P1-A-1 Upright time and transitions long-term post-stroke

Mona Aaslund[1], Bård Bogen[1], Rolf Moe-Nilssen[1], Kristin Taraldsen[2]

[1]University of Bergen, [2]Norwegian University of Science and Technology

Background: Patients post-stroke often have sequelas that limit their ability to be physically active and to maintain their desired level of function, which may greatly impact on quality of life and well-being long-term after stroke. However, only limited information is available about physical activity, sedentary behaviour and function long-term after stroke. A project titled "Long-term Activity and Function after Stroke" started in 2013, where the aim was to gain more knowledge about physical activity, sedentary behaviour and function approximately 4 years after stroke and will still be on-going at the time of the ISPGR World Congress 2014. On this occasion we would like to present some aspects of the project in an early phase. Physical activity in terms of upright time and sit-to-stand transitions long-term post-stroke has to our knowledge not been investigated previously. Aim: To investigate upright time and transitions during 24-hours 4 years post-stroke and association with walking speed, grip strength, Short Physical Performance Battery and falls. Method: All 306 persons who approximately 4 years previously participated in a randomized controlled intervention study "Early Supported Discharge (ESD) after Stroke in Bergen" was considered for inclusion if still alive and if they had not dropped-out of the ESD study. The participants are assessed in their homes with questionnaires and tests investigating comorbidities, medication, cognition, stroke severity, handicap, physical capability, falls, activities of daily living, quality of life, fatigue, sleep and depression. They were also asked to wear activity monitors (ActivPAL3TM PAL technologies Ltd., Glasgow, Scotland) for 7 days. Results: At the end of October 2013, 23 persons on average 53 months post-stroke and with a mean age of 73 (±13) years (14 males and 9 females) have been included in the study. All persons except one lived at home. They spent 4.3 (±2.3) hours per day in an upright posture (standing and walking) and had 47 (±18) sit-to-stand transitions. They also had a 4-m walking speed of 0.76 (±0.38) m/s, an average score on the Short Physical Performance Battery of 7 (±4), 27 (±11) kg in hand grip strength and 7 persons had experienced falls during the last 6 months. Summary: At the ISPGR World Congress 2014 we expect to have data on approximately 60 participants, and we will focus the presentation on upright time and transitions during a 24-hour day and in particular association with other physical functioning test scores.

P1-A-2 New Smartphone system for personalized and at-home rehabilitation of people with Parkinson's disease: Preliminary Clinical Experience

Marina Brozgol[1], Moran Dorfman [1], Eran Gazit [1], Pablo Bezalel[1], Pieter Ginis[2], Alice Nieuwboer[2], Sinziana Mazilu[3], Alberto Ferrari[4], Laura Rocchi[4], Anat Mirelma[1], Jeffrey Hausdorff [1]

[1]Sourasky Medical Center, [2]Department of Rehabilitation Sciences, KU Leuven, [3]Wearable Systems Laboratory, Swiss Federal Institute of Technology, Zurich, [4]Department of Electronics, Computer Science, and Systems, University of Bologna

Background and aim: The use of technological aids to deliver exercise has been limited in patients with Parkinson's disease (PD), but its potential is acknowledged for promoting long-term adherence. Our aim was to develop and assess a new system for at-home rehabilitation designed to autonomously improve the gait pattern and to ameliorate freezing of gait (FOG) in those PD patients experiencing this symptom. Methods: The system consists of two wireless inertial measurement sensors and a Smartphone that is used as a wearable processing unit. In this system, two application modules were

used during the protocol in the lab and in the home environment. In the FOG module, the signals were analyzed in real-time to detect FOG during a set of scenarios with different types of FOG provoking circumstances. In the second module, Audio Bio-Feedback (ABF) was provided based on specific gait parameters that were extracted and processed in real-time to improve the gait pattern. The proof-of-concept protocol consisted of 3 training sessions during one week in the lab and in the patient's home. At the end of the last session, patients completed satisfaction questionnaires using a Likert scale, indicating 0 as unsatisfactory and 5 as highly satisfactory. Results: Five patients with PD participated (mean age: 75.6 +/- 4.7yrs; 3/5 males) in the first stage at the lab. During the first day of training, the system, operated by a clinician, correctly detected 99 out of 102 FOG episodes in real-time (97% sensitivity), with 59 false positives during 46 minutes of total exercise time. In addition, the ABF module, administered in 30 minutes sessions, successfully provided real time feedback regarding various gait parameters. In general, the patients reported that the system enhanced their confidence while walking and reduced their FOG duration. In the second stage that was conducted in the home of each subject, 9 patients participated (mean age: 68.3 yrs +/-10.7; 78% males) in a usability evaluation while operating the system independently. In general, subjects were satisfied with the system's performance and its clinical potential according to satisfaction questionnaire (ave. score 3.77 +/- 1.0 and 4.06 +/- 0.77 respectively). Specific events that caused false positive detection of FOG-episodes or incorrect feedback in ABF module were identified to allow for further improvement of the algorithms. Conclusion: This system allows patients to carry out exercises designed to reduce FOG episodes and to improve gait by receiving real-time feedback. The possibility of home-training in the patients home has the potential for improving compliance and, ultimately, efficacy and symptom relief. The initial findings are promising and serve as the basis for additional testing in an upcoming efficacy study. The research leading to these results was supported by the European Union--Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n. 288586 (CuPiD Project)

P1-A-3 Sensor-derived Physical Activity Parameters Predict Future Falls in Individuals with Dementia

Michael Schwenk[1], Klaus Hauer[2], Tania Zieschang[2], Jane Mohler[1], Bijan Najafi[1]

[1]University of Arizona, [2]Bethanien-Hospital at the University of Heidelberg

BACKGROUND AND AIM: There is an urgent need for simple clinical tools that can objectively assess fall risk in patients with dementia. Wearable sensors seem to have an enormous potential for fall prediction. However, there has been only limited work performed in this direction. The aim of this study was to explore the validity of sensor-derived physical activity (PA) parameters for predicting falls in patients with dementia. A second aim was to compare sensor-based fall risk assessment with established conventional fall risk measures. METHODS: This study included 77 persons (mean age: 82 years) with confirmed dementia. PA was quantified by a motion-sensor over 24-hours. PA parameters (percentage of walking, standing, sitting, lying; step number; duration of single walking and standing episodes) were extracted by specific algorithms. Conventional assessment included performance-based tests (Timed-Up-and-Go, Performance-Oriented-Mobility-Assessment, 5-chair-stand) and questionnaires (cognition, ADL-status, fear of falling, depression, previous falls). Falls were quantified prospectively by calendars during 3-month. Discriminative validity (fallers vs. non-fallers) of each measure was obtained by Mann-Whitney-U-test. Multivariate logistic regression was performed to investigate the independent effects of each variable in predicting fallers. Odd Ratios (OR), sensitivities and specificities were calculated for

variables shown to have an independent effect on predicting fallers. RESULTS: Twenty-nine (36.4%) patients had fallen during the three month follow up period. Surprisingly, fallers and non-fallers did not differ in any conventional assessment parameter (p=.221-.991), except for 'previous faller' (p= .006). Interestingly, several PA parameters (average duration of single walking and standing episodes, duration of longest walking episode, maximum continuous step number) were significantly different between groups (p=.008-.027). Two variables, 'average duration of single walking episodes' [OR 0.79; p=.012)] and 'previous faller' [OR 4.44; p=.007)] were identified as independent predictors for falls. Each second of shorter 'average duration of single walking episodes' was associated with a 21% increased chance of being a faller. The OR for an 'average duration of single walking episodes' of less than 12 seconds for predicting fallers was 3.24 (p=.030] and the sensitivity/specificity was 79/47%. The OR for the combination of previous falls and an 'average duration of single walking episodes' for predicting fallers was 6.03 (p≤.001) and the sensitivity/specificity was 78/61%. DISCUSSION: Results demonstrate for the first time that sensor-derived PA parameters are independent predictors of fall risk and may better predict falls compared to performance based tests. Our findings highlight the potential of telemonitoring technology for estimating fall risk in subjects with dementia. Results need to be confirmed in a larger study sample.

P1-A-4 Comparing Cognition and Sedentary Behavior in People with Parkinson Disease with Matched Healthy Adults

Chad Swank[1], Ann Medley[1], Mary Thompson[1], Elaine Trudelle-Jackson[1]

[1]Texas Woman's University

BACKGROUND AND AIM: Regular physical activity (PA) improves cardiopulmonary, musculoskeletal, and cognitive function in older adults. People with Parkinson disease (PwPD) demonstrate progressively deteriorating motor and cognitive function, particularly executive function, resulting in sedentary behavior. The aims of this study were to compare physical activity in PwPD and their peers and identify contributing factors to PA participation. METHODS: Thirty six individuals (18 with PD plus 18 age and gender matched healthy community dwelling adults) were recruited. Participants completed the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), Beck Depression Inventory-II (BDI-II), and Timed Up and Go (TUG) under single and dual task conditions (motor=TUGm; cognitive=TUGc) to evaluate cognitive status, followed by wearing a StepWatch? step activity monitor (SAM) for 3 consecutive days to determine PA level. Both volume (#steps/day) and intensity (peak activity index) of PA were used to ascertain sedentary behavior. We analyzed differences between groups with ANOVA and determined predictors of PA level with stepwise multiple linear regression. RESULTS: PwPD, duration 8.22±5.96 years, included 13 men and 5 women (mean age 67.78±7.24) and matched healthy community dwelling adults (mean age 67.83±7.72). Mean PA scores for PwPD were 3964.56±2061.78 (steps/day) and 35.69±10.53 (peak activity index). Mean PA scores for healthy adults were 4706.11±1637.20 (steps/day) and 43.47±9.87 (peak activity index). Differences between groups were observed in BDI-II (F=6.752, p=0.015) and peak activity level (F=5.217, p=0.029) with the PD group having a higher BDI-II score and lower peak activity. A trend was observed on the RBANS (F=3.696, p=0.067) for PwPD to score lower than their peers. For PwPD, PA level predictors for # steps/day was TUGc (R^2=0.522, F(1,16)=17.482) and for peak activity index, predictors were TUGc (R^2=0.670, F(1,16)=32.546) and Hoehn & Yahr stage (R^2=0.773, R^2 change=0.103, F(1,15)=6.793). For matched healthy community dwelling adults, no variables predicted # steps/day, though age (R^2=0.220,

F(1,16)=4.517) predicted peak activity index. CONCLUSIONS: Neither our participants with PD nor community dwelling controls met the minimum recommendations of 10,000 steps/day for PA. However, PwPD had greater depression, lower executive functioning and were less physically active than healthy peers. While advancing age influences PA in our healthy controls, for PwPD, progressing disease severity and executive function predicts PA. Specifically, the ability to ambulate with a cognitive distractor dual task was the largest predictor of PA (volume and intensity) in PwPD. Executive function, specifically divided attention, appears to play a role in the sedentary lifestyle of PwPD. If PwPD are to increase their level of PA and maximize associated benefits, cognitive dysfunction must be addressed.

P1-A-5 Daily physical activity after hip fracture

Kristin Taraldsen[1], Olav Sletvold[1], Pernille Thingstad[1], Ingvild Saltvedt[1], Malcolm Granat[2], Sebastien Chastin[3], Stian Lydersen[1], Jorunn Helbostad[1]

[1]Norwegian University of Science and Technology (NTNU), [2]University of Salford, [3]Glasgow Caledonian University

Background: Hip fracture patients are old and frail, and early mobilisation is important for regaining function. This study is a part of a randomized controlled trial, the Trondheim Hip Fracture Trial, where in-hospital assessment and treatment of hip fracture patients with comprehensive geriatric care (CGC) in a geriatric ward were compared to traditional orthopaedic care (OC) in an orthopaedic ward. The primary outcome was lower limb function measured 4 months after hip fracture by the Short Physical Performance Battery. In a recent publication on activity monitoring data 4 days following hip surgery, we demonstrated more upright time and number of upright events in patients treated with CGC in the geriatric ward compared to OC in the orthopaedic ward. The present study aims to assess the effect of the intervention 4 and 12 months after the hip surgery. Method: 397 older persons (70+) admitted to St.Olavs Hospital with a hip fracture, who were home dwelling and able to walk 10 m prior to hip fracture, were included. Single axis accelerometers from PAL Technologies were used to assess daily physical activity over 4 days, both 4 and 12 months after hip fracture surgery. Outcome measures included time spent in an upright posture (standing and walking) and number of sit-to-stand transitions. Participants with at least 24 hours of continuous activity monitoring data were included in the analyses. Outcomes will be compared between groups at 4 and 12 months using mixed model analysis. Results: Activity monitoring data from 283 patients (143/140: CGC/OC) 4 months after surgery and 250 patients (133/117: CGC/OC) 12 months after surgery are included in the analyses. Participants had a mean age of 83 years (SD6) and 74% were women. 60% had intracapsular fractures, and of them 65% were operated by use of arthroplasty. First results indicate that the total group spent 3.5 hours in an upright posture both 4 and 12 months after hip fracture. Conclusions: The group effects of the hospital treatment on daily physical activity 4 and 12 months after surgery will be presented.

P1-B-6 The impact of fear of falling on gait under cognitive dual-task.

Daniela Abreu[1], Paulo Santos[1], Paulo Roberto Santiago[2], Erika Tanaka[1]

[1]University of São Paulo, School of Medicine, Ribeirão Preto, SP, Brazil, [2]University of São Paulo, Ribeirão Preto, SP, Brazil

BACKGROUND AND AIM: Gait can be classified as a complex motor behavior that suffers adjustments through cognitive processes. During gait under dual-task conditions, changes are observed in the gait

pattern, being observed severe changes in elderly, due to the greater attention required by them during this task. Additionally, the fear of falling (FOF) in the elderly may interfere with intentional demand, which also impairs the gait under dual-task. However, few studies evaluated the relation between dual-task and FOF in the elderly. The aim of the study was to evaluate the influence of cognitive dual-task in elderly with fear of falling on gait pattern. METHODS: Twenty six community-dwelling elderly of both sexes participated in the study. All the participants signed an informed consent form and the study was previously approved by the local ethics committee. The Falls Efficacy Scale - International adapted to the Brazilian population (FES-I-Brazil) was used to assess FOF, followed by a gait analysis (gait speed and cadence variables) associated to cognitive dual-task, using 8 cameras Qualisys Pro-Reflex Oqus 300®. Two reflexive spherical markers (18mm) for each foot were placed 8 mm proximal to the metatarsal heads, between the 2nd and 3rd heads and the heels. The elderly were instructed to perform the gait associated with cognitive double-task, which consisted of saying the days of the week in reverse order, starting with Saturday. The participants started walking barefoot in a 6 m track. The initial 1.5 m and the final 1.5 m were disregarded to allow acceleration and deceleration. Each volunteer performed 3 trials for each task and the mean value was obtained. Analysis of variance (ANOVA) was used for statistical analysis, at significance level of 0.05. RESULTS: The FES-I detected 5 elderly with low FOF, 12 elderly with moderate FOF and 9 elderly with high FOF. No significant difference was observed for gait speed and cadence between elderly with low and moderate FOF ($p>0.05$), however there was difference for gait speed ($p=0.02$) and cadence ($p=0.03$) between the groups with moderate and high FOF. CONCLUSION: FOF can promote even greater changes on gait pattern during cognitive dual-task in older adults, which suggests the interference of psychological aspects in the intentional demand.

P1-B-7 Fractal analysis of the postural system in elderly subjects with dizziness due to vestibular disorder

Mitsuhiro Aoki[1], Keisuke Mizuta[1], Yatsuji Ito[1], Takashi Tokita[1], Bunya Kuze[1]

[1]Gifu University Graduate School of Medicine

Background: The subjective symptoms in the elderly with dizziness due to vestibular disorder are more severe or prolonged in comparison with younger patients and it is often difficult to manage their symptoms. A quantitative analysis of the dynamic characteristics of postural disorders may help to define the optimum management for elderly dizzy subjects. Methods: Patients aged ¡Ý 65 years (75.8 ¡À 4.3 years old, n = 22) and patients aged < 65 years (47.4 ¡À 10.9 years old, n = 22) with dizziness and disequilibrium due to vestibular disorder (Vestibular neuritis, Meniere's disease et al.) were instructed to stand on a force plate for 60 seconds. The detrended fluctuation analysis (DFA) was applied to the center of pressure (COP) position series in the medial-lateral (ML) direction and the anterior-posterior (AP) direction. Results: The scaling exponents (¦Á) by the DFA in the ML direction of the COP in the eyes closed condition were significantly lower than those in eyes open condition in both groups ($p < 0.05$). In the AP direction, the value of ¦Á in patients aged ¡Ý 65 years, which was significantly lower than that in patients aged < 65 year, was closed to 1, especially in eyes closed condition ($p < 0.05$). The value of ¦Á in the AP direction in the eyes closed condition was significantly correlated with the mean velocity of the COP by the traditional method ($r = 0.64$, $p < 0.01$). Conclusions: The postural control in the patients with vestibular disorder may characterized by a less complex and higher regularity in the ML direction under eyes closed. In addition, the elderly with dizziness due to vestibular disorder has much less complex and more regularity in the AP direction in comparison with younger patients. The characteristics in postural

system of the elderly may be associated with severity of the subjective symptoms and the difficulty of managing their symptoms.

P1-B-8 Modulations on spatial-temporal parameters of gait in the Parkinson disease individuals under muscle fatigue

Fabio Barbieri[1], Paulo Santos[1], Rodrigo Vitório[1], Lucas Simieli[1], Lilian Gobbi[1]

[1]UNESP - São Paulo State University at Rio Claro - Brazil

BACKGROUND AND AIM: The effects of muscle fatigue on walking are age-dependent. The adjustments in gait with fatigue are more pronounced in individuals over 50 years old than in younger individuals, which seek balance and safety to counteract adverse fatigue effects (Barbieri et al., Submitted). However, the effects of muscle fatigue on gait of elderly with Parkinson's disease (PD) are comparatively uncharted. PD individuals show higher fatigue symptoms than healthy individuals (Stevens-Lapsley et al., 2012; Garber & Friedman, 2003), which could increase the effects of muscle fatigue on walking. So, the aim of this study was to investigate the effects of muscle fatigue on spatial-temporal parameters of gait in the Parkinson's disease individuals. METHODS: Twenty PD individuals (H&Y: 1 to 3; UPDRS motor: 30.45±6.59 pts; age: 69.35±5.85 years) and twenty matched-healthy participants were instructed to walk over an 8m pathway, at his self-selected speeds. They performed 3 trials before and after muscle fatigue. To induce muscle fatigue, the participants performed the sit-to-stand task (Barbieri et al., 2013), at a frequency of 0.5Hz controlled by a metronome. An optical system (100 samples/s) was used to record spatial-temporal parameters (stride length, step width, stride duration, double support duration and stride velocity) of the central stride. Anova two-way (group x fatigue), with repeated measure for fatigue, was used to evaluate the effects of fatigue. RESULTS: Independently of muscle fatigue, PD individuals showed shorter stride length ($p<0.01$) and slower stride duration ($p<0.04$) in comparison to healthy individuals. Both groups increased stride length ($p<0.001$) and speed ($p<0.001$), and decreased stride duration ($p<0.002$) after muscles fatigue (Table 1). Moreover, healthy individuals increased step width ($p<0.03$) and decreased percentage of double support ($p<0.006$) after muscle fatigue, while PD individuals did not change these parameters after muscle fatigue. CONCLUSION: PD individuals and healthy individuals seek stability after quadriceps muscle fatigue. However, healthy individuals were more safety after muscle quadriceps due to larger basis of support (step width). References Barbieri, F.A. et al. Gait Post 2013; Submitted. Barbieri, F.A. et al. Gait Post 2013;38,702-707. Garber C.; Friedman J. Neurology 2003;60,1119-1124. Stevens-Lapsley, J. et al. Neurorehabilitation and Neural Repair 2012;26,533-541.

