopsia caused by involuntary eye movements. The patients also complain of instability of gait; however, the characteristics of gait disturbance are largely unknown. Gait disturbance could be a result of impaired visual feedback due to the involuntary ocular oscillations. Alternatively, a malfunction of cerebellar locomotor control might be involved, since DBN is considered a vestibulocerebellar disorder. Methods: We simultaneously investigated gait performance and eye-head coordination of 18 patients with downbeat nystagmus syndrome (62.2±6.3 years, 6 females) and 17 healthy controls (HS, 61.0±5.7 years, 6 females) using a treadmill system (Zebris, hp cosmos®) and an eyetracking system (EyeSeeCam®). Gait tasks were walking with slow, preferred and maximal velocity walking. A mixed model with "subject group" and "walking speed" as factors was used for statistical decision. Results: The majority of temporal, spatial gait parameters and coefficients of variation differed between DBN patients and HS with significant model effects for "walking speed". Slow walking and preferred walking were the most powerful discriminators for the factor "subject group" (all $p<.01$). During gait, the gain of the vertical vestibulo-ocular reflex was significantly decreased in DBN compared to HS ($p<.05$) with significance for the cofactor "walking speed" ($p<0.01$). The slow-phase velocity of DBN was not speed-dependent. Conclusion: These results show that gait of patients with DBN is impaired due to a disturbed balance control. Gait parameters were predominantly impaired during slow and preferred walking mode indicating a disturbed central sensory integration process. The intensity of DBN does not depend on the current walking speed. However, the gain of the vertical VOR is decreased in a speed dependent manner. Thus, DBN can be considered as a vestibulocerebellar disorder with impairments of central vestibular motor processing. A direct relationship between the oculomotor deficiency and locomotor control due to a deficient vestibulocerebellar control is reasonable.