P1-B-9 Differences in Head and Body Stability between Old and Young Adults during Level Walking under Low Light

Gyerae Tack[1], Jinseung Choi[1], Dongwon Kang[1]

[1]Konkuk University

BACKGROUND AND AIM: In general, the physical and sensory ability of the old is deficient compared to those of the young. These declines can be led compensation strategies for improving body stability such as low walking speed and/or reduced range of motion of joints during locomotion. Low light, related to the intensity of illumination of the surroundings (i.e., insufficient visual information), increases the risk of falls by hindering discrimination of obstacles as well as by decreasing the stability of body control

[Brooke-Wavell, et al, 2002.]. However, most previous studies were focused more on changes of the body control strategy due to walking environments (i.e.: uneven walkway or stairs) than on those of low light. The purpose of this study was to identify the effect of only low light in young and old adults during even walking. METHODS: Fourteen old (age, 72.92 ± 5.78 years; height, 162.09 ± 5.30 cm; weight, 63.16 ± 7.22 kg) and fourteen young (22.1 ± 2.21 years, 174 ± 3.74 cm, 68.86 ± 10.81 kg) male subjects without problems in the lower extremities participated in this study. 3D motion analysis system was used to acquire trajectory of markers attached at top head and lumbar (L4-5). All experiments were performed on a 7 m level walkway with two conditions using self-selected walking speed: walking with normal light (>300 lux) and walking with low light (<10 lux, only with infrared light of motion capturing camera). Subjects were performed each 5 trials for two conditions. For a comparison of gait and body stability, the root mean square of an acceleration (RMSacc) of mediolateral (ML) and vertical (VER) direction at the center of mass (i.e., body stability) and head (i.e., head stability) were used. RMSacc, which is used to provide an indication of the average magnitude of accelerations in each direction during a complete walking trial, can represent body (i.e., acceleration RMS at COM) and head stability (i.e., acceleration RMS at head) [Menz, H.B., et al., 2003]. RESULTS: In young adults, there was no significant difference in RMSacc of all direction at COM and head between normal (ML:0.52±0.23m/s^2, VER:0.94±0.43m/s^2; ML:0.14±0.09m/s^2, VER:0.27±0.17m/s^2, respectively) and low light walking (ML: 0.50±0.29m/s^2, VER:0.87±0.51m/s^2; ML:0.14±0.08m/s^2, VER:0.24±0.13m/s^2, respectively). In contrast, RMSacc of all direction at COM and head between normal (ML: 0.43±0.3m/s^2, VER: 0.84±0.57m/s^2; ML:0.14±0.09m/s^2, VER:0.27±0.17m/s^2, respectively) and low light walking (ML: 1.09±0.46m/s^2, VER: 2.14±0.87m/s^2; ML:0.48±0.33m/s^2, VER:0.88±0.62m/s^2, respectively) in old adults were significantly increased (Fig. 1, Table 1). CONCLUSIONS: Despite even level walking under low light, we confirmed that there was a difference in gait stability between young and old adults. From these results, further study is necessary to identify the gait adaptation pattern under low light between ages by using various approaches.

P1-B-10 Comparison of the postural sway velocity of women of different ages

Elisa Libardi[1], Margarete Kochi[1], Roberta Brunelli[1], Jaqueline Porto[1], Carina Junqueira[1], Daniela Abreu[1]

[1]University of São Paulo

Background and aim: Balance or postural stability can be defined as the ability to control the center of mass relative to base support. However, there are changes in this stability according to different activities (Shumway-Cook and Woollacott, 2010). A previous study examined young (18-25 years), middle-aged (35-45 years) and late middle-aged (55-64 years) women using the Balance Master System to determine whether the increase of age influences the variables of balance and postural stability. As expected, the measures of balance were better for the youngest and lowest for the older group (Weirich et al., 2010). The objective of this study was to compare the postural sway velocity of women of slightly different decade-based age groups since there are few studies about this in the Brazilian context. Methods: Women were divided into three groups according to their age: group 1: between 40 and 49 years (n=7), group 2: between 50 and 59 years (n=11) and group 3: between 60 and 69 years (n=10). Postural sway velocity (°/s) was evaluated during four upright position situations: open and closed eyes on a stable and unstable surface (i.e. foam) using the Balance Master System® (Neu¬rocom Inc, Oregon, USA) equipment. During the balance test, women remained standing, barefoot, feet parallel and 10 cm distance between the medial edges of the calcaneous with 45 degrees of angulation in the platform and

with the upper limbs along the body. During the test with their eyes open, women remained staring at a target on the wall. Each situation lasted 10 seconds and was repeated three times, with the mean value being obtained. A Shapiro-Wilk's test was used to verify the normal distribution of the observed variables, an ANOVA test was used for normal data and a Kruskall Wallis test for nonparametric findings, with a 95% confidence interval and 5% significance. Results: The preliminary results show that there were no significant differences among groups, which can suggest that the influence of age may be less important in comparison to physiological age when considering independent women up to 69 years. However, the number of people in the study will need to be increased in order to confirm these results. Conclusions: With the increase of age, although body changes become more evident, the postural sway velocity was similar among all of the evaluated age groups.

P1-B-11 The Effects of Advancing Age on Adaptive Gait: A Comparison of Adults Aged 20-25 years, 65-79 years, and 80-91 years

Brittney Muir[1], Shirley Rietdyk[1], Jeffrey Haddad[1], Michel Heijnen[1]

[1]Purdue University

BACKGROUND AND AIM: The ability to safely move through challenging environments is an important factor in maintaining mobility in older adults. Given that fall rate increases after the age of 80, it may be important to examine two groups of older adults one 65-79 and one 80+ years. By separating older adults into two age groups we can determine if gait adaptations and strategies change with advancing age. Therefore, the purpose of this study is to determine if new behaviors emerge or if existing behaviors become more prevalent with advancing age during obstacle negotiation. METHODS: Three age groups were examined: 20-25yo (N=19), 65-79yo (N=11), and 80-91yo (N=18). Participants walked along a 3.2 m walkway and stepped over a stationary, visible obstacle placed at 1.5 m. Six trials of each obstacle height (1, 10 and 20 cm) were observed. RESULTS: Nineteen obstacle contacts were observed in 840 trials (2.1%), with each age group demonstrating similar percent contacts. In 20-25yo, 100% of contacts were with the trail limb, but in the two older groups 66% of contacts were with the lead limb. However, no change in either lead or trail foot clearance was observed with age. Thus, foot clearance on successful trials may not be indicative of trip risk. Consistent with previous literature, gait speed progressively decreased across all groups ($p<0.01$) and step length was shorter in the two older groups compared to the 20-25yo. These changes are consistent with a strategy to increase stability. However, higher step width variability observed in 80-90yo may be indicative of increased likelihood of a fall. Trail HTD (the distance between the obstacle and the trail toe before crossing) was similar across all groups ($p=0.33$). This invariance across age may indicate that trail HTD is an important control variable in successful negotiation of obstacles. However, lead HHD (the distance between the obstacle and the lead heel after crossing) progressively decreased with advancing age ($p<0.01$). This may place older adults at increased risk of obstacle contact with the lead limb. This is consistent with the increased lead limb contact rates of older adults from this study. Contacts with the lead limb are more destabilizing than trail limb contacts; however, with advancing age, older adults were more likely to clear the obstacle with the heel closer to the obstacle than the toe. Thus, if a heel contact occurred, the foot is less likely to be arrested; rather, it would 'skim' over the obstacle, and could be placed appropriately to establish a new base of support. CONCLUSION: No change in trip rate with age was observed, but progressive changes such as decreased lead HHD put older adults at higher risk of falls or trip related injury. New behaviors such as increased step width variability may also put 80-91yo at increased risk of falling.

P1-B-12 ASSESSING MOTOR PERFORMANCE BY MEANS OF WEARABLE INERTIAL SENSORS

Erika Nerozzi[1], Maurizio Maria Monaco[1], Claudio Tentoni[1]

[1]School of Biotechnology, Pharmacy and Motor Sciences University of Bologna

BACKGROUND AND AIM: The ability to walk, to climb stairs, and perform postural transfers, is essential for daily living activities. This study investigates differences in motor performance between groups of elderly and young subjects when performing functional tests in a public place. A wearable inertial sensor connected to a smartphone has been used for assessing subjects' motor performance. METHODS: 46 Elderly Subjects [ES; 42 females (ESv 14 HV grade 2-3 Manchester scale); age: 70±9] and 12 Young Subjects [YS; 4 females; age: 29±4] have been recruited for this study. A smartphone (Motorola RAZR XT910) was connected via Bluetooth to a wearable inertial unit (pERhl) embedding triaxial accelerometer, gyroscope, and magnetometer. The sensing unit was worn on the lower back (L3) by means of an elastic belt. An application (uPerhl) was used to start/stop the recording and to insert temporal markers. Subjects were asked to perform three repetitions of four functional tests: Quiet Standing (QS), Timed Up and Go (TUG), 10 Meters Walking (10MW), and Stair Climbing (SC). A set of parameters have been extracted from the measured signals. ANOVA was used to identify differences between groups. RESULTS: QS: ES show higher sway velocity, higher sway path, and higher sway area in both Anterior-Posterior (AP) and Medio-Lateral (ML) direction with respect to YS. TUG: the total duration of the test is lower in YS compared with ES, gait speed and turning duration are also lower in ES. 10MW: Mean Cadence, initial contact of one foot to the initial contact of the contralateral foot, does not differ significantly between US and ES. AP and ML step regularity (Ad1 AP and Ad1 ML) are significantly lower in ES. SC: ES significantly reduce their cadence both ascending and descending stairs with respect to YS. In both groups, MC measured during SC is significantly correlated with MC measured during 10MW: the association is stronger for YS (R = 0.76 ascending, descending R = 0.73) compared to the ES (R = 0.36 ascending, R = 0.46 descending). ESv subjects during SC ascending have reduced AP and ML step regularity respect ES and YS, gait speed is also lower in ESv with high severity (R =0.33) CONCLUSIONS: ES significantly lower their cadence in CS with respect to 10MW, slower stepping can be associated with motor difficulties, age-related biomechanical changes, and loss of confidence. NJS AP and ML measured during 10MW are not correlated with their values measured during SC in both YS and ES but the significantly higher values of ES when ascending/descending stairs can be associated with a worsened motor control, also confirmed by the lower values of step regularity in10MW, SC, TUG, QS. ESv subjects also showed specific characteristics that should be considered. Results are coherent with the expected and observed motor performance and parameters are sensitive to age-related motor changes. Acknowledgements: Regione E. Romagna,DGRn.1631/2009"pERsonal health lab",U.I.S.P Bologna

P1-B-13 Attuning one's steps to visual cues reduces comfortable walking speed in both young and elderly adults

C. (Lieke) E. Peper[1], Miek de Dreu[1], Melvyn Roerdink[1]

[1]VU University Amsterdam

BACKGROUND AND AIM: Comfortable walking speed has been shown to be associated with clinically relevant factors, such as fall risk and survival in elderly. However, walking is a context-dependent

activity. Whereas standard tests involve walking on a straight, uncluttered surface, in real life secure foot placement requires visually guided adaptations in order to avoid trips or slips. Attuning one's steps to visually presented stepping stones has been demonstrated to increase both the energy expenditure and the attentional demands of walking. In this experiment we examined how visually guided walking affects preferred gait speed in young and elderly adults. METHODS: Young (n=18) and elderly (n=18) adults indicated their preferred walking speed while walking on a treadmill (C-Mill, ForceLink, Culemborg, The Netherlands). Four conditions were examined: (i) uncued walking, and cued walking with visual stepping stones involving (ii) 0%, (iii) 20%, or (iv) 40% of variation in the inter-stepping-stone distance. For each condition, belt speed was gradually increased from a lower than preferred speed until the participant indicated that the preferred speed was reached. Next, belt speed was gradually decreased from a considerable higher than preferred speed, until again the participant indicated to have reached the preferred speed. The average of these two indications was used as the individual's comfortable walking speed (CWS) for the corresponding condition. During this assessment, the average inter-stepping-stone distance was carefully adjusted for each level of belt speed based on the relation between walking speed and preferred step length as determined in pre-experimental measurements for each individual. RESULTS: On average, CWS was -surprisingly- higher for elderly than for young participants. Both groups demonstrated a significantly lower CWS when stepping stones were present. The amount of variation in the inter-stepping-stone distance did not affect CWS. There was no interaction effect. CONCLUSIONS: Attuning one's steps to visual stepping stones significantly affected the preferred walking speed, even when the patterning of the stepping stones resembled the preferred gait pattern. This effect was more pronounced than a potential influence of variability in the stepping stones pattern. The reduction of preferred speed may be an adaptation to reduce energy expenditure and attentional demands. Given the dominant role of visual guidance in gait control, our results indicate that in clinical assessments it may be advisable to consider walking speed not only under standard conditions, but also in situations that require visual attunement of one's steps. It is then important to quantify the quality of visually guided stepping in addition to gait speed, because (i) elderly may show higher gait speeds in order to camouflage reductions in gait adaptability and (ii) our unexpected observation that CWS was higher for elderly than for young adults.

P1-C-14 The influence of a damper system on the energy expenditure of forearm crutch gait

Megan MacGillivray[1], Bonita Sawatzky[1]

[1]University of British Columbia

BACKGROUND AND AIM: Forearm crutches have evolved minimally compared to other assistive mobility devices. A novel crutch design was developed utilizing a polymer damper system to help absorb joint impact. Previous research found that the damper system decreased braking impulse and peak braking force while increasing the propulsive impulse and peak propulsive force. Although kinetic advantages were observed, it is unknown how these kinetic changes influence energy expenditure related to crutch gait. METHODS: Sixteen able-bodied participants were taught how to perform unilateral partial weight bearing gait. They were instructed to apply 25% of their body weight to their non-dominant foot while using a generic aluminum crutch (Gen) and two models of ergonomic SideStix? crutches (one with a damper (DampErgo) and the other without (Ergo)). Participants returned one-week later to complete the metabolic testing and were given twenty minutes to re-familiarize themselves with the type of gait and walking on the treadmill. Once participants were comfortable, we conducted 6-min of 'normal' gait

to reach steady state followed by a 10-min rest period. Once participants returned to resting state, they completed the three crutch trials in a randomized order. Participants were provided sufficient rest between trials to reduce fatigue. Upon completion of the metabolic portion of the study, participants filled out a questionnaire about their impression of the different models of crutches related to comfort, weight of the crutch, ease of use, and overall impression. Repeated measures ANOVA was used to evaluate energy expenditure data and the Friedman test was used to evaluate differences in Likert scores (1=strongly disliked, 5=strongly liked) between crutches. RESULTS: No significant differences were observed between crutch type for the rate of O2 consumption (ml/kg/min) (Gen=13.9(mean)(2.1(sd)), DampErgo=14.2(2.7), Ergo=14.0(2.3), p=0.5), the measure of gait efficiency (O2 cost of crutch/O2 cost of 'normal' gait) (Gen=1.4(0.2), DampErgo=1.4(0.2), Ergo=1.4(0.2), p=0.6), or the rate of energy expenditure (kJ/min) (Gen=20.3(5.9), DampErgo=20.6(6.1), Ergo=20.4(5.7), p=0.7). Participants rated the DampErgo and Ergo higher on the Likert scale than the Gen for comfort (4.0 vs. 4.0 vs. 2.7) ($p<0.005$), weight (4.3 vs. 4.1 vs. 3.2) ($p<0.005$), and overall impression of crutch (4.1 vs. 4.1 vs. 2.9) ($p<0.005$). There was no significant difference in ratings of 'ease of use' for DampErgo, Ergo and Gen respectively (4.1 vs. 4.0 vs. 3.4) (p=0.1). CONCLUSIONS: Despite the potential benefits of the damper system on decreasing peak force and braking impulse, there appears to be no significant difference in energy used for level treadmill walking. As was expected, the novel ergonomic design of the SideStix? crutches were preferred based on comfort, weight, and overall impression of the crutch.

P1-C-15 Determinants of Usability During Rollator-Assisted Ambulation on Ramps in Adults with Multiple Sclerosis

Ivan Solano[1], William Gage[2], Karl Zabjek[3], George Mochizuki[1], William McIlroy[4]

[1]University of Toronto, [2]Toronto Rehabilitation Institute; School of Kinesiology and Health Science, York University, [3]Toronto Rehabilitation Institute; Graduate Department of Rehabilitation Science, University of Toron, [4]Toronto Rehabilitation Institute;

BACKGROUND AND AIM: Rollators are commonly prescribed for persons with multiple sclerosis (MS). There is, however, limited research on the upper extremity's role during rollator-assisted ambulation and on the users' experience on the use of the rollator on common environmental challenges such as the ramp. This study aims to provide a better understanding of the relationship of the person, specifically on usability and perceived effort, with the ramp characteristics and the rollator; and the role of the upper extremity in maintaining balance and mobility. METHODS: Using an instrumented walker (iWalker), ten MS subjects were asked to walk up and down outdoor ramps of varying inclinations along a designated course. Effort, balance control, demand, and fall risk were measured using electromyography. Subjective perception of effort was evaluated using Borg's Rate of Perceived Exertion. Ramp usability was assessed using Usability Rating Scale. RESULTS: Initial findings indicate a trend showing that descending the ramp was perceived as being more challenging in terms of control and balance compared to ascending the ramp. In contrast, early results show that ascending the ramp required more physical effort compared than ramp descent. EMG findings revealed a trend indicating considerable use of UE musculature, which may be a response to control their balance and regain stability while the trunk and the legs continuously moves forward. CONCLUSIONS: Preliminary findings reveal complexity of person-environment transactions. Initial results suggest that ramps on descent may have less usability than ascent which may indicate that descent is more challenging in terms of control and balance compared to ascent that can potentially pose a risk for falls if MS clients fail to control the

rollator. In contrast, ascent was reported as requiring more physical effort compared to descending the ramp. Results also suggest that accessibility standards, particularly for ramps, may need to be reviewed in terms of usability. Recommend looking into elderly population and use of additional outcome measures to measure usability of ramps.

P1-D-16 Forward Head Posture in Older Subjects is Associated with Executive Deficits

Rajal Cohen[1], Britany Smith[1], Nicole Sanders[1], Kaci Johnson[2], Anita Vasavada[2], Maureen Schmitter-Edgecombe[2]

[1]University of Idaho, [2]Washington State University

BACKGROUND AND AIM: Older people have a tendency to carry their heads forward of their torsos. This forward head posture (FHP) has been associated with multiple health problems, including neck pain, carpal tunnel syndrome, headaches, and a drastic reduction of lung capacity. In addition, forward-stooped posture has been associated with increased fall risk and mortality for older adults, and stooping has been shown to reduce postural stability in healthy subjects. Thus, explorations of the causes of stooped posture and FHP are merited. Cognitive factors, especially executive function (EF), have been associated with postural control, both in healthy older subjects and in subjects with Parkinson's disease. However, the possible associations between cognition and postural alignment have not yet been explored. The aim of this study was to investigate the possible relationship between FHP and specific aspects of cognition in older adults. METHODS: Fifty three neurologically healthy older adults (aged 50-86, median 67) completed a battery of cognitive tasks. FHP was defined based on neck angles (C7-tragus) measured from horizontal with an inclinometer during normal stance. Two cognitive tasks were selected to represent each of three EF categories: inhibition, switching, and working memory. Inhibition tasks were the FAS (verbal fluency) and Stroop tests, switching tasks were Trails B-A and category switching, and working memory tasks were backward digit span and backward spatial span. Non-EF memory tasks included list memory, prose recall, prospective memory, facial recognition, and spatial span. Correlations were computed between performance on these tasks and measured tragus angle. Age-corrected correlations were also computed. RESULTS : Neck angles averaged 37 degrees, which is about 13 degrees less than what is typically seen in healthy young adults. FHP was significantly correlated with age and with two types of EF: inhibition and switching. Performance on verbal fluency, Stroop, and category switching tasks remained significantly correlated with FHP after correcting for age. Of the memory tasks, only the word list acquisition and the delayed recall of the word list were significantly correlated with FHP, and none of the memory tasks correlated with FHP after accounting for age. CONCLUSIONS: These results suggest that FHP in older adults may be associated with deficits in EF. List learning, the only aspect of memory that correlated with FHP, was recently shown to be related to EF in subjects with Parkinson's disease. These results provide an intriguing link between postural alignment and EF in healthy older adults, and they are consistent with recent findings that inhibition and task switching are associated with deficits in postural control in Parkinson's disease. Further studies will examine the influence of cognitive load on postural alignment and will explore the possible causal relationship between postural alignment and postural control.

P1-D-17 Effect of dual-task on sitting postural control among individuals with a spinal cord injury

Murielle Grangeon[1], Audrey Roy[2], Sylvie Nadeau[1], Cyril Duclos[1], Dany Gagnon[1]

[1]Université de Montréal, [2]Rehabilitation Institute Gingras-Lindsay

Background/Aim: Identifying whether individuals with a spinal cord injury (SCI) have impairments in their ability to divide their attentional resources between cognitive and postural tasks might have significant clinical implications in terms of postural assessment and training design. However, such studies among individuals with SCI are rather limited. Thus, the present study aimed to investigate the effects of dual-task (DT) on sitting stability among individuals with SCI compared to healthy controls. Methods: Eleven individuals with complete or incomplete SCI (American Impairment Scale: A-D) affecting various spinal cord neurological levels (C6-L1) and 14 healthy controls maintained sitting position for 60 seconds, eyes closed in two conditions of difficulty: 1) with both hands on thighs (supported sitting), and 2) with both shoulders flexed at 70° and abducted at 45° (unsupported sitting). A mental 6-digit rehearsal task was performed in one of the two recorded trials in each condition. Displacements and frequency variables were computed from centre-of-pressure (CoP) measurements made by force plates placed underneath the buttocks and feet. Non-parametric Wilcoxon signed-rank tests were applied to compare each sitting condition under single and dual task conditions in each group. Results: Under single task condition, mean CoP velocity increased during unsupported sitting compared to supported sitting condition in both groups ($p<0.01$), as did the mean CoP distance in individuals with SCI ($p<0.05$). During unsupported sitting, mean CoP velocity was lower in dual than in single task condition for both groups ($p<0.05$), as was the mean CoP distance in the healthy controls ($p<0.01$). During supported sitting, no change occurred under DT compared to single task condition in individuals with SCI, but mean CoP velocity was reduced in the healthy controls ($p<0.05$). Additionally, no difference in the cognitive performance was found during DTs between both groups ($p>0.10$). Conclusions: The present findings revealed an increase in the performance of postural control, i.e. lower CoP velocity, in the task with a higher difficulty (unsupported task) during DT conditions in individuals with and without SCI. Postural control also improved in the healthy group under DT condition in the task with lower difficulty, confirming the effect of a simple cognitive task on postural control. That no effect of DT condition was observed in the lower difficulty task in participants with SCI suggests that the attentional resources required for the cognitive task might interfere with processing of the proprioceptive information provided by hand support. Such interference has already been observed in older adults with proprioceptive deficits. These preliminary results support further paradigms manipulating both cognitive and postural constraints to quantify the DT demands limits in individuals with SCI.

P1-D-18 The effects of height-induced postural threat on lower-limb cutaneous reflexes.

Brian Horslen[1], Jean-Sébastien Blouin[1], J Timothy Inglis[1], Mark Carpenter[1]

[1]The University of British Columbia

BACKGROUND AND AIM: There is now considerable evidence to suggest that sensory systems involved in balance control can be affected by a height-induced postural threat. Tendon stretch reflexes [1-2] and vestibule-motor responses [3] are facilitated with threat; generally suggesting higher gain of these distinct reflex pathways. Cutaneous reflexes are also known to be subject to state-dependent modulation; lower-limb reflexes to sural and/or tibial nerve stimulation are known to be altered when people stand on unstable surfaces [4] or during walking while threatened with a perturbation to balance

[5]. Therefore, the purpose of this study was to determine if cutaneous reflexes are altered when standing with a height-induced postural threat. METHODS: Eight subjects (3 female; 27.6 ± 2.0 years) stood still on a hydraulic lift positioned at LOW (0.8m, away from the edge) and HIGH (3.2m, at the edge) heights to manipulate postural threat. Reflexes were evoked with trains of 5 electrical pulses (200Hz, 2x radiating threshold, 30 trains/condition) to the sural nerve at the lateral maleolus. Reflexes were recorded from soleus (SOL), medial gastrocnemius (MG), tibialis anterior (TA), vastus lateralis (VL), and biceps femoris (BF) of the stimulated leg; and SOL and TA from the contralateral leg. EMG was sampled at 1000Hz, rectified, and trigger averaged to the onset of the trains in each condition. Reflex amplitudes were calculated as the area of the average trace 50-125ms after onset, and baseline corrected to a 75ms period of background EMG. The shape of the reflexes differed by subject and muscle; in the event of inhibition (negative area) in both LOW and HIGH, an absolute value was calculated to reflect the magnitude of inhibition. RESULTS: Cutaneous reflexes were observed in all subjects, although not all subjects had reflexes in all muscles examined. Reflexes were most prominent in MG, VL, and BF. Reflex amplitudes were generally unaffected by threat in the lower leg muscles, but larger in VL and BF. There was a trend to larger BF reflexes ($p=0.081$) in the HIGH compared to LOW condition, while background EMG was unchanged ($p=0.48$). There was a significant increase in the amplitude of VL reflexes at height ($p=0.013$), however there was also an increase in background VL EMG ($p=0.014$). CONCLUSIONS: These preliminary data suggest that cutaneous reflexes to mild electrical stimulation are amplified when people stand at height. In gait, these cutaneous reflexes are thought to stabilize the body to uneven surfaces or clear obstacles [6]. When standing still, larger reflexes may serve to promote stabilizing responses, or to facilitate or inhibit other balance relevant reflexes. REFERENCES: [1] Davis et al. J Neurophysiol 2011; [2] Horslen et al. J Neurophysiol 2013; [3] Horslen et al. ISPGR World Congress 2012; [4] Burke et al. J Physiol 1991; [5] Haridas et al. Brain Res 2005; [6] Zehr et al. J Physiol 1998 ACKNOWLEGEDMENTS: This work was funded by NSERC.

P1-D-19 Effects of transcranial direct current stimulation (tDCS) to left dorsolateral prefrontal cortex (DLPFC) on working memory and level walking in young adults

On-Yee Amy Lo[1], Sandra Liu[2], Li-Shan Chou[1]

[1]University of Oregon, [2]South Eugene High School

BACKGROUND AND AIM:The role of dorsolateral prefrontal cortex (DLPFC) in dual-task gait remains unclear partially due to the lack of an on-line brain imaging tool during walking. Transcranial direct current stimulation (tDCS) modulates the excitability of cortical membrane and its aftereffects allow the examination of cortical contribution to gait. We aim to 1) investigate the cognitive and gait performances while individuals concurrently perform a working memory task (N-Back) during walking; and 2) examine the aftereffects of the tDCS on DLPFC. METHODS: Eight young healthy subjects performed 2-, 3- and 4-back tasks in sitting and walking before and after a 20-min tDCS. Each subject visited twice for anodal and sham stimulations. Dependent variables were the error percentage (%Error), verbal reaction time (VRT), gait velocity and the changes in aforementioned parameters between pre and post tDCS. RESULTS: The 2-back was significantly easier than 3- or 4-back in both sitting and standing while the 3- and 4-back were not significantly different from each other. After anodal tDCS, %Error and VRT tended to improve in sitting and walking, but gait velocity stayed the same. Furthermore, the improvement was most noticeable in the 4-back task during sitting and the 3-back during walking. Although the tDCS-induced effects were not statistically significant yet, no trends were

observed in the sham tDCS condition. CONCLUSIONS: The aftereffects of the anodal tDCS over left DLPFC potentially enhanced working memory in sitting and walking. The degree of enhancement could depend on the level of working memory load and variability among subjects.

P1-D-20 Effects of mild cognitive impairments on multi-tasking during stair descent in community dwelling older people

Bradford McFadyen[1], Sophie Blanchet[2], Costis Maganaris[3], Bill Baltzopoulos[1]

[1]Laval University, [2]CIRRIS, [3]Liverpool John Moores University

Background and aim: Descending stairs is a leading cause of falls and trauma in older adults and our work has shown that the transition to descent requires attention. Mild cognitive impairments (MCI) affect about 17% of older Canadian adults and are known to affect level gait and visual attention. However, nothing is known about the ability of persons with MCI to descend stairs. The present aim was to study the ability of community dwelling older adults with MCI to descend stairs with and without divided visual attention as compared to older adults without MCI. Methods: To date, 7 older adults (72.1 ± 7.2 yrs) with MCI based on cognitive tests and medical diagnoses were compared to 24 older adults (control group; 71.6 ± 11.8 yrs) with no MCI (also based on the same cognitive tests). All subjects were tested for basic physical capacity (gait speed, balance, falls efficacy) and neuropsychological function (attention and executive functioning). In a separate visit, subjects were required to descend a 5 step staircase under 4 randomized conditions including no simultaneous visual stimulus, and a simultaneous visual Stroop task (presented on screens at the bottom of the staircase) during : approach; preparation for descent (transition); and contact on the second step down (steady state). Using motion analyses (Optotrak) and voice recordings, dependent variables reported here are forward trunk velocity, minimum foot sole clearance over step edges, and Dual Task Cost (DTC) as the difference between response times to visual Stroop during stair descent and at baseline when sitting. Repeated measures ANOVAs were used, 3-way (Stroop tasks x steps x groups) for the 2 steps of transition and of steady-state respectively, and 2-way (Stroop tasks x groups) for the second step of approach. Group comparisons for clinical tests involved independent T-tests. Results: The MCI group differed clinically than the control group for visuo-spatial attention, memory and multi-tasking abilities, as well as for falls efficacy and balance, but not for activity scores. Even though the MCI group took more time to respond to the Stroop task when sitting, there were no group differences in dual-task costs during stair descent, although MCI subjects were more variable. There were no group effects for any spatio-temporal variables, but there were Stroop by group interactions at transition for speed (MCI group sped up for dual tasking) and clearance (MCI group had lower clearances for single task on the first transition step raising it during dual tasking while the control group slightly decreased clearance for dual tasking). Conclusions: Preliminary findings suggest only subtle effects from visual interference (with no demands on working memory) during stair descent for fit, community dwelling older adults with MCI, particularly at the transition phase to stair descent which is riskier. The testing of more subjects with MCI and further analyses related to postural control continue.

P1-D-21 Balance ability in older adults with and without mild cognitive impairment

James Moore[1], Neva Kirk-Sanchez[1], David Mandel[1]

[1]University of Miami

BACKGROUND AND AIM: Recent evidence suggests a relationship between balance and mild cognitive impairment (MCI) in aging adults. Comprehensive evaluations of both balance and cognitive status are required to identify specific impairments and individualize treatment to improve balance and reduce fall risk. The purpose of this study was to compare balance in older adults with MCI and those with no cognitive impairment (NCI) using the Balance Evaluation System Test (BESTest), the Sensory Organization Test (SOT)), and the 10 meter walk test (10MW). METHODS: Thirty-nine community-dwelling older adults participated in the study: mean age of 74.8 ± 8.05 years, 15.1 ± 3.5 years of education, 72% female, and 51% Hispanic. Each subject completed a battery of balance tests (BESTest, SOT,10MW) and the Montreal Cognitive Assessment (MOCA) on the same day. Subjects with MOCA <26 were categorized as MCI, and those with a MOCA ≥26 were categorized as NCI. T-tests were used to determine differences between scores for subjects with MCI and NCI. Regression analysis was used to determine the percent of variance for walking speed and physical performance explained by age and cognitive status. RESULTS: NCI and MCI subjects were not different in age and education level. NCI subjects had better scores than MCI subjects in the total BESTest (83 vs 77, p=0.04), and in the stability limits/verticality (87 vs 78, p=0.05), anticipatory postural responses (78 vs 69, p=0.02), sensory orientation (95 vs 86, p=0.02), and gait stability (87 vs 77, p=0.02) sections. NCI subjects performed better than MCI subjects for specific BESTest items: inches forward lean (12.5 vs 9.7, p=0.003), seconds to complete 8 alternating steps (7.7 vs 9.6, p=0.02), seconds to complete dual task Timed Up and Go (TUGdual) (10.4 vs 13.6, p=0.02). There was no difference between the two groups in Timed up and Go and timed gait over an obstacle. NCI subjects took less time than MCI subjects to complete a 10MW test at normal speed (4.8 vs 5.9, p=0.001) and fast speed (3.4 vs 4.4 seconds, p<0.001). NCI subjects performed better on Condition 2 of the SOT (eyes closed, firm surface) (92 vs 90, p=0.02), but there was no difference between the two groups in other conditions of the SOT. Age and MCI status predicted 32% of the variance in normal 10MW, 34% of the variance in fast 10MW, and 53% of the variance in TUGdual. CONCLUSIONS: In general, subjects with NCI scored higher on most balance and physical performance test tests administered. In addition, individuals with MCI had slower normal and fast walking speeds. Individuals with MCI appear to rely less heavily on somatosensory input (condition 2 of SOT) than do those with NCI. Physical therapists should conduct a comprehensive balance assessment to be better prepared to provide an individualized treatment program. They must also be aware that individuals with MCI perform differently than those with NCI, and may have an increased risk of falli

P1-D-22 Cognitive task performed during upright stance improves postural control in older adults

Natalie Richer[1], Nadia Polskaia[1], Yves Lajoie[1]

[1]University of Ottawa

BACKGROUND AND AIM: Studies suggest that using a more automatic type of postural control, promoted by an external focus of attention (focusing on movement effects), is beneficial for stability in young adults as opposed to consciously controlling posture [e.g.1]. Few studies have examined the effect of varying attentional focus in older adults [2,3]. Due to the increased attention required for postural control in this population [4], it is unsure whether older adults would demonstrate benefits of removing attention from their posture. According to the "posture first" principle, older adults prioritize stability at the expense of cognitive performance in a dual-task scenario [5]. Furthermore, due to the fear of falling which can be experienced in this population [6], they might fail to properly allocate

attention away from postural control. Therefore, the aim of this study was to confirm the effect of attentional focus in older adults. METHODS: Sixteen healthy older adults between the ages of 64 and 81 were recruited. The postural task consisted of standing as still as possible on a force platform while focusing on one of 3 conditions: an internal focus condition (focus on reducing movement of the hips), an external focus condition (focus on reducing movement of markers placed on the hips), and a cognitive task (counting the occurrence of a specific randomized digit in a sequence of 3 digit numbers). Six 60-sec trials of each condition were performed. One-way ANOVAs with repeated measures on Condition (internal, external, and cognitive) were performed for postural measures and LSD post hoc tests were used to determine the location of significant differences. RESULTS: Results demonstrated that the cognitive task promoted the most stable posture, as it was associated with lower sway area ($p<0.01$) and lower variability in the x and y axes ($ps<0.01$) than the internal and external foci of attention. CONCLUSIONS: The cognitive task promoted a more stable stance than the internal and external foci of attention. This improved stability was observed when participants were prevented from focusing on movement production, allowing the use of a more automatic type of posture [1]. Contrary to our hypothesis and to previous findings [2,3], there was no significant difference in postural measures between an internal and external focus. Despite the increased attention required for regulating posture in older adults [4], results suggest that they are able to allocate their attention to a secondary task unrelated to postural control, therefore promoting the use of more automatic motor processes. [1] Wulf et al (2001) Q J Exp Psychol, 54A, 1143-54 [2] McNevin et al (2013) Res Q Exerc Sport, 84, 96-103 [3] Huxhold et al (2006) Brain Res Bull, 69, 294-305 [4] Lajoie et al (1996) Exp Aging Res, 22, 185-98 [5] Lacour et al (2008) Clin Neurophysiol, 38. 411-21. [6] Adkin et al (2000) Gait Posture, 12, 87-93

P1-D-23 Influence of visual target distance on body sway and muscular coactivation at the ankle joint under conditions of fear

Junichi Suganuma[1], Kozo Ueta[2], Shu Morioka[2]

[1]kio univercity, [2]Kio University

Background and aim: Recent studies have examined the direct influence of fear induction on postural control. Significant changes in the frequency amplitude (RMS) and the mean position of the center of pressure displacements were observed in young healthy adults during quiet stance when fear was induced by making them stand at the edge of an elevated surface. The importance of visual target distance on postural stabilization is well known. It promotes the stabilization of postural control and makes the visual target distance near. However, no study has examined the stabilization of postural control under conditions of fear. The purpose of this study was to investigate whether a change in the visual target distance under conditions of fear influences body sway and muscular coactivation at the ankle joint. Methods: Eight healthy young adults (4 men, 4 women; mean age, 23.3 ?} 3.9 years) volunteered to participate in this study. Participants stood at 2 different heights (at ground level: fearless condition, at a height of 1.1 m: fear condition) and were asked to fixate on a visual target placed at eye level in front of them (40 cm: near distance, 300 cm: far distance). Participants stood quietly with their arms at their sides and their eyes open. We measured postural sway and coactivation after 30 s. Postural sway was measured with a stabilometer. The total trajectory length (TTL) and the area of a rectangle (AOR) were calculated. Surface electromyography electrodes were placed at the tibialis anterior and gastrocnemius muscles to measure the muscular coactivation at the ankle joint during activities that required postural control. Coactivation was used to calculate the co-contraction index (CI).

Participants rated their fear between 0% (fearless) and 100% (fear) after each condition using a Visual Analog Scale (VAS). Results: The VAS scores obtained during conditions of fear were significantly higher than those obtained during the absence of fear ($p < 0.05$). There was a significant influence of fear ($F1, 7 = 6.40$, $p = 0.03$). The TTL was significantly lower in near distance than in far distance ($p < 0.005$). There was a significant influence of the visual target distance ($F1, 7 = 21.21$, $p = 0.0025$). The AOR did not show significant influence. The CI increased significantly in near distance compared to that in far distance ($p < 0.01$). There was an influence of the visual target distance ($F1, 7 = 14.83$, $p = 0.0063$).?@?@?@ Conclusions: These results suggest that because of the significant increase in the muscular coactivation at the ankle joint, a closer visual target distance may influence the stabilization of postural control under conditions of fear.

P1-D-24 Clinical objectification of the postural and pelvic instability in unipodal, with children presenting developmental dyslexia

Philippe Villeneuve[1], Hélène Bost[2], Fabienne Mons[2], Bernard Weber [2], Sarah Recoules[2]

[1]Institut de Posturologie, [2]Association Posturologie Internationale

BACKGROUND AND AIM Kohen-Raz (1970) has already shown the relation between reading disorders and postural instability. This was instrumentally confirmed by Stoodley and al (2005), Pozzo and al (2006), Kapoula and Bucci (2007). Our objective is to demonstrate, clinically, the correlation between children presenting a dyslexia of development and the defect of control of the postural stability in unipodal and the preservation of the horizontality of the pelvic and scapular girdles. Our study leans on two simple and rapid clinical tests, allowing to improve the interdisciplinary communication. METHODS A first study estimates the unipodal postural stability of 66 normal-readers children, from age 7 to 11 years old, recruited in schools. A second one, realized on 95 previously diagnosed dyslexic children : 70 boys (73 %) and 25 girls (27 %), from 7 to 16 years old. To compare to their age-matched controls, we kept 51 of the 95 dyslexics from the second study. Desciption of the tests - Time of stability on one foot (TSOF): the child stands on one foot and maintains his unipodal stability for 30 seconds. He has to stabilize without translating or lifting his weight-bearing foot and without putting the contralateral foot on the ground or touching the weight-bearing lower limb. Upper limbs are not in touch with the environment. - Unipodal Test of Pelvic Stability : it estimates the pelvic kinematic dysfunctions and the muscular capacity to stabilize the pelvis. The practitioner, behind the patient, puts his thumbs in contact (light pressure) with the subject's pelvis at the level of the Posterior superior iliac spine? Then, the patient raises one foot with his leg flexed on the thigh between 20 to 30 °, during 15 seconds. The practitioner estimates with his hands if the horizontality of the pelvis has been maintain or not and if he can see the translations and inclinations of the scapular girdles. RESULTS The first study shows that only 10 % of normal-readers children present an instability to the TSOF and 34 % a pelvic tilt. The second one shows that 90 % of the dyslexic children between 7 and 11 years present an instability to the TSOF and 92 % a pelvic tilt. There is a significant variation calculated with the χ_2 between the group of the normal-readers children and the one of the dyslexics according to the age : for the 8 years old children ($P < 0,03$) and for the 10 years old children ($P < 0,01$). CONCLUSIONS This study confirms the previous instrumental studies. The dyslexic child presents a defect of control of his unipodal postural stability compared with the normal-reader child. Furthermore, we draw the attention to both the role of the stabilization of the pelvic and scapular girdles which support the head and stabilize and direct the gaze. This instability is

easily observed thanks to the two proposed tests, easy and rapid, which can be effectuated by medico-psycho-social staff who is in charge of the child presenting a dyslexia of developm

P1-D-25 Margin of stability while crossing a dynamic obstacle during overground walking

Tim Worden[1], Lori Vallis[1]

[1]University of Guelph

BACKGROUND AND AIM: Past methods of examining dynamic stability during gait have provided a generalized understanding of whole body stability, however, reported values are typically averaged across multiple time points (e.g. across multiple steps or a portion of the gait cycle). For example, Hof's dynamic margin of stability (J Biomech, 2005; 38: 1-8) has been used during treadmill walking to quantify 'instantaneous stability', defined as the extrapolated center of mass (COM) location with respect to base of support at heel contact. Little work has used this approach to quantify dynamic stability for adaptive locomotor tasks. Thus, the goal of our work was to calculate frontal plane stability in healthy young adults for only the crossing step over either a static or dynamic obstacle. To further challenge the control system, participants were required in some trials to simultaneously respond to a challenging cognitive task. We hypothesized that, i) crossing a dynamic obstacle would be more destabilizing than crossing a stationary obstacle, and that ii) having to focus attention on a challenging cognitive task would decrease the margin of stability further. METHODS: Sixteen healthy young adults walked along a path and stepped over either a dynamic obstacle (50% of lower leg length) or a stationary obstacle (~15 cm lower). At the same time, an auditory Stroop task was presented to the subjects, who had to respond as quickly and accurately as possible. Kinematic data was collected (100 Hz; Optotrak, NDI, Waterloo) using rigid bodies and digitized anatomical landmarks. COM was estimated (adapted Winter et al 1998 model), and step width (distance between the fifth metatarsal heads when both feet are in contact with the ground; BOS) as well as dynamic margin of stability in the frontal plane was calculated (Hof et al.,J Biomech, 2005; 38: 1-8) Number of correct responses and response latencies were also calculated for the Stroop task. RESULTS: Preliminary findings (N=13) from a multivariate ANOVA (independent variables: margin of stability; response latency) indicate a significantly smaller ($p<0.05$) frontal plane margin of stability for the step crossing a dynamic obstacle (0.0380.014 m) as opposed to crossing a static obstacle (0.050 0.018 m). Similar trends were observed for the step before obstacle crossing ($p=0.063$). Cognitive task difficulty had no effect on the frontal plane margin of stability or step width ($p>0.05$). Linear regression analyses revealed that an increase in COM velocity in the frontal plane could be predicted by an increase in step width (adj. $R2=0.580$; $p<0.05$). CONCLUSIONS: Preliminary analyses indicate that although increasingly difficult postural tasks affect dynamic stability, challenging cognitive tasks had no effect on dynamic stability in this paradigm. This measure of frontal plane margin of stability may be useful in quantifying instantaneous moments of instability during external perturbations such as obstacle crossing.

P1-D-26 Dual-Tasking Postural Control: Age-Related Changes in Visuomotor Control and Attentional Capacity

Ting Ting Yeh[1], James Lyons[1], Timothy Lee[1]

[1]McMaster University

Maintaining upright posture is seemingly an automatic task in younger adults, but it may require additional resources in late adulthood due to decreases in sensorimotor and cognitive functions. This study investigated how older and younger adults differ in employing sensorimotor and attentional strategies for a visuomotor tracking task while maintaining upright balance. Twelve healthy elderly (65-84 years) and 12 young subjects (19-30 years) shifted their upright balance in the mediolateral (ML) direction in order to track a center of pressure (COP) feedback cursor in a specific target location. As well, the participant's orientation to the computer monitor was varied from 0° to 45° in order to assess how visual orientation influenced postural sway variability in the ML and anteroposterior (AP) axes. In some trials, participants performed a concurrent, silent arithmetic task together with the visuomotor tracking task. We compared changes in postural control in terms of standard deviation (SD) of COP in both age groups. We found that: (1) the SD in the ML axis was higher for older, compared to the younger participants in accomplishing the postural precision task; (2) when the body orientation changed from 15° to 45°, younger adults accomplished the task requirement by applying looser control (more variability) in the ML axis but tighter control (less variability) in the AP axis. Older adults, however, did not decrease sway variability when the task goal was to minimize sway in either ML or AP directions, and (3) cognitive dual-task improved postural control in the younger adults, but not for the older adults. Specifically, postural sway variability decreased significantly in both the ML and AP axes while performing a secondary task in the younger group. Sway variability did not change in older adults in the dual task trials. The current study revealed two age-related differences between young and older adults. First, compared to younger adults, older people showed decreased ability to coordinate posture in a visuomotor tracking task. Older adults may have difficulty to accomplish a visually-based postural tracking task which required integration of sensory feedback and motor response due to age-related sensorimotor and visuomotor deficits. Second, simultaneous execution of a cognitive task together with a postural precision task improved postural control in the younger, but not older adults. We suggest that the additional cognitive task shifted attention away from, and increased the automatic processing, of posture in the young adults. An impaired ability of the attention switching in older adults however, may adversely affect the execution under dual-task situations. We propose that deterioration of peripheral sensorimotor systems and reduced flexibility in central information processing are responsible for these age-related differences in postural control.

P1-E-27 Adaptive locomotion strategies in a single and double obstacle avoidance task

Russell Kennedy[1]

[1]Wilfrid Laurier University

BACKGROUND: Adaptive locomotion in response to environmental factors requires stable footholds to maintain dynamic stability. Previous research assessing preferential foot placement when avoiding a single ground-level obstacle found the emergence of three selection strategies to guide foot placement: 1) placing the foot in the plane of progression; 2) choosing to take a longer step over a shorter step; and 3) selecting a medial rather than lateral foot placement1. These alternate foot-placement choices have been shown to coincide with a minimal foot displacement from one's normal footfall location1,2. The purpose of this study was to examine the dominant foot placement responses of individuals while avoiding one or two consecutive planar obstacles placed along the path of progression. METHODS: Participants (N=8, $\bar{x}$ age=23.6 ±2.0 years) were instructed to walk along a 13m long path at a self-selected pace toward a goal. Participants were asked to avoid one or two obstacles if present, otherwise

just walk as normal as possible. Long planar obstacles (15cmx70cm) were located 8m from the starting point, projected from a ceiling mounted data projector on to the ground after the participants attained steady state locomotion (i.e. 4 steps). The obstacles were in line with the plane of progression and projected where the left and right footfalls would normally occur (O1 and O2). Participants performed a total of 40 randomized trials: 24 with no obstacle, 8 with a single obstacle, and 8 with two obstacles. RESULTS: All participants maintained consistent foot placement strategies amongst themselves throughout the entirety of the study. Variability arose between participants and not within participants. During the avoidance of a single planar obstacle, 87% of the trials resulted in participants stepping medially along the plane of progression. When avoiding two consecutive planar obstacles, the participants elicited one of two foot placement strategies: 1) double crossover (i.e. stepping medially for both obstacles); or 2) steering (i.e. stepping medially then laterally, vise versa). The dominant foot placement strategy was the double crossover observed in 75% of the trials. CONCLUSION: The initial results from this study are consistent with previous finding for avoiding single planar obstacles1, suggesting that individuals prefer to step medially along the plane of progression. However, when avoiding two planar obstacles no single strategy dominated. Some participants chose to maintain momentum in the plane of progression (double cross over) while some chose to maintain step width (steering). Further analysis will determine the factors that predispose one to select one strategy over the other when avoiding two obstacles. It is believed that differences in gait parameters (i.e. step width, velocity) during the approach phase, trunk orientation and stability following the first adaptive step are the factors contributing to one's stepping strategies.

P1-E-28 Knee Range of Motion Influences Obstacle Avoidance Strategies During Gait.

Emily McIntosh[1], Damjana Milicevic[1], Nicholas Frank[1], Andrew Laing[1], Stephen Prentice[1]

[1]University of Waterloo

BACKGROUND AND AIM: Stepping up onto sidewalks and climbing stairs are common tasks where individuals must adapt their foot placement appropriately in order to be successful. Patla and Rietdyk demonstrated that individuals typically cross barriers with 80? of knee flexion. However, it is unknown how the lower limbs adapt to this task when the knee's range of motion (ROM) is constrained [1]. The purpose of the current study was to examine how a limited ROM of the knee joint would influence obstacle avoidance strategies in the sagittal plane. As the knee was constrained more (less ability to flex) it was expected that the hip joint elevation would play a larger role in the clearance motion over the obstacle. It was therefore hypothesized that the hip height would increase in trials where the knee had less ROM and that minimum toe clearance and foot placement relative to the obstacle would be optimized for each condition to allow a safe clearance. METHODS: Eight healthy young adults (4 female, 23.0 ± 1.8 years, 1.7 ± 0.1 m tall, 69.6 ± 15.0 kg) with no history of knee or hip injuries participated. Lower limb kinematic data were collected at 60 Hz with a six camera Optotrak system (Certus, NDI, Waterloo, ON) using 5 rigid bodies affixed to the pelvis, right thigh and shank, and both feet. Participants had their right knee fitted with a knee brace with manufacturer flexion stops which allowed ROM to be constrained. Four blocks of walking trials were completed for each knee constraint: no brace, 70?, 50?, and 30? (smallest ROM) flexion stop, as measured from full extension. The unbraced block was performed first to establish a baseline, then was followed by three randomized blocks for the brace conditions. These blocks consisted of three randomized conditions (unobstructed walking, 18 cm obstacle, 6 cm obstacle) which each had five trials. Hip height was the vertical location of the greater

trochanter at the time of obstacle crossing, while toe clearance and foot placement were defined as the vertical distance from the obstacle to the toe of the lead foot, and the horizontal distance from the obstacle to the trail toe, respectively. RESULTS: There was no significant difference between any of the trials or conditions for minimum toe clearance above the obstacle or foot placement before the obstacle (p>0.05). A main effect of flexion stop on hip height was observed for the high obstacle condition. Hip height was highest for the 30? flexion stop trials, followed by the 50? and 70? of flexion limitation, which were both larger than the non-braced condition. CONCLUSIONS: Participants were able to successfully complete the obstacle avoidance task, even with a brace that severely limited ROM. As trials increased in difficulty (i.e. with constrained knee ROM) participants maintained a constant and safe trajectory over the obstacle by increasing their vertical hip height. References: [1] Patla & Rietdyk (1993) Gait Posture.

P1-E-29 Differences of trunk control between trimesters during gait in nulliparous women

Ryuichi Sawa[1], Takehiko Doi[2], Tsuyoshi Asai[3], Sho Nakakubo[1], Kaori Watanabe[4], Takeshi Taniguchi[5], Rei Ono[1]

[1]Kobe University Graduate School of Health Sciences, [2]National Center for Geriatrics and Gerontology, [3]Kobegakuin University, [4]University of Shiga Prefecture, [5]Taniguchi Hospital

BACKGROUND AND AIM: The most visible change during pregnancy occurs in trunk and this is remarkable in 3rd trimester (28 gestational week and over). Nevertheless, few studies investigated trunk control during gait in pregnant women. The purpose of this study was to compare trunk control during gait between women before 3rd trimester and those in 3rd trimester in nulliparous women. METHODS: Twenty-seven healthy nulliparous women (1st and 2nd trimester [ET]: n=16, 3rd trimester [LT]: n=11) were asked to walk along a 15-m section of the walkway was marked off by two lines, one positioned 2.5 m from each end, to allow space and time for acceleration and deceleration. Walking time over the middle 10 m was measured with a stopwatch. Trunk acceleration was measured using a wireless miniature sensor unit located along the cranio-caudal axis at pelvis (L3) and shoulder (C7) levels. In addition to gait velocity, we calculated mean stride time, autocorrelation coefficient (AC) and coefficient of attenuation of the acceleration (CoA) from L3-level to C7-level in three directions respectively (vertical: VT, mediolateral: ML and anteroposterior: AP) from trunk acceleration data. AC was used to represent trunk regularity and CoA was used to quantify the ability to attenuate the acceleration going from L3-level up to C7-level. Statistical significance level was set at 0.05. Comparisons of gait parameters between groups were assessed using unpaired t test and, after that, multiple regression analyses were performed to adjust for other factors. Apart from the groups, age, height and gait velocity were used as independent variables, whereas gait parameters were dependent variables. RESULTS: Gait velocity and stride time were not significant different between groups (Gait velocity: ET: 1.07±0.15 [m/s], LT: 1.05±0.24 [m/s], p = .721; stride time: ET: 1.10±0.08 [s], LT: 1.16±0.19 [s], p = .232). ACs in all directions and CoA in VT and ML directions were also not significant between groups (AC-VT: ET: 0.71±0.13, LT: 0.67±0.14, p = .511; AC-ML: ET: 0.55±0.17, LT: 0.54±0.11, p = .843; AC-AP: ET: 0.81±0.09, LT: 0.80±0.08, p = .605; CoA-VT: ET: 6.68±13.26 [%], LT: 14.14±7.83 [%], p = .107; CoA-ML: ET: 38.69±14.84 [%], LT: 30.31±15.83 [%], p = .172). However, CoA in AP direction was significantly lower in 3rd trimester (ET: 39.49±16.71 [%], LT: 16.67±20.89 [%], p = .004). This relationship was also significant even after adjusted for other factors (p = .008). CONCLUSIONS: Nulliparous women in 3rd trimester were able to maintain the trunk regularity during gait as well as 1st and 2nd trimester, however, unable to attenuate the

acceleration progressing from L3 to C7 in the AP direction. These results suggest that nulliparous women in 3rd trimester would increase trunk rigidity more than those before 3rd trimester when they walk.

P1-E-30 Postural control changes in visual height intolerance: balance control and anti-gravity muscle activity

Klaus Jahn[1], Max Wuehr[1], Guenter Kugler[1], Roman Schniepp[1], Doreen Huppert[1], Thomas Brandt[1]

[1]University of Munich

Background and aim Visual height intolerance (vHI) occurs when a visual stimulus causes the apprehension of loosing balance and falling [1]. Although vHI affects almost one-third of the general population [2] and has relevant consequences on the quality of life [3], a quantitative assessment of physiological alterations that may trigger postural imbalance in vHI is missing. Methods VHI-related changes in postural control were assessed by center-of-pressure displacements and electromyographic recordings of selected leg, arm, and neck muscles in 16 subjects with vHI while standing at heights on an emergency balcony vs. standing in the laboratory at ground level. Characteristics of open- and closed-loop postural control were analyzed. Body sway and muscle activity parameters were correlated with the subjective estimates of fear at heights. Results During height exposure, (1) open-loop control was disturbed by a higher diffusion activity ($p<0.001$) and (2) the sensory feedback threshold for closed-loop control was lowered ($p<0.010$). Altered postural control was predominantly associated with increased co-contraction of leg muscles. Body sway and leg and neck muscle co-contraction correlated with the severity of subjective anxiety ($p<0.050$). Alterations in postural control diminished if there were nearby stationary contrasts in the visual surrounding or if subjects stood with eyes closed. The performance of a cognitive dual task also improved impaired balance. Conclusions Visual heights have two behavioral effects in susceptibles: a change occurs in (1) open- and closed-loop postural control strategy and (2) co-contraction of anti-gravity leg and neck muscles, both of which depend on the severity of evoked fear at heights. 1. Brandt, T., J. Benson, and D. Huppert, What to call "non-phobic" fear of heights. Br J Psychiatry. 2012a, 2012. 190: p. 81. 2. Huppert, D., E. Grill, and T. Brandt, Down on heights? One in three has visual height intolerance. Journal of Neurology, 2013. 260(2): p. 597-604. 3. Schaffler, F., et al., Consequences of visual height intolerance for quality of life: a qualitative study. Quality of Life Research, 2013.

P1-H-31 Effects of medication on temporal aspects of unplanned turning in Parkinson´s disease

David Conradsson[1], Caroline Paquette[2], Erika Franzén [1]

[1]Karolinska Institutet, [2]Department of Kinesiology and Physical Education, McGill University and Centre for Interdisciplinary

BACKGROUND AND AIM: Locomotion in everyday life often incorporates unexpected and rapid shifts. Turning while walking is a critical activity that often leads to falls in individuals with Parkinson's disease (PD). Although several studies have described turning characteristics in PD, knowledge concerning the influence of anti-Parkinson medication on unpredictable turns is lacking. Our aim was to investigate temporal aspects of turns while walking in individuals with PD with and without anti-Parkinson medication. METHOD: Four individuals (two females) with mild to moderate PD (Hoehn & Yahr score 2 to 3), average age of 71 years (range 69-72), disease duration of 8 years (range 1-17) and daily Levodopa

equivalent of 657 (range 600-725), participated in this study. All subjects were able to ambulate independently without a walking aid, and had no other medical conditions affecting gait, no dyskinesia or dizziness. A movement analysis system (Elite-system, BTS Inc.) was used to record three-dimensional position of retro-reflective markers positioned on the head, trunk, and pelvis segments. Similar to Mak et al. (2008), an unplanned paradigm was used in which the participants walked at their normal pace along a 9-meter T-shape walking alley. At 0.6m prior to the intersection point, participants received a visual cue indicating one of 3 choices: walking straight or performing a right or left 135°-turn. Five trials were collected for each turning direction and for straight walking (randomized order of presentation). Outcomes were: turning time (i.e. the time for pelvis segment to turn 90°) and movement onset latencies with respect to the visual cue for the head, trunk and pelvis segments. Right and left turning trials were averaged and presented as individual/group mean. Participants were tested twice, first after overnight withdrawal of medication (OFF, average OFF time = 15 hours, range 14-17) and approximately one hour after taking their usual dose of medication (ON). Before each test-session, the Unified PD Rating Scale (UPDRS) motor part was administered. RESULTS: All subjects improved their UPDRS-motor score (OFF: 48, ON: 32) and turning time (OFF: 2.40 sec, ON: 2.16 sec) by anti-Parkinson medications. Regarding inter-segmental sequencing, the results revealed individual differences with earlier segmental onset and less "en-bloc" sequencing for most of the subjects (see Figure 1). CONCLUSIONS: These preliminary results indicate positive effects of PD-medication on temporal aspects of turning performance during unplanned conditions. Further analysis with a larger sample size in comparison to a healthy control group is in progress. REFERNCES: Mak MK, Patla A, Hui-Chan C. Sudden turn during walking is impaired in people with Parkinson's disease. Exp Brain Res. 190(1):43-51. 2008

P1-H-32 The effects of fall-risk-increasing drugs (FRIDs) on gait variability in frail elderly

Maartje de Groot[1], Jos van Campen[1], Nienke Kosse[2], Oscar de Vries[3], Jos Beijnen[1], Claudine Lamoth[2]

[1]Slotervaart Hospital, [2]University of Groningen, University Medical Center Groningen, [3]VU University Medical Center

BACKGROUND AND AIM: The use of psychotropics and some cardiac drugs is associated with increased risk of falling in elderly [1]: these are the so-called FRIDs (fall-risk-increasing drugs). The increased fall risk with witch these FRIDs are associated, might be caused by underlying problems in postural control these drugs can induce due to sedative side-effects [2]. The current literature on the relation between FRIDs and postural control only examined single-drug effects, assessed postural control during quiet standing, and included relatively healthy young older adults (about 65 years of age) [2]. Consequently it is not clear what the impact of FRIDs is on gait in frail elderly with polypharmacy. Therefore, the aim of the present cross-sectional study was to examine the relation between medication-use and gait in geriatric outpatients with co-morbidity and polypharmacy. METHODS: 56 patients were included (80±5.2 years; 30% male). The following patient characteristics were binary recorded: ≥2 co-morbidities, cognitive impairments (MMSE≤23), increased fall risk (Pluijm score ≥8), and presence of frailty (≥3 Fried's criteria). Medication-use was systematically noted, and coded according to the Anatomical Therapeutic Chemical classification system. Patients walked 160-m while trunk accelerations were recorded. Walking speed (m/s) was determined, and mean stride time (s), CV of stride times (%), and SD of relative phase between the lower limbs (°) were calculated from trunk acceleration data. Multivariate Partial Least Squares (PLS) regression analyses were used to examine the relation between patient characteristics and medication use (the independent variables), and gait parameters. RESULTS: The PLS

regression of patient characteristics and medication use versus gait parameters yielded a model explaining 53% of the variance in gait parameters (=R^2). The variables which were most influential to the model were the presence of frailty (R^2=53%), the use of hypnotics (excl. benzodiazepines; R^2=42%), drugs for ulcer and reflux disease (R^2=41%), laxatives (R^2=40%), and the use of vitamin and/or mineral supplements (R^2=38%). These variables were associated with lower walking speed, higher mean stride times, more variability in stride times (higher CV of stride times) and a more asymmetric walking pattern (higher SD of relative phase). Other variables, including the use of FRIDs, were less associated with variability of the gait pattern (R^2<28%). CONCLUSIONS: From the results, we can conclude that particularly the presence of frailty, and some "frailty markers" (e.g. using hypnotics (excl. benzodiazepines), laxatives, drugs for ulcer and reflux disease, or vitamin and mineral supplements) were associated with lower walking speed and higher gait variability. The use of FRIDs did not effect gait in the examined population of geriatric outpatients. REFERENCES: [1] Leipzig et al. J Am Geriatr Soc 1999;47:30-50. [2] De Groot et al. Drugs Aging 2013;30:901-20.

P1-H-33 A double blind randomized, placebo-controlled single dose study of methylphenidate to reduce fall risk in older adults

Itshak Melzer[1], Zamir Shorer[2], Bachner Yaakov[1], Tal Guy[1]

[1]Ben-Gurion University, [2]Ben-Gurion University and Soroka Medical Center

BACKGROUND and AIMS: Age-related deterioration in gait and balance as well as impaired executive function abilities are a major contributor to falls in older adults. Therefore, it was suggested that improvements in executive function might improve gait by improving planning, control, and execution of movements, and thus are likely to reduce risk of falls. Given the known deficits in executive function in older adults, as well as evidence for benefits of methylphenidate for divided attention and evidence suggesting that gait and balance control requires attention, we sought to investigate the effects of single dose methylphenidate on gait and postural stability in older adults, in both single task (ST) and dual task (DT) conditions. METHODS: In a randomized controlled double-blind study, 30 healthy older adults (mean age 74.9±5.6) were examined in four task conditions: (1) Single task, 7 standing still trials; (2) Dual task, 7 standing still trials performing a memory task; (3) Single task, 3 narrow base walking trials; (4) Dual task, 3 narrow base walking trials, performing concurrent cognitive tasks. After the completion of the baseline examination, the subjects of both groups were given methylphenidate medication (10 mg of short-acting methylphenidate to the experimental group and 10 mg of placebo methylphenidate to the controls). Subjects were re-tested 1.5 to 2 hours post-drug administration. Postural stability parameters were: 1) Mediolateral sway (mm); 2) Anterioposterior sway (mm); 3) sway velocity (mm/sec); and 4) Sway area (mm2). The parameters of the narrow base walking trials were: the number of steps, trial times, steps errors, trial velocity, step error (i.e., step outside the narrow walking path) and the number of cognitive task errors during single and dual tasks. We applied a separate ANOVA models where the dependent variables were the average values of the postural stability or gait stability parameters (a continuous one) and the independent variables were categorical: the group (experimental vs. controls) and time (pre-test vs. post-test). RESULTS: No significant interaction effect between group and time was observed for the postural stability parameters during ST and DT. An improvement was found in the experimental group in gait parameters. We found a significant group-by-time interaction in the number of step errors during walking, in ST and DT. In DT condition a significant group-by-time interaction effect was found for walking time and walking velocity. Also, a significant time-by-trial

interaction effect was found for average values of cognitive task error rates during ST and ST trials. CONCLUSIONS: Old adults showed improvement in gait stability after single dose methylphenidate, especially in complex dual tasks that require higher executive control. This could largely account for the effects of methylphenidate on a sustained attention dual task, but direct effects on the motor system may have also played a role

P1-H-34 Hip fractures and "drugs to be avoided"

Margareta Reis[1], Torsten Johansson[1]

[1]Linköping University

Background: Fall accidents among the elderly is a common but serious Public Health Care problem. In Sweden, the number of deaths due to a fall is twice as high as deaths due to traffic accidents; all ages included. Many falls result in a hip fracture; the yearly rate of hip fractures in Sweden is 25 000 and the mean patients age is 83 years. One main reason to a fall is drugs; i.e. psychotropic drugs and drugs with anticholinergic adverse effects including dizziness; hence fore denoted "drugs to be avoided". Thirteen percent of Swedish elderly above 80 years take ≥ 10 prescription drugs; 5 % take ≥ 3 psychotropic drugs and 6 % one or more anticholinergic drugs. This data is retrieved from prescription registers. We also know that drug compliance is ambiguous and decreasing with the number of drugs prescribed. The question remain: Which drugs/combination of drugs were in the bloodstream when the person fell? Our hypothesis is that patients with a hip fracture take more "drugs to be avoided" than other persons in the same age category. We also hypothesize that drug serum concentrations of antidepressants and antipsychotics is higher in hip fracture patients than in published reference material. Aim: To investigate which drugs (54 substances) with anticholinergic effects including antidepressants and antipsychotics, some opioids, and benzodiazepines that actually were in the bloodstream at the time of the fall. Method: 100 consecutive patients with a hip fracture coming to the ER at the Linköping University Hospital were included. Immediately upon arrival with the ambulance a blood sample was taken for drug analysis: We have established techniques for broad approaches of screening and analysis of drugs and their metabolites (known or unknown) with ultra-high performance liquid chromatography in combination with tandem quadrupol high-resolution time of flight mass spectrometry (LC-Q-TOF-MS30; TOF analysis). In short, a very small blood sample can with this technique be screened for several hundreds of substances. Further, in patients with detected antidepressant and/or antipsychotics a quantitative serum drug analysis will be performed. Results: 100 patients with hip fractures were recruited; mean age 84 years; 68 women and 32 men. The last patient was included in the beginning of February 2014. All blood samples will undergo the TOF analysis before the end of March and the crude results will be presented at the ISPGR meeting in August. Conclusion: Results from blood analysis is pending and a clinical relevant conclusion is not possible to draw to date. However, regardless if the results support our hypothesis or not the study most probably will have impact on prescription routines for the elderly and be important for future pharmacovigilance studies.

P1-I-35 UNDERSTANDING THE EFFECTS OF LEARNING ON CHANGE IN SUPPORT REACTIONS WHEN EXPOSED TO CONTINUOUS MULTI-DIRECTIONAL PERTURBATIONS

Carolyn Duncan[1], William McIlroy[2], Avril Mansfield[3], Jeannette Byrne[4], Wayne Albert[5], Scott MacKinnon[4]

[1]Toronto Rehabilitation Institute/Memorial University, [2]Toronto Rehabilitation Institute/University of Waterloo, [3]Toronto Rehabilitation Institute, [4]Memorial University, [5]University of New Brunswick

Background and Aim: Moving environments caused by wave-induced perturbations are a significant risk factor for fall-related injuries for those working in offshore environments. Although postural responses in these environments are becoming better understood, the effects of prolonged exposure and habituation remain unknown. The purpose of this study was to examine the effects of habituation and repeated exposure on the adaptation of postural responses, specifically compensatory change-in-support reactions, in simulated wave-induced ship motions among individuals with no experience working in offshore environments. Methods:. Participants (n=24, ages, 12 male, 12 female) were exposed to ten 5-minute manual material handling trials on two separate days, separated by at least 48 hours. During all trials participants were exposed to simulated wave motions while standing on a six degree of freedom motion simulator. Participants concurrently performed manual materials handling tasks to simulate typical task demands (e.g lifting boxes, carrying of loads etc.) Characteristics of compensatory CS reactions were determined from video-taped records and included: number of CS responses, number of multiple step CS events and total postural correction time. Results: Within a single session there was significant adaptation over trials with reduction in CS occurrence, total time spent performing CSs and total number of multi-step CSs decreased significantly with regardless of the task being performed. Overall the number of CS (day 1: 780 events, day 2: 420 events) and total postural correction times (day 1: 7959.39s; day 2: 1934.63s) remained significantly reduced on the second day of testing. Conclusions: These results suggest that postural response to a simulated moving environment is quickly habituated (within a session), and was maintained following 24 hours of non-exposure. The mechanisms of the This information may be useful in the development of effective occupational training for preventing falls in maritime environments. These adaptive changes need to be determined but may include both adaptive changes to both predictive and reactive control processes. The human neural control system's ability to adapt quickly to these extreme motions suggests that simulated wave-like motion of perturbation-based training may benefit individuals entering the maritime workforce to minimize occupational related hazards that are most likely in initial exposure to such environments. Questions arising from this research have led us to examine the postural responses of experienced offshore workers to assess if work experience alone results in these habituations or whether it requires simulated training as was done in the previous study. Results of this ongoing work will also be presented.

P1-I-36 How much force do you need to do it?

Martine Gilles[1], Pascal Wild[1]

[1]Institut national de recherche et de sécurité

ABSTRACT:For ergonomical, purpose, we looked at posture and vertical force applied on a workstation when doing a standing repetitive assembly task at different rhythm and as a matter of age. These two factors seem to increase the vertical force used to make a same task without changing the posture. BACKGROUND AND AIM: Because of the economical context, the number of ageing workers increases. To reinforce the protection of senior workers from musculo-skeletal diseases, we set up a laboratory experiment to simulate a repetitive assembly task similar to those observed in the industry. The aim of this project was to investigate the effect of age and work rhythm on the posture adopted and the force exerted during the assembly task. METHODS: 65 subjects in three age groups (juniors: 30 to 35,

medians: 45 to 50 and seniors: 60 to 65 years old) standing in front of the workstation, did a repetitive assembly with two different work rhythms (comfortable and rapid). The task was to fix a handle with two bolts on a base at the workstation. They did each rate for 20 minutes. Motion kinematics was recorded with a Vicon system ® and dynamics with two force plates: one on the ground and the other one under the workstation. Joint centres were computed through the Hanavan model based on 37 markers and 70 anthropometric measures. Euler angles from ankles, knees, hips, shoulders and elbows were computed as recommended by the Internal Society of Biomechanics (2002). RESULTS: We did not observe any significant difference in standing posture between age groups or between rhythms. Senior subjects were able to increase their work rhythm in the same manner as the two other groups did when the work rhythm was increased. However, in both pace, senior subjects exerted significantly ($p < 0.01$) more vertical force to assemble parts than the two other groups. We also observed that all groups increased significantly ($p < 0.001$) the vertical exerted force on the workstation with increasing pace. CONCLUSIONS: This laboratory study showed that, not only the frequency of movement, but also the force exerted during a repetitive assembly task increased with rhythm, irrespective of the age. The results also showed that older subjects exerted more force than younger to do a same task. The decrease of dexterity (Desrosier et al., 1995) could be a hypothesis to explain these differences. A more pronounced increase of exerted force combined with a decrease of force capacity with age could explain a higher risk of musculoskeletal disorders for seniors, especially for constrained time tasks.
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P1-I-37 Feasibility and Validity of Functional Movement Screen in Assessing Postural Control of Operative Firefighters Aged 22-59

Anne Punakallio[1], Miia Wikström[1], Sirpa Lusa[1]

[1]Finnish Institute of Occupational Health

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.

P1-J-38 Resistance Training, White Matter Lesion Progression, and Falls Risk: A 12-Month Randomized Controlled Trial

Niousha Bolandzadeh[1], Roger Tam[1], Lindsay Nagamatsu[2], Liang Hsu[1], David Li[1], Todd Handy[1], Peter Graf[1], Lynn Beattie[1], Teresa Liu-Ambrose[1]

[1]University of British Columbia, [2]University of Illinoise

BACKGROUND: Maintaining both cognitive function and mobility are essential for healthy aging and to function autonomously within society. White matter lesions (WMLs) are associated with impaired mobility and reduced cognitive performance in older adults. These lesions are due to damage to the brain parenchyma, ranging from demyelination to complete axonal disruptions. Slowing the progression of WMLs may reduce the risk of both cognitive impairment and falls in older adults. We hypothesize that one promising approach to slow down the progression of WMLs is targeted exercise training. Thus, we aimed to assess the effect of 12 months of resistance training (RT) on the progression of WMLs. Secondarily, we examined the association between changes in WMLs, cognitive function, and physiological falls risk. METHODS: Participants were a subset of 155 community-dwelling older women, aged 65 to 75 years old, who were otherwise cognitively intact (Mini-Mental State Examination [MMSE] ≥24/30). They were randomly assigned to either: 1) twice-weekly RT (2xRT); 2) once-weekly RT (1xRT); or 3) twice-weekly balance and tone exercises (BAT; control group). Assessments of cognitive function and falls risk were conducted at baseline, 6 months, and trial completion (i.e., 12 months). Standard tests were used to assess executive functions and processing speed. Falls risk was assessed by Physiological Profile Assessment (PPA). Structural magnetic resonance imaging (MRI) was acquired only at baseline and trial completion. To identify WMLs, seed points were manually placed on co-registered pairs of T2-weighted/PD-weighted images by an expert radiologist blinded to exercise assignments. A trained technician blinded to exercise assignments applied a semi-automatic region-growing method to each tagged image, and WML volumes in mm3 were quantified. The non-normally distributed WML volumes were transformed and used as continuous log-transformed variables. Statistical analyses included analysis of covariance with simple contrasts and Pearson correlations. Covariates included baseline WML volume, waist-to-hip ratio, and functional comorbidity index. RESULTS: Of those who completed baseline and trial completion MRI, 42 had pre-existing WMLs. Among these 42 participants, after adjusting for covariates, those participants in the 2xRT group had significantly lower WML volumes compared with those in the BAT group (p=0.037). Furthermore, reduced WML progression over the 12-

month RCT was significantly associated with reduced physiological falls risk, as assessed by the PPA (r=0.447, p=0.019). Reduced WML progression was also significantly associated with improved set shifting measured by Trail Making Test (A&B) (r=-0.497, p=0.008). CONCLUSIONS: These novel RCT results suggest that targeted exercise training can minimize the progression of WMLs in older adults. Furthermore, reduced WML progression may be an underlying mechanism by which targeted exercise training reduces falls risk.

P1-J-39 Virtual reality for rehabilitation in Parkinson's disease: preliminary results of a systematic review

Kim Dockx[1], Veerle Van den Bergh[1], Esther Bekkers[1], Pieter Ginis[1], Sabine Verschueren[1], Lynn Rochester[2], Jeff Hausdorff[3], Anat Mirelman[3], Alice Nieuwboer[1]

[1]KULeuven, [2]UNEW, [3]TASMC

BACKGROUND AND AIM: Virtual reality (VR) based exercise interventions are a promising new rehabilitation approach with wide future applications, particularly for rehabilitation of patients with neurodegenerative disorders. Patients with Parkinson's disease (PD), for example are likely to benefit from the augmented feedback, the repetitive practice of motor function and the opportunity to simultaneously train motor and cognitive functions which are made possible by VR. In addition, by offering a safe and motivating environment for skill practice, VR appears to present opportunities likely to enhance compliance and long-term training in PD patients. Objectives: We performed a systematic review to investigate the effectiveness of VR exercise interventions on gait and balance in patients with PD. METHODS: The Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL and the Physiotherapy Evidence Database (PEDro) were used. Articles included were those designed to determine the effect of VR interventions on balance and gait and/or global motor function and quality of life in patients with PD. We focused on randomized controlled studies, while also including case series study designs in an exploratory analysis. Two reviewers independently selected trials based on pre-defined inclusion criteria and extracted data. A third review author moderated disagreements if required. RESULTS: We included 8 trials, 3 of which were randomized controlled studies, 5 were case series of which none had a control group. All studies had a high risk of bias. Study sample sizes were generally small and interventions and outcome measures varied, limiting the ability to which studies could be compared in a meta-analysis. We pooled 8 studies, involving 98 participants in a preliminary analysis. Results showed a statistically significant improvement of balance after VR on the Berg Balance Scale (BBS) (standardized mean difference (SMD) of 2.19, 95% confidence interval (CI) 0.78 to 3.60 based on 4 studies with 37 participants) and on the one leg stance test (SMD 10.87, 95% CI 0.18 to 21.55 based on 2 studies with 20 participants). We were unable to determine the effect on gait due to insufficient numbers of comparable studies. Post VR improvements were also statistically significant for global motor function, as measured using the UPDRS motor part (SMD -3.15, 95% CI -0.08 to -6.23 based on 3 studies with 44 participants). Quality of life was found to be significantly improved after VR (SMD -9.19, 95% CI -2.60 to -9.19 based on 3 studies with 46 participants). CONCLUSIONS: We found evidence suggesting that the use of VR may be beneficial in improving balance, global motor function and quality of life in PD patients. However, this evidence was derived from weak study designs implying that adequately controlled randomized studies are urgently needed to determine whether VR has an added benefit over traditional rehabilitation approaches in PD.

P1-J-40 Different Effect of Stepping Cadence with Pinnacle Trainer

Yu-Chi Hsu[1], Yu-lin Yu[1], Li-Chieh Kuo[1], Fong-Chin Su[1]

[1]National Cheng Kung University

BACKGROUND AND AIM:Pinnacle trainer (S770, SportsArt Fitness, Taiwan) is the new exercise device which combines the frontal and sagittal planes movements (Fig. 1). Nowadays, only one study uses the pinnacle trainer to do the biomechanics research that observed the significantly increasing abduction moment in the knee which was expected to be helpful for deformity and painful from knee osteoarthritis. However, the study didn't investigate the effects of cadence during stepping. The faster stepping rate may increase the joint loadings which would cause injuries. Therefore, the objective of the study is to compare the biomechanics effect among three different stepping cadences with pinnacle trainer. METHODS: 1 male and 3 females (age: 24.8±1.5 yr; body height: 164.8±11.7cm; body weight: 59.5±15.3kg) without history of knee injury participated in this study. The newly design pinnacle trainer (S770, SportsArt Fitness, Taiwan) used in the study (Figure 1). A six-axis force/torque sensor was placed on the center of right pedal. Eight cameras motion capture system collected 3-dimensional kinematics data. Reflective markers were attached following the Modified Helen Hayes marker set. Speed was varied from the self-preferred speed (P) to that 25% faster (F) and 25% slower (S). Foots were asked to place fully contact on the pedal during stepping. Each condition recorded 5 trails for 15 seconds. The cycle of pinnacle trainer was divided into the two phase. Recovery phase (0-50% stride cycle) was the period from the lowest pedal position to the highest position. The stepping phase (51-100% stride cycle) was the period from the highest pedal position to the lowest position. ANOVA with post hoc comparison was used to determine the difference among conditions ($p<0.05$) with SPSS software. RESULTS: There were no significantly differences among three conditions, but it still could find some trends. Because of foots must fully contact on the pedal, the ankle had dorsiflexed during all condition. Knee and hip had flexion angles during all conditions (Fig. 2). Because the trajectory of pedal move downward and outward, the ankle shown less inversion at the terminal stepping phase (Fig. 2). The knee angles follow the pedal trajectory from adduction to abduction, and the P had less knee adduction and more abduction in the stepping phase (Fig. 2). The S had larger ankle plantarflexor, knee extensor and hip extensor moments than P and F during the terminal stepping phase. The peak ankle inversion moment of F was lately shown than P and S in the stepping phase (Fig. 3). The knee adductor moments decreased during the stepping phase and then abductor moments shown at the terminal stepping phase. The results of knee were shown similar with previous study. CONCLUSION: Through the small sample size affected the results, there still had some trends that S had larger ankle plantarflexor, knee extensor and hip extensor moments than P and F at the terminal stepping phase.

P1-J-41 A comparison of the influence of postural and non-postural muscle fatigue on anticipatory and reactive postural strategies

Ashleigh Kennedy[1], Arnaud Guével[2], Heidi Sveistrup[3]

[1]Toronto Rehabilitation Institute, [2]Université de Nantes, [3]University of Ottawa

BACKGROUND AND AIM: We have shown that peripheral and central fatigue alter anticipatory postural control during oscillating platform perturbations, causing earlier muscle activity and a decreased center of pressure displacement. Presently, it is unclear whether reactive postural strategy changes are also present during oscillations that are not anticipated. The primary aim of this study was to compare the

influence of fatigue on postural control at the beginning of a minute long postural trial, the transition (reactive) period, to the strategy found at the end of the trial once the person had experience with the task, the steady state (anticipatory) period. The secondary aim was to see if postural and non-postural muscle fatigue affected the transition and the steady state postural strategies differently. METHODS: Two separate fatigue protocols, peripheral and central, were designed and characterized in our laboratory. The peripheral protocol fatigued the ankle plantar and dorsiflexor muscles while the central protocol fatigued the central nervous system through fatigue of non-postural (forearm) muscles. Pre- and post-fatigue muscle activity, centre of pressure and body kinematic data from twelve participants were collected as they responded to continuous, externally driven support surface oscillations. Anticipatory ankle plantar and dorsiflexor muscles activity as well as the center of mass displacement were analysed for each of the first 5 cycles, transition period, and the last 5 cycles, steady state, of the minute long postural trials performed before and after each of the fatigue protocols. RESULTS: The peripheral fatigue protocol did not affect the muscle onset latency during the transition period but did cause earlier activation during the steady state period in the ankle plantar and dorsiflexor muscles. The central fatigue protocol resulted in an earlier activation of the plantar flexors muscles during both the transition period and the steady state while earlier activation of the dorsiflexor muscles were only recorded in the steady state period. The centre of mass displacement was not affected by the fatigue protocols. CONCLUSIONS: A common pattern of APA adaptations was found after both peripheral (ankle muscle) and central fatigue. These data support the hypothesis that there is a centrally mediated adaptation that responds generally to the presence neuromuscular fatigue as opposed to one that alters the motor plan based on the specific location and characteristics of fatigue. However, the fatigue induced changes are not reliably found during the transition period while participants habituate to the task, suggesting that the centrally mediated adaptation is not a pre-programmed plan based on afferent feedback directly from the muscles. Instead, it seems the participant must perform the motor task to discover that the postural (peripheral protocol) and forearm (central protocol) muscle fatigue have altered the task requirements.

P1-J-42 Effects of Tandem Cycling on Gait and Balance in Parkinson's Disease

Ellen McGough[1], Cynthia Robinson[1], Valerie Kelly[1]

[1]University of Washington

BACKGROUND AND AIM: Forced exercise is a mode of exercise that mechanically assists participants in achieving and maintaining an exercise rate greater than their preferred voluntary rate. (Alberts, 2011) An indoor tandem cycling class using tandem bicycles mounted on trainers is a mechanically augmented method to facilitate sustained cycling at a higher cadence and consistency than self-paced cycling for individuals with Parkinson's disease (PD). Tandem cycling with a healthy partner combines the benefits of aerobic exercise with neuromuscular training using high cadence, high repetition and cardiovascular training. The aim of this study was to examine the effects of a tandem cycling intervention on spatiotemporal gait parameters, lower extremity function, and fall risk in individuals with PD. METHODS: A waiting list control study design was used to compare spatiotemporal gait parameters in 21 tandem cycling participants, compared to 11 waiting list control participants. All participants (ages 45-75) had a diagnosis of PD. Tandem bicycles were mounted on trainers and volunteer cyclists (front seat) provided pacing. The intervention was a 10-week, 3x/week, 60-minute class. A high cadence tandem cycling protocol was tailored for the class protocol (Rigdel, Vitek & Alberts, 2009). Following a warm-up,

participants pedaled at a cadence of 80-90 revolutions/minute (RPMs) for 40 minutes maintaining a target heart rate (HR) within 60-75% of their estimated maximum. Baseline and 12-week data collection included: 1) The GAITRite Walkway System to test gait during usual pace and fast pace walking, measuring gait speed (cm/s), stride length, percent double support, and step length differential; 2) The Short Physical Performance Battery (SPPB) to measure lower extremity function; and 3) The Berg Balance Scale to measure fall risk. RESULTS: Gait speed (cm/s) during usual pace walking increased significantly (mean = 5.2 cm/sec.; p = .02) in the cycling group, but not in the control (mean = 2.6 cm/sec; p =.30). Gait speed during fast pace walking showed an upward trend (mean = 3.82 cm/sec; p = .07), but not in the control (mean = -4.1 cm/sec; p =.46). There were no significant differences in the other spatiotemporal gait parameters. Scores significantly improved on the Berg Balance Scale (mean increase = 2.5; p = .009), and the SPPB (mean increase = 0.91, p = .001) in the tandem cycling group, but not in the control group. CONCLUSIONS: Usual gait speed, lower extremity function, and balance improved following a 10-week tandem cycling intervention in individuals with PD. Further research is needed to develop innovative exercise programs that aim to improve the health and function of individuals with PD.

P1-J-43 ACUTE MUSCLE FATIGUE ALTERS REACTIVE POSTURAL CONTROL IN HEALTHY ELDERLY INDIVIDUALS

Evan Papa[1], Bo Foreman[2], Leland Dibble[2]

[1]University of North Texas Health Science Center, [2]University of Utah

BACKGROUND AND AIM: Acute muscle fatigue (AMF) has been shown to alter postural control in healthy elderly (HE) persons in static stance positions.1 However, only recently have studies examined the effects of fatigue on dynamic postural control tasks such as reactive stepping responses.2 In addition, few studies have focused on these issues in at-risk populations or examined the recovery timeline of post-fatigue postural control.3 To address these gaps in the literature, the purpose of this investigation was to elucidate the alteration and recovery timeline of reactive stepping following exposure to lower extremity AMF in HE persons. METHODS: Whole body kinetic and kinematic data were gathered on 8 HE persons using a Vicon 10-camera motion analysis system and in-ground force plates. The reactive postural control task utilized a tether-release model, which caused the subject to take a protective step to regain stability following a reproducible perturbation. AMF was induced via lower-extremity eccentric resistance exercise. The tether-release test was performed before (T0) and immediately after (T1) exercise, as well as after a 15-minute rest (T15) and another 15-minute rest period (T30). Pre and post fatigue effects were compared using paired t tests. Time effects were tested using repeated measures ANOVA with Tukey's HSD post hoc pairwise comparisons. RESULTS: Between T0 and T1 stepping limb angular displacements of the knee and ankle during the support phase were increased 37% (p=0.02) and 23% (p=0.008) respectively. In addition, center of pressure (COP)-center of mass (COM) difference during the swing phase of the tether-release was increased 19% (p=0.014) after AMF in the forward fall, and 17% (p=0.036) in the posterior fall. The analysis of T0-T30 time effects revealed that only 3 out of the 20 outcome measures altered by AMF returned to baseline within 30 minutes of rest. CONCLUSIONS: These data suggest that AMF has deleterious effects on reactive postural control in HE persons including increases in angular displacements at joint centers critical to fall recovery. These data contradict previous reports suggesting postural control recovers within 10 minutes.4 This report should serve to heighten clinical awareness of the consequences of AMF on

stepping responses critical for postural control. REFERENCES: 1. Moore J et al. Acute effects of a single bout of resistance exercise on postural control in elderly persons. Percept Mot Skills. Jun 2005. 2. Riemann B et al. The relationship between various modes of single leg postural control assessment. Int J Sports Phys Ther. Jun 2012. 3. Sell T. An examination, correlation, and comparison of static and dynamic measures of postural stability in healthy, physically active adults. Phys Ther Sport. May 2012. 4. Parreira R et al. Effect of trunk extensor fatigue on the postural balance of elderly and young adults during unipodal task. Eur J Appl Physiol. Aug 2013.

P1-J-44 MET equivalent of gait in people with Chronic Conditions

Daniel Rafferty[1], Martijn Steultjens[1], James Woodburn[1], Lorna Paul[2]

[1]Glasgow Caledonian University, [2]University of Glasgow

Background & Aim: Metabolic equivalent of task (MET) is often quoted to facilitate comparisons of the energy requirements of physical activity. It is a ratio of the oxygen uptake (VO2) required performing a task expressed in relation to VO2 during quiet sitting (Resting Metabolic Rate (RMR)). Gait is the most common form of physical activity that we undertake and greatest efficiency is achieved at self selected walking speed (SSWS). People with chronic conditions tend to adopt a slow, less efficient gait pattern. In healthy adults the speed of gait has a linear relation with VO2. The translation of energy requirements of gait using METs is dependent on this relationship. The aims of this work are to explore a) if gait speed is linearly related to METs in people with chronic conditions and b) if MET for gait is greater in people with chronic conditions than controls walking at matched speeds. Methods: This work presents a secondary analysis of data collected over four independent. Sixty-one people with chronic conditions (13 Stroke, 12 MS, 17 CFS and 19 RA) and 61 age, gender and BMI individually matched controls were analysed. All people with chronic conditions walked for 5 minutes at their SSWS. Controls walked at a gait speed matched to the SWSS of the person with chronic condition to which they were matched. VO2 of walking was recorded using a portable indirect calorimeter and MET calculated for minutes 3-4 during steady state gait. Correlates of MET and gait speed were explored using the PCC and differences explored using appropriate statistics dependant on the distribution of the data. Results: There were no statistical differences between the controls and people with chronic conditions for age (48 ±10.6 and 49 ± 10.8 yrs), BMI (25.4 ±4.1 and 25.7 ± 4.7 kg m2) or speed (0.71 ±0.31 and 0.70 ± 0.31)(all p>0.05). RMR was similar in people with chronic conditions and controls (3.6± 0.97, 3.5± 0.95 ml kg-1 min-1)(p=0.64). There was no significant correlation between speed and MET for people with chronic condition (r2=0.09, p=0.49) whereas controls walking at the matched speed of the people with chronic conditions had a significant and moderate relationship between MET and speed (r2=0.64, p<0.001). People with chronic condition had a significantly greater MET for gait than controls (3.16 ±0.78 and 2.56 ± 0.72 METs, p<0.001). Conclusions :The use of METs when estimating the energy requirements for gait in people with chronic condition at SSWS is questionable. This study did not find a linear relationship between MET and gait speed for people with chronic conditions additionally the MET requirement was significantly greater than controls walking at matched speeds. Translating self reported or objectively measured gait activity into METs should be undertaken cautiously in healthy participants as a consequence of the moderate relationship demonstrated and may be inappropriate in people with chronic conditions.

P1-K-45 Does hip abductor fatigue affect hip position sense and gait parameters in older adults?

Mina Arvin[1], Marco Hoozemans [1], Bart Burger [2], Sabine Verschueren [3], Jaap van Dieën [1], Mirjam Pijnappels [1]

[1]VU University Amsterdam, [2]Medical Centre Alkmaar, [3]KU Leuven

Background and aim: Aging is associated with a decline in proprioceptive acuity, which affects postural and movement control. Additionally, muscular fatigue can affect proprioceptive sensitivity as well as postural stability. During walking, hip abductors play an important role in mediolateral stability. The aim of our study was to assess the effect of unilateral hip abductor fatigue on hip position sense and gait parameters in older adults. Methods: Seventeen healthy volunteers (age: 73.2 (SD 7.7) years) participated in this study. Joint position sense (JPS) was tested by an active-active reproduction method while participants stood on one leg. Then participants walked on the treadmill at preferred walking speed for 5 minutes to collect 3D linear trunk acceleration and angular velocity by an inertial sensor at the lower back. Afterwards, participants performed a fatigue protocol with hip abduction movement in side-lying position. The JPS and walking test were repeated immediately after the fatigue protocol. Absolute and relative errors were calculated to determine the JPS. Gait parameters including step and stride time, local dynamic stability, harmonic ratio as well as trunk angular displacement in sagittal and frontal planes were also quantified. Results: For the JPS test, participants reproduced the target angle with 81% more absolute error after fatigue (pre-fatigue: Mdn=1.00°, IQR=0.70°, post-fatigue: Mdn=1.81°, IQR=1.19°, p=0.02). The result of relative error showed that the bias was overestimated after fatigue (p=0.02). For the gait measurements, step and stride time variability were considerably increased after fatigue, while step-to-step symmetry was decreased in medio-lateral direction (Table 1). Mean step time of the fatigued-leg was slightly shorter than non fatigued-leg (p=0.01). Trunk movement was larger in the sagittal plane after fatigue (M = 3.61°, SD = 1.80°) compared to pre-fatigue (M = 3.02°, SD = 1.19°), p=0.02. Local dynamic stability during walking was not affected by fatigue. Conclusions: Local fatigue of the hip abductors negatively affected joint position sense, spatiotemporal parameters and trunk movement during gait, but not on gait stability in healthy older adults. Changes in JPS and gait parameters such as stride time variability and step-to-step symmetry might increase fall risk in older population, but the healthy older participants in our study were able to remain stable, despite the effects of fatigue on JPS and spatiotemporal parameters.

P1-K-46 Improved cognitive flexibility is independently associated with reduced falls risk and falling

Teresa Liu-Ambrose[1], John Best[1], Chun Liang Hsu[1], Jennifer Davis[1], Lindsay Nagamatsu[1]

[1]University of British Columiba

Background and Aim: Fall-related injuries are the leading cause of unintentional injury among those 65 and older (Dellinger & Stevens, 2006). The widely accepted dogma is that improved physical function, balance, and muscle strength underlie the effectiveness of exercise in reducing falls. However, emerging evidence now suggests that improved executive functions (EFs) may be an important yet under-appreciated mechanism by which exercise reduces falls in older adults (Liu-Ambrose et al., 2008; Liu-Ambrose et al., 2013). Using data from a randomized controlled trial (RCT), we aimed to determine whether changes in EFs during a 6-month exercise training intervention predicted reduced falls risk and

the likelihood of falling over that same period of time. Methods: Participants were 86 older women (M=74.9 years, SD=3.5) with probable mild cognitive impairment (self-reported memory difficulties and <26 on Montreal Cognitive Assessment) but who were otherwise cognitively intact (Mini-Mental State Examination [MMSE]≥24/30). All women were participants in a 6-month RCT, testing the effects of twice-weekly resistance training (28 women), aerobic training (30 women), or balance and toning (control group; 28 women). Assessments were conducted at baseline and at trial completion. Executive functions were assessed with the Trail Making Test (TMT) (cognitive flexibility); the Stroop Test (inhibitory control); and Backward Digit Span (working memory). The Physiological Profile Assessment (PPA) assessed falls risk. Falls were tracked throughout the 6-month RCT by monthly falls diaries. Statistical analyses included multiple linear and Poisson regression, using maximum likelihood estimation with robust standard errors. Covariates included baseline and change scores for the Functional Comorbidity Index, the Timed Up and Go Test, and the National Institute on Aging Balance Scale, as well as baseline MMSE score, falls history (12 months prior to study) and exercise group. Results: Improved TMT performance correlated with reduced falls risk over the 6-month RCT (r=.27, p=.012). Neither change in Stroop interference nor change in backward digit span correlated with change in falls risk (ps>.30). Multiple linear regression analysis revealed that the association between improved TMT performance and reduced falls risk remained significant (p=.016) after accounting for the covariates and baseline PPA score (see Table). During the RCT, 27.2% of the sample reported one or more falls (range:0-4 falls). A Poisson regression analysis (treating reported falls as a count variable) showed that improved TMT performance predicted decreased likelihood of falling during the intervention period (p=.013), after accounting for the covariates and change in falls risk. Conclusions: These results add support the Central Benefit Model (Liu-Ambrose et al., 2013) for falls prevention. Specifically, improved cognitive flexibility may be an important mechanism by which exercise reduces falls.

P1-K-47 Attentional demands of falls: Effect of dual-tasking on reactive balance response to large magnitude perturbations.

Tanvi Bhatt[1], Prakruti Patel[1]

[1]University of Illinois at Chicago

cognitive task simultaneously with reactive balance task can lead to reduced performance on the cognitive task, but does not affect the balance response. These studies suggest that reactive balance responses may not be attentionally demanding. However, use of small magnitude perturbations which may not be sufficient to elicit a stepping strategy makes it difficult to understand whether the reactive balance responses do not require attentional resources or the attentional requirement depends on the magnitude of the perturbation. This study examined the effect of a concurrent cognitive task on the ability to execute a compensatory step response in presence of sudden large magnitude forward perturbation. It was hypothesized that the ability to initiate and execute appropriate compensatory stepping response will be compromised while simultaneously performing a cognitive task (dual-task-DT) compared to no cognitive task performance (single-task-ST) condition. Methods: Fifteen healthy young adults were instructed to maintain their balance in response to sudden forward directed perturbations. Perturbations were delivered with velocity of 0.86m/s, displacement 0.38m, and acceleration of 21m/s2 for 0.33s. Neuromechanical variables such as compensatory step length, peak COM displacement, and step initiating time were recorded using motion capture. The reaction time was obtained from tibialis

anterior muscles. After receiving a familiarization trial, subjects performed the reactive balance task without a cognitive task (ST-balance) and while performing an alphanumeric cognitive task (DT). The cognitive task was also performed while standing (ST-cognition). The number of correct responses on the cognitive task was recorded. Results: The compensatory step length significantly reduced ($p<0.05$) and reaction time significantly increased in DT compared to ST-balance conditions ($p<0.05$). Peak COM displacement significantly increased in DT compared to ST-balance conditions. Further, the number of correct responses on the alphanumeric cognitive task also declined in DT compared to ST-cognition condition ($p<0.05$). Conclusions: The deterioration of both motor and cognitive variables under DT conditions supported our hypothesis that reactive responses to large real-life like perturbations require attentional resources. These responses therefore, might involve higher order planning and co-ordination processes. It is suggested that pre-occupying attentional resources with an additional cognitive task could potentially interfere with the cortex's ability to provide feedback for timely and appropriate recovery response initiation and execution-hence predisposing an individual to an increased risk of falling. Considering the attentional demands of reactive balance tasks, fall-prevention interventions should focus on simultaneous cognitive-balance training under more challenging environmental conditions.

P1-K-48 Age-related differences in the control of weight-shifting within the surface of support

Elisabeth de Vries[1], Simone Caljouw[1], Milou Coppens[1], Klaas Postema[1], Gijsbertus Verkerke[2], Claudine Lamoth[1]

[1]University of Groningen, University Medical Center Groningen, [2]University of Groningen, University Medical Center Groningen and University of Twente

BACKGROUND AND AIM: An important reason for falling in elderly is incorrect weight-shifting[1]. In many daily life activities quick and accurate weight-shifting is needed to maintain balance, especially in situations when balance is suddenly disturbed and anticipation on the upcoming movement is difficult. Considering the deterioration in postural control in elderly[2], it is expected that they have more difficulties with executing these quick and accurate weight-transfers[3]. The present study aims to gain more insight in age-related differences in postural control strategies during a postural control task requiring weight-transfers of different amplitudes and in different directions within the surface of support. METHODS: Nine healthy older adults (70.3±6.9 years) and twelve young adults (20.9±0.5 years) participated in the study. The participants performed a weight-shifting task by moving the whole body in different directions to move a cursor, representing real time COP position, towards targets of different sizes and at different distances projected on a screen. Movement time (MT) was the time between the appearance of the goal target and the moment a target switch was realized (i.e. the cursor stayed in the goal target for 0.5 second). The accuracy of the movement was quantified by Counts on Goal (CoG), that is the number of times the cursor hit the goal target before a target switch was realized and by Dwelling Time (DT), the time required to realize a target switch after the goal target was hit by the cursor for the first time. Fluency was expressed by the maximal deviation (MD) of the performed path with respect to the ideal path and the number of peaks (nP), or inflections in the performed path. RESULTS: Significant main effects of target size, target distance and age on all outcome measures were found ($p<.01$). With decreasing target size, increasing target distance and increasing age, MT significantly increased and fluency and accuracy significantly decreased (nP, MD, CoG and DT increased). Elderly used a slower, less accurate and less fluent weight-shifting strategy compared to younger adults with increasing task

difficulty (e.g. decreasing target size and increasing target distance) as indicated by significant interaction effects of size*age and distance*age (p<.05). CONCLUSION: The results of this study provided insight in how elderly control their weight-shifting when the movement cannot be anticipatorily planned. Elderly exhibited slower and more variable movements, especially with increasing task difficulty. This weight-shifting strategy seems characterizing for an increased fall risk in elderly, since the results indicate that elderly might have more difficulties with executing an adequate (quick and accurate) adaptation to a perturbation in daily life. [1]SN Robinovitch et al. Lancet. (2013), 381(9860), 47-54. [2]FB Horak. Age Ageing. (2006), 35(2), 7-11. [3]V Jongman et al. Stud Health Technol Inform. (2012), 181, 93-97.

P1-K-49 Slow Gait, Mild Cognitive Impairment and Fall: Obu Study of Health Promotion for the Elderly

Takehiko Doi[1], Hiroyuki Shimada[1], Hyuntae Park[1], Hyuma Makizako[1], Kota Tsutsumimoto[1], Kazuki Uemura[1], Ryo Hotta[1], Sho Nakakubo[1], Takao Suzuki[1]

[1]National Center for Geriatrics and Gerontology

Background and aim: Gait slowing is linked to be worsening with cognitive impairment such as dementia and preceded to even MCI, considered as a clinical signature that the prodromal phase of Alzheimer disease (AD), most types of dementia. The deficits of gait and cognition may contribute to disabling forms of fall or dementia. However, the association of combination status of slow gait speed with MCI, cognitive function and fall were not investigated among a large cohort study with fully sample. To examine whether combination status of slow gait and MCI associate with cognitive functions and fall in community-dwelling older people. Methods: Participants (n = 3400) from Obu Study of Health Promotion for the Elderly underwent gait examination and neuropsychological examinations, and interviewed a series of questionnaires including fall history. Results: Participants were classified as healthy control (N = 2281), slow gait speed (SG, N = 278), MCI (N =673) and MCI with SG (MCI+SG, N = 168) groups. All of cognitive functions were significantly affected by group factor even adjusted for subjects' characteristics as covariates (p < .001). Post-hoc analysis showed that control group had better performances than any other groups and MCI+SG group had worse performances than any other groups in all of cognitive functions (all p < .05). In multiple logistic regression analysis, status of SG and MCI was independently associated with fall (p < .05) and MCI+SG had higher odds ratio against fall (adjusted OR: 1.99 [95%CI: 1.08-3.65]). Conclusions: Our findings support the idea that slow gait speed had impact on cognitive function separately from MCI. Combined slow gait speed and MCI had strongly affected cognitive function in comprehensive domains and associated with fall.

P1-K-50 Failure to clear stationary, visible obstacles is affected by surface characteristics

Michel Heijnen[1], Shirley Rietdyk[1]

[1]Purdue University

BACKGROUND AND AIM: Previous research has examined the changes in gait characteristics as a function of environmental manipulations and related these changes to trip risk. These studies describe gait characteristics of the successful trials. To fully describe the risk of tripping, it is important to also examine the unsuccessful trials when the subject's foot contacts the obstacle (failures). Heijnen et al. (2012) examined failures and found that foot elevation progressively decreased with each trial (slope -

1.0 mm/trial), which continued until the subject contacted the obstacle. In the study, high contrast was provided between the black obstacle and the solid gray carpet, and the carpet provided a good amount of friction. It's important to extend these failure observations to different environments. The purpose of this study was to determine changes in failure as a function of flooring surfaces. METHODS: Eighty-two young healthy adults participated in one of two experiments (carpet or hardwood floor). Subjects walked on an 8 m walkway, stepping over an obstacle placed in the middle of the walkway (obstacle height was 25% of leg length), for 150 trials. Trial of first contact was measured. Minimum foot clearance (MFC) for the lead and trail limb was the minimum distance between the toe and obstacle, and the heel and obstacle. The change in MFC over trials until contact was described with a linear regression. RESULTS: Subjects contacted the obstacle earlier on a hardwood floor compared to the carpet ($p<0.001$; trial 44 vs 86 on hardwood vs carpet, respectively). MFC during the first three trials was not different ($p=0.93$), but the rate of decrease of MFC was steeper for the hardwood floor (-1.9 mm/trial) and was almost twice as high as the slope in the carpet condition (-1.0 mm/trial). These findings suggest that there is a decreased risk of obstacle contact when walking on the solid grey carpet vs the hardwood floor. Possible explanations are the differences in friction and contrast between the two conditions. First, while a higher clearance decreases the risk of obstacle contact, it also is destabilizing because the center of mass is higher, and the limb is likely moving faster. Therefore, on the hardwood surface, subjects may have decreased MFC at a faster rate to become more stable when the friction was lower. Secondly, differences in obstacle contrast on the two surfaces may lead to differences in gaze fixation as the obstacle is more visible on the solid grey carpet compared to the 'visually cluttered' hardwood floor (visual clutter from lines and patterns). Subjects may fixate less on the obstacle with repeated crossings when there is greater visual clutter. CONCLUSIONS: Minimal changes in environmental characteristics affected failure to clear a stationary, visible obstacle. These findings may have implications for the built environment and proactive obstacle avoidance training interventions.

P1-K-51 Towards a better understanding of turning deficits in people with Parkinson's disease.

Sophia Hulbert[1], Ann Ashburn[1], Lisa Roberts[1], Geert Verheyden[2]

[1]University of Southampton, [2]University of Leuven

AIM: To examine the relation between head/trunk and limb movement during turning on-the-spot in people with Parkinson's disease (PwPD) and healthy controls (HC). BACKGROUND: Parkinson's disease (PD) is a common, progressive, neurodegenerative movement disorder of the central nervous system, presenting with impairment of the motor system. Clinically, PwPD demonstrate a loss of axial rotation of the spine often described as moving "en bloc", with little dissociation between the head, trunk and lower limbs whilst turning, unlike the inter-segmental reciprocal movements seen in HC. Deficits of the axial (head and trunk) and perpendicular (limbs) body segments have been demonstrated in the literature; the exact relationship and effect on function (in particular turning) is less understood. METHODS: Using 3-D movement analysis (Coda motion analysis and VNG Ulmer), five PwPD (median age 73, median Hoehn & Yahr 2) and four HC (median age 71) completed twelve 180° on-the-spot turns. Data were collected on (1) latency and change in horizontal movement of the eyes, head, thorax, shoulders, pelvis and feet from a light cue to the point of first foot movement (FFM), (2) centre of mass (COM) displacement, (3) peak horizontal force and (4) time of the turn. The standing start 180 degrees turn test (SS180) was also completed. Descriptive statistics and correlation analysis enabled preliminary

comparisons of variables between PwPD and HC. RESULTS: HC showed shorter latencies in all body segments and faster total turn time compared to PwPD, replicated in the SS180. There were similarities in the order of initiation of lower segments (pelvis and feet) between groups, but upper-segments (eyes, head, shoulder, and thorax) in PwPD failed to show the 'top-down' order seen in HC. In the initial stages of the turn (up to FFM), PwPD showed less rotation in the shoulders and thorax, and greater rotation in the head and pelvis. In PwPD the pelvis was negatively correlated with the head (r= -0.10) but positively correlated with the shoulders (r= 0.63) and thorax (r= 0.72), with the reverse occurring in HC (r = 0.73, 0.34 and 0.47 respectively). Number of steps taken was greater in PwPD, which correlated to the change in angle of the head, shoulders and thorax in PwPD but not HC. PwPD showed reduced COM displacement relative to base of support but greater in total distance, with peak horizontal force occurring later compared to HC. CONCLUSION: PwPD had a tendency towards a slower, altered co-ordination, 'en bloc' pattern of axial segments with corresponding perpendicular deficits of increased step number compared with HC. Our results and the literature support the notion of axial deficits driving perpendicular deficits in PwPD. The exact mechanism of such interplay remains unclear and requires further investigation. Clinically, these preliminary results highlight the need for axial deficits to be considered in rehabilitation programmes.

P1-K-52 Does the smoothness of walking under dual-task conditions reflect the risk of falling in patients with stroke?

Yu Inoue[1], Tetsushi Nonaka[2], Kazuhiro Harada[2]

[1]KIBI International Universit, [2]KIBI International University

BACKGROUND AND AIM Smoothness of walking is one of the important gait dynamics to assess the recovery of walking capacity in clinical rehabilitation. We previously reported that power spectrum entropy (PSEn), a measure of smoothness of walking, calculated from the vertical component of trunk acceleration is sensitive to the change in task loads (single task vs. dual task). The purpose of this study was to investigate in which phases of gait cycle PSEn values are affected by the dual-task loads, and whether smoothness of walking is associated with the risk of falling in patients with stroke. METHOD Subjects were 14 patients with stroke who were capable of walking without assistance (66.6±9.3 years, female: 6). Participants were instructed to walk a 12m walkway at fast walking speed under single and two dual-task conditions (walking with arithmetic task: (1) addition, (2) subtraction). Trunk acceleration was recorded under each condition using tri-axial accelerometer attached to the L3 spinous process (MVP-RF8; Microstone, sampling rate: 200Hz). Using the peak AP accelerations of the non-paralyzed side at heel contact, ten gait cycles were extracted from time-series data (the first two gait cycles were excluded from the analysis). The vertical component of accelerometer signal in each gait cycle was divided into seven 64-sample sections with 50% overlapped portions (32 samples). Within each section, root mean square (RMS), auto-correlation coefficient (AC), and PSEn were calculated. On the basis of Berg balance scale and Stops walking when talking test, participants were allocated to high-risk of falling group or low-risk of falling group. Ethical approval was obtained from the local ethics committee. All the participants provided written informed consent after the purposes of this study were explained to them. RESULT A linear mixed model ANOVA on mean PSEn involving PHASE, TASK and RISK as fixed effects and SUBJECT as a random effect found significant effects of PHASE, TASK, PHASE*TASK, PHASE*TASK and PHASE*TASK*RISK interactions. There were no significant effects of RISK and TASK*RISK interaction. Pair-wise, Bonferroni-corrected post-hoc comparisons found that dual-task loads affected the

smoothness of walking to a greater degree in high-risk group compared to low-risk group during the pre-swing and terminal-stance phase of the paralyzed leg. CONCLUSION The smoothness of walking reflects the risk of falling, especially in the pre-swing and terminal-stance phase of the paralyzed leg.

P1-K-53 Identifying fall risk factors in psychogeriatric nursing home residents

Nienke Kosse[1], Maartje de Groot[2], Tibor Hortobágyi[1], Claudine Lamoth[1]

[1]University of Groningen, University Medical Center Groningen, [2]Slotervaart Hospital

BACKGROUND AND AIM: Falls lead to substantial physical and mental costs for psychogeriatric patients and increase the financial burden for institutions [1]. Identifying fall risk factors and the relation between factors may contribute to more individual and effective prevention programs. Although it is becoming clear that complex interactions among numerous factors underlie the occurrence of falls [2], the identification and interaction of these factors are rarely investigated in residents of psychogeriatric wards. Therefore, the aim of the present study was to examine the relation between multiple patient characteristics and fall frequency in psychogeriatric residents. METHODS: Twenty nursing home residents diagnosed with dementia (80±11 years; 60% male), living on a psychogeriatric ward participated in the study. Based on available information in patient records, 56 patient characteristics (factors) and number of falls were documented for 19 months. The factors represented 7 domains: demographics, activities of daily living (ADL), mobility, cognitive and behavioural factors, visual and hearing abilities, medical conditions, and drug use. To examine the relation between the factors and fall frequency a multivariate Partial Least Squares (PLS) regression was performed [3]. The PLS model shows the capacity of the factors to explain the variance (R^2) in fall frequency. Variable importance in projection (VIP) values summarize the importance of factors in the model (VIP>1 is considered important). The regression coefficient (RC) indicates the association between each factor and the fall frequency (high RC is strong association). RESULTS: A total of 113 falls (5.7±7.0 falls) occurred during the study period. Factors included in the PLS model explained 94% (R^2) of the variance. Figure 1 presents the most important factors (VIP>1), and the relation between the factors and fall frequency (RC). The domains mobility, ADL, cognitive and behaviour factors, and medical conditions were most important to the model. Factors that cause difficulties in walking, indicators of disinhibited behaviour, and inactivity were strongly related to fall frequency. Demographics and visual and hearing abilities were less important. CONCLUSION: Cognitive impairment is often indicated as fall risk factor; however, our results showed that especially cognitive impairment related to disinhibited behaviour is associated with a high fall frequency. Moreover, being immobile seems to decrease fall frequency. The novel analytic approach gives a detailed view of the fall risk factors and interactions in psychogeriatric residents and enables more effective fall prevention. [1]Eriksson et al 2008 Arch Gerontol Geriatr; [2]Davison et al 2007 Rev Clin Gerontol; [3]Abdi 2010 WIREs Comput Stat FIGURE: The influential factors (VIP>1) and the association with fall frequency (RC). E.g. the presence of feet inconveniences and the absence of heart failure are associated with high fall frequency

P1-K-54 Postural strategies to regain balance after dynamic perturbation

Julie Nantel[1], Shaun Porter[1]

[1]University of Ottawa

Background and aim: The inability to regain balance after a self-initiated activity like walking or taking a lateral step in response to an external perturbation is highly related to the risk for falls. In particular, postural control in the medial-lateral (ml) direction is of particular interest to assess changes in the integrity of postural control (Maki and McIlroy, 1996). The objectives of this study were to assess the postural control strategies used to regain balance following a stepping task (SIP, Nantel et al., 2011) and compare these strategies between young and older adults. Methods: Twenty-three subjects, 14 healthy young (20-40 years) and 9 healthy older (60-90 years) adults, participated in the study. Subjects were excluded if they reported any impairment that could interfere with balance. Task: Participants stood quietly for 30s, stepped laterally to the left, performed 60s of SIP, then took a step to the right and stood quietly for 30s. The task was performed three times on two force platforms (Kistler, Switzerland). Kinetics was captured at 200 Hz and filtered with a zero-lag fourth-order Butterworth filter with a 10Hz cut-off frequency. Center of pressure displacement (CoP) and velocity (VCoP) in both anterio-posterior (ap) and ml directions were analysed to assess postural control. Postural control before (CoP1) and after (CoP2) the dynamic tasks were compared with Student's paired t-tests. CoP2 was also divided in three 10s bins (2a to 2c) and compared to CoP1. Independent samples t-tests were used to compare CoPs between groups. Modified Bonferroni procedures were used when necessary. Results: Older adults showed larger CoP2, 2a and 2b-ml ($p<0.05$) and VCoP2 (ml: $p<0.01$, ap: $p<0.05$) compared to young subjects. In young subjects, CoP2 and CoP2a were larger compared to CoP1 and decreased significantly in both CoP2b and 2c in ml and ap. VCoP2 and 2a were also larger, but went back to normal in VCoP2b, 2c-ml/ap. In older adults, CoP and VCoP were larger in bins 2 and 2a ($p<0.01$) and stayed larger for VCoP2b ($p=0.027$ corrected value). Conclusions: Both groups showed larger CoP and VCoP following dynamic tasks, especially within the first 10s and both groups return to normal within 20s. However, the groups used different postural strategies to regain balance. Following the large instability in the first 10s, young subjects significantly reduced CoP and VCoP in the second 10s while values in older adults stayed high and then return to normal in the last 10s. Older adults took twice the time to regain balance after self-initiated perturbation, which emphasises the risk for postural instability and falls during this balance recovery phase.

P1-K-55 Walking while listening in an audio-visual virtual reality street scene: Effects of age, dual-task demands, and target location uncertainty

Victoria Nieborowska[1], Sin-Tung Lau[2], Linda Truong[3], Eugene Alexandrov[1], Alison Novak[2], Jennifer Campos[2], M. Kathleen Pichora-Fuller[4], Karen Li[1]

[1]Concordia University, [2]Toronto Rehabilitation Institute , [3]Ryerson University, [4]University of Toronto

Background and aims: Age-related hearing loss is associated with reduced cognitive functioning (Lin et al., 2011), mobility decline, and greater falls risk in older adults (Viljanen et al., 2009). Cognitive resources are required for both locomotor activity and communication, the resources required may increase with age and with hearing loss (Meister et al., 2013). Our study examined the immediate competition for cognitive resources between walking and listening. Method: Healthy young and older adults with normal pure-tone thresholds (≤25 dBHL below 4kHz) participated. Three sentences (1 target, 2 maskers) were played simultaneously from different apparent locations (left, right, center) using simulated spatial separation in a virtual reality street scene. There was 100% or 60% probability of the target sentence being presented from the center. Participants reported the number and colour in the target sentence that was identified using a callsign cue. There were three conditions: walking, listening,

and walking while listening. Infrared emitting diodes secured on the head, upper body and sacrum permitted identification of head and trunk angles in three dimensions. Results: Listening accuracy was significantly worse in (a) older than young adults, (b) dual-task than single-task conditions, and (c) 60% than 100% location probability. Older adults' listening accuracy was disproportionately worsened by concurrent walking and less predictable auditory target locations. Preliminary walking analysis revealed that RMS trunk and head angle measurements showed reduced variability in dual-task condition with 60% location probability, followed by dual-task condition with 100% location probability, in comparison to walking alone conditions in older adults. In contrast, no similar trend was found in younger adults. This trend of decreased variability across increasingly complex conditions was observed for head pitch and roll, and to a certain degree trunk roll in older adults. Conclusions: The findings suggest that listening performance in old age is particularly hampered when concurrently walking, and when the location of the signal is less predictable. The relationship between hearing acuity and listening performance in dual-task conditions aligns with previous evidence of a link between hearing loss and mobility. In addition, there is evidence to suggest postural prioritization during walking in older adults as the dual-task condition becomes more challenging, however this is not evident in younger adults. A possible explanation is that as task conditions increase in difficulty older adults reduce their walking speed, resulting in lower variation in head and trunk movement. Together, the results support the hypothesis that listening challenges have an effect on mobility and provide early experimental evidence to explain the epidemiological link between age-related hearing loss and reduced mobility.

P1-K-56 Does dual task performance predict recurrent falling in Parkinson's disease?

Carolien Strouwen[1], Esther Molenaar[2], Liesbeth Münks[1], Samyra Keus[2], Bastiaan Bloem[3], Alice Nieuwboer[1]

[1]KU Leuven, [2]Radboud University Nijmegen Medical Centre, [3]Radboud University Medical Centre

BACKGROUND AND AIM: Despite clear dual tasking (DT) difficulties in patients with basal ganglia dysfunction, DT performance was previously not found to be associated with falling in people with early Parkinson´s disease (PD). Therefore, we examined whether DT performance predicted recurrent falling in patients with mid stage PD. METHODS: Thirty six participants with PD (Hoehn and Yahr stage II or III) were included as part of the DUALITY study. Fall frequency was determined over a period of six months by weekly phone calls. Patients were divided into two groups: no or non-recurrent fallers (0 or 1 fall) and recurrent fallers (2 falls or more). Predictors consisted of disease severity measures, the Freezing of Gait Questionnaire (FOGQ), cognitive tests and DT gait outcomes. Gait was assessed with the GaitRite mat under single and dual task conditions using the digit span task, the auditory Stroop task and a mobile phone task, where participants had to type the date while walking. Single and dual tasks were administered in randomized order. After controlling for co-linearity, a forward binary logistic regression model to predict recurrent falling was used. RESULTS: Twenty participants (55.5%) fell twice or more in the six month follow-up period and were classified as recurrent fallers. Twenty participants (55.5%) indicated to experience freezing of gait and fifteen of them (75%) fell recurrently. The regression model proved reliable in distinguishing between fallers and no fallers when compared against the constant model (chi square=18.687; $p<0.001$; df=2) with an accuracy of 77.8% (75.0% for recurrent falls and 81.3% for no falls). Nagelkerke's R2 showed a relationship of 54.2% between the predictors and falling. FOGQ (Wald=5.588; $p=0.018$) and DT cadence as tested by the auditory Stroop task (Wald=4.495; $p=0.034$) contributed significantly to fall prediction. Exp(B) values were 1.155 (95%CI[1.025 to 1.302]) for

FOGQ and 1.134 (95%CI[1.010 to 1.274]) for DT cadence, implying that an increase with the score of 1 on the FOGQ or an increase of 1 step/minute on the Stroop task increased the risk of falling by 15.5% and 13.4% respectively. CONCLUSIONS: Although only 54% of the variance was explained by the model, this study showed that cadence during the auditory Stroop task together with the FOGQ contributed significantly to the prediction of recurrent falling in mid stage PD. This supports the contention that patients, and particularly freezers, need to be made aware of inherent fall risk in relation to dual tasking and also points to the need for appropriate rehabilitation.

P1-K-57 Are falls related to daily acitivity? Preliminary results of a comparative investigation in neurogeriatic high-risk groups.

Matthis Synofzik[1], Cornelia Schatton[1], Kristin Teubner[1], Karin Srulijes[1], Lars Schwickert[2], Jochen Klenk[2], Winfried Ilg[1], Walter Maetzler[1], Clemens Becker[2]

[1]Hertie-Institute for Clinical Brain Research, [2]Robert-Bosch Hospital

Background and aim: Falls are a leading cause for nursing home placement, disability and injury-related death in elderly persons. Neurogeriatric patients suffering from extrapyramidal, cerebellar or afferent gait disorders are at high risk for falls. It is still unclear whether and how daily activity is related to falls in these high-risk groups. Here we perform a comparative investigation within and between several neurogeriatric high-risk groups, investigating the relation between falls and the amount and type of real-world daily activity, while assessing in parallel also many other additional factors known to be associated with falls. Methods: Four neurological disease and two control cohorts were examined: subjects with (i) Parkinson's Disease (PD), (ii) atypical Parkinsonism, (iii) cerebellar ataxia, or (iv) afferent ataxia compared to (v) elderly healthy subjects (age 65-80 years) and (vi) young healthy subjects (age 18-30 years). A comprehensive clinical and biomechanical assessment was performed, using different clinical rating scales as well as quantitative movement analysis by MobilityLab?(APDM) and/or VICON MX motion capture system, including dual task conditions. This extensive assessment served to detect and quantify several factors known to be associated with an increased risk of falls. Subjects' daily activity was quantified by prospective 7-day monitoring of daily activity in their real world-settings by body-worn sensors (ActivePal?). Falls and fall-related injuries were assessed by a retrospective questionnaire. Results: Preliminary results are provided. Falls and fall-related injuries are much more frequent in neurogeriatric patients suffering from Parkinsonian syndromes or degenerative ataxias than in age-matched controls, supporting their classification as ,,high-risk groups". Disease severity, balance functioning, and quantitative gait and stance parameters each seem to be only loosely related to the amount and type of daily activity. Falls and fall-related injuries might be particularly associated with an intermediate and low amount of daily activities: while highly active subjects did not fall, subjects with an intermediate and low amount of daily activities fell frequently. However, these subjects were also the ones that were most severly affected by disease. Conclusions: Our preliminary results suggest that the risk of falls is related to the amount of daily activities. To corroborate this presumed relationship and to rule out potential confounders (e.g. disease severity), prospective assessments using exact exposition measures that directly calculate falls per unit of activity are required to investigate this relationship more closely. This is currently done by a prospective 6-months monitoring of daily activities of these neurogeriatric groups by a a smartphone-embedded inertial sensor.

P1-K-58 The Relevance of the Nerve Conduction Velocity to Assessment of Balance Performances in Older Adults with Diabetes Mellitus

Chien-Hung Lai[1], Ting-Yun Wang[1], Shih-Ching Chen[1], Chun-Wei Kang[2], Hsiang-Ching Lee[1], Yun-Han Chao[1], Chih-Wei Peng[1]

[1]Taipei Medical University and Hospital, [2]Taipei Medical University Hospital

BACKGROUND AND AIM: Diabetic peripheral neuropathy (DPN) is a common complication of diabetes mellitus (DM). DPN can cause loss of distal sensation and strength which can lead to postural instability and falls. Although DPN can be assessed by nerve conduction studies (NCS), there is limited evidence for the relevance of these electrodiagnostic findings to the balance ability. It is still a challenge for early detection of balance impairment. Therefore, the purpose of this study was to investigate the relationship between peripheral nerve conduction velocity (NCV) on the lower limbs and balance performances in diabetic older adults. METHODS: Twenty-one older adults with diagnosed DM were recruited (age: 68±6 years; height: 159±7 cm; weight: 63±10 kg; 7 males). All participants were evaluated for the nerve conduction velocity in the lower limbs and the balance performances. Peripheral sensory NCV was performed on the sural nerve, and the motor NCV was performed on the peroneal and tibial nerves. The balance assessments consisted of Timed Up and Go test (TUG), Berg Balance Scale (BBS), One Leg Stance (OLS), Multi-Directional Reach Test (MDRT), Maximum Step Length test (MSL), and Quiet Standing with Eyes Open (QEO) and Eyes Closed (QEC). During OLS, the participants were asked to stand on one leg as long as they could. The participants performed maximum reach forward and sideways during MDRT, and performed maximum step in forward, right and left, and backward directions during MSL. Three trials in each direction were performed during MDRT and MSL, and the reaching distance and step length were recorded. During QEO and QEC, participants were asked to stand quietly with both eyes open and closed for 1 min. The balance performances during QEO and QEC were evaluated by postural sway related parameters including sway area, trajectory, and velocity. The Pearson correlation coefficients were performed to investigate the relationship between changes in the NCV and balance performances. RESULTS: The sural sensory NCV ranged from absence to 46 m/sec. The peroneal and tibial motor NCV ranged from 36 to 58 m/sec and 36 to 54 m/sec, respectively. Overall, both sensory and motor NCV had significantly moderate to good correlations with most of the balance tests: TUG ($r = -0.459 \sim -0.612$, $p < .05$), OLS ($r = 0.420 \sim 0.672$, $p < .05$), and MSL ($r = 0.476 \sim 0.599$, $p < .05$). However, the NCV had poor correlations with BBS, MDRT, QEO, and QEC (all $p > .05$). CONCLUSIONS: For diabetic older adults, the peripheral NCV on the lower limbs had significant correlation with balance tests commonly performed in clinic, such as TUG, OLS, and MSL. Such findings indicated that decline in functioning of the peripheral nerves on the lower limb could be utilized as an indicator to detect potential impairment in balance ability in people with DM.

P1-K-59 Utility of physical performance testing in injurious falls risk stratification among older adults

Rachel Ward[1], Marla Beauchamp[2], Alan Jette[3], Suzanne Leveille[4], Jonathan Bean[2]

[1]Spaulding Hospital, Harvard University, Boston Unviersity, [2]Spaulding Hospital, Harvard Medical School, [3]Boston Unviersity School of Public Health, [4]University of Massachusetts College of Nursing and Health Sciences

BACKGROUND AND AIM: Injurious falls are a major source of mortality and disability in the elderly. While multifactorial interventions and exercise programs can effectively prevent falls, limited healthcare resources necessitate that they be reserved for high risk individuals. Medicare and CDC guidelines suggest falls risk assessment include physical performance, although evidence supporting use of specific tests is lacking. We investigated whether the Short Physical Performance Battery (SPPB) or its components predict time to injurious fall alongside fall history and falls efficacy. METHODS: Analyses include data from a population-based sample of 755 community-dwelling adults from the MOBILIZE Boston study. Fall data were collected using a daily calendar. Injurious falls were ascertained via phone interview and defined as falls that resulted in fractures, sprains, dislocations, and pulled or torn muscles, ligaments or tendons or in seeking medical attention. Physical performance was measured by the SPPB, which comprises a 3 stage test of standing balance, a timed 4-m walk test, and a timed test of 5 repetition chair stands. Each component is scored from 0 to 4 with a maximum summed score of 12; higher scores represent better functioning. Fall history (yes/no) within the past year was assessed by self-report. The Falls Efficacy Scale, in which confidence in performing 10 daily activities without falling are rated from 1 (not at all confident) to 10 (extremely confident), was included. Cox proportional hazards models were built to predict incident injurious falls from fall history, falls efficacy score, and SPPB or SPPB component groups, adjusting for age, sex, race, and BMI. Findings were used to create injurious fall risk groups. Injurious fall probabilities per risk group were plotted against follow-up time. RESULTS: Participants had a median follow-up of 2.43 years (IQR: 1.40-3.23). The poorest chair stand performance group (¡Ý16.7 seconds) had a greater hazard of injurious falls compared to all other chair stand groups (HR [95% CI]: 2.06 [1.23-3.46], 1.65 [1.07-2.54], and 1.57 [1.01-2.44] for 1 vs. 2, 3, and 4, respectively). The full SPPB was not predictive of injurious falls. Fall history predicted injurious falls (HR [95% CI]: 1.84 [1.40-2.42]), while falls efficacy did not. A self-reported positive fall history combined with a chair stand slower than 16.7 seconds compounded the probability of an injurious fall (0.43, 95% CI: 0.29-0.54) compared to either a positive fall history (0.28, 95% CI: 0.21-0.33) or a slow chair stand alone (0.20, 95% CI: 0.04-0.26; all at 2 years). CONCLUSIONS: An easily administered chair stand test alongside assessment of fall history enhances risk stratification for fall-related injuries in community-dwelling older adults. Future studies should investigate the effectiveness of intervening on stratified risk groups and whether treatment strategies should differ based on results from risk assessments.

P1-L-60 Cerebral hemispheres: a proprioceptive dependence for postural control?

Noémie DUCLOS[1], Luc MAYNARD[2], Djawad ABBAS[2], Serge MESURE[1]

[1]Institut of Movement Sciences, [2]CRF Valmante

Background and Aim: Proprioception is an important source of information in the postural control. A proprioceptive impairment contributed to a greater risk of falling. Ankle tendon vibration is a useful tool to explore the weight of proprioception in the sensorymotor integration process. Some studies had explored the cerebral activation in response to ankle tendon vibration and affirm right hemisphere dominance for muscle spindle feedback processing [1]. Our main objective was to explore the postural consequences of this dominance for stroke patients. Which are consequences when we stimulate the affected or the "non-affected" hemisphere? Are consequences different if the affected hemisphere is the left or the right one? Methods: We applied Achilles tendon vibration (20 seconds, 80Hz) on the paretic or on the non-paretic lower limb of stroke patients with a right cerebral hemispheric lesion (RCH lesion, n=8) or a left one (LCH lesion, n=11). They were asked to staying as stable as possible, in standing

position, without vision. Standard posturographic parameters were computed (Y and X positions of the Center Of Pressure; covered length; and their evolution along time). Statistic analyze was realized through a repeated measures ANOVA. Results: Both groups reacted in a similar way to vibration on the non-affected limb (Y: backward shift; X: contro-lateral shift of the CoP and increase of the covered length). With LCH lesion, no displacement resulted from the application of vibration on the affected limb. With RCH lesion, a displacement resulted from the application of vibration on the affected limb, limited in regards to the displacement with vibration of the non-affected limb. This group always showed the highest covered length. The resulting instability from vibration appeared faster when the right hemisphere was targeted by vibration (during first seconds of vibration applied on the affected limb) whereas it appeared after more than 10s of vibration when the left hemisphere was "targeted" (vibration applied on the non-affect limb). Conclusions: The proprioceptive perturbation is not integrated when the left hemisphere is both the affected and the "targeted" hemisphere. The left hemisphere appears not sensitive to proprioception aspects. The proprioceptive perturbation is well integrated in the postural control when the right hemisphere is the "targeted" hemisphere in spite of its lesion. This hemisphere integrates immediately the proprioceptive information in the postural control. We confirm here the right dominance for proprioceptive process in postural situation. With RCH lesion, postural consequences are majored, not compensated by the non-affected limb and hemisphere. In contrary, with LCH lesion, the right hemisphere plays its role of "postural hemisphere" [2] and permits an adapted stability by the non-affected. [1] Goble DJ & al. J Neurosci. 2011;31(45):16344-52. [2] Bonan I & al. Arch Phys Med Rehabil. 2004 ;85:268-273.

P1-L-61 Neurorehabilitation in degenerative cerebellar disease by exergames: improvements of ataxia-specific dysfunctions in complex movement sequences

Winfried Ilg [1], Cornelia Schatton[1], Bjoern Mueller [1], Nicolas Ludolph[1], Martin Giese[1], Ludger Schoels [1], Matthis Synofzik[1]

[1]Hertie Institute for Clinical Brain Research

Background: The cerebellum is crucial for motor control (e.g. of gait and posture) and motor learning. Therefore, motor rehabilitation in patients with degenerative cerebellar disease is challenging, and the capability of motor improvements for these patients is still an open question. We have recently shown that an 8 weeks motor training program, based on playing whole-body controlled video games, can lead to a reduction of ataxia symptoms and an improvement in gait for children with degenerative cerebellar disease [1]. However, the functional mechanisms underlying these improvements are poorly understood, and it is unclear whether they transfer to movements relevant for everyday life. The goal of this study was to examine whether long-term exergames training leads to improved control capacities in complex movement sequences and whether these improvements transfer to other movements in patients with degenerative cerebellar disease. Methods: We performed a quantitative analysis of rapid goal-directed stepping movements while repeatedly playing a commercially available videogame version of a choice stepping reaction time task [2] called "Light Race" (Xbox Kinect?). This game was part of an eight-week exergames training program for 10 children with degenerative cerebellar disease. The rapid stepping sequences during game playing were analyzed with respect to dynamic stability [3], multi-joint coordination and movement variability. Results were compared to the improvements of age-matched controls playing the game for short-term. Results: After 8 weeks of? training, children improved their general game play with respect to games scores, increased step frequency, decreased movement

variability (p<0.003),as well as decreased movement decomposition (p=0.01). Additionally, ataxia-specific measures revealed improvements in inter-joint coordination (p=0.04) as well as increased dynamic stability (p=0.02). These improvements correlated with changes in gait and goal-directed leg placement. Conclusion: Exergame-training leads to specific improvements of ataxia-specific dysfunctions like multi-joint coordination and dynamic stability. This includes complex whole-body movements highly relevant for everyday living, e.g. rapid stepping movements to compensate for gait perturbations and to prevent falls. Improvements transferred also to other movements, indicating a generalization effect of the underlying control mechanisms. Therefore, directed training with exergames presents a highly motivational, cost-efficient and home-based rehabilitation strategy to train dynamic balance, multi-joint coordination and interaction with dynamic environments in children with progressive cerebellar degeneration and potentially also in a large variety of young-onset neurological conditions. References: (1) Ilg W, et al. Neurology 79: 2056-2060, 2012. (2) Lord SR, Fitzpatrick RC. J of Gerontology.2001;56(10):627-632. (3) Hof A, et al. J Biomech 38:1-8, 2005.

P1-L-62 Development and preliminary evaluation of an enhanced fitness program to promote long-term engagement in physical activity after stroke

Svetlana Knorr[1], Vivien Poon[1], Elizabeth Inness[1], Lou Biasin[1], Avril Mansfiled[1]

[1]Toronto Rehabilitation Institute

BACKGROUND AND AIM: Staying physically active post-stroke is important for maintaining or promoting functional gains of rehabilitation and for reducing risk of secondary stroke. However, people with stroke do not maintain adequate levels of physical exercise following discharge from the rehabilitation settings due to physical and psychosocial barriers. The goal of this study is to evaluate effectiveness of the enhanced fitness program with progressive self-management strategies within rehabilitation to promote self-directed physical activity after discharge into the community. METHODS: Participants with sub-acute stroke were recruited at discharge from one of three rehabilitation hospitals. One hospital offered an enhanced fitness group to participants (FIT group) whereas the other two did not (No-FIT group). The enhanced fitness program involved up to 30 minutes of aerobic fitness training three times per week for 6 weeks, and additional activities that aimed to equip individuals with the knowledge, skills and self-efficacy to remain physically active following discharge from rehabilitation. Physical activity was monitored for 6 weeks post-discharge using the Actigraph activity monitor and the physical activity scale for individuals with physical disability (PASIPD [1]). PASIPD score and step count were compared between groups using t-test. RESULTS: Preliminary data from 10 participants are included; data from a larger sample will be presented at the conference. Participants in both groups were similar in clinical presentation of post-stroke motor recovery and balance deficits. Compared to the No-FIT group, participants in the FIT group reported significantly higher post-discharge levels of physical activity (PASIPD score No-FIT: 6.7±3.1, FIT: 12.7±4.0; p<0.01). FIT participants took on average 4870±2281 steps per day whereas No-FIT participants took 3265±2062 steps per day; this difference was not statistically significant (p=0.31). CONCLUSIONS: The enhanced fitness program may have a beneficial effect on participants with stroke for staying physically active following discharge into the community. FUNDING: This study is supported by the Ministry of Health and Long-Term Care - Ontario Stroke Network. REFERENCES: [1] Washburn et al, Arch Phys Med Rehabil 2002;83:193-200.

P1-L-64 Postural control in young adults after chemotherapy in childhood

Måns Magnusson[1], Einar Einarsson[1], Hannes Petersen[2], Per-Anders Fransson[1], Thomas Wiebe[1], Christian Moell[1]

[1]Lund University, [2]University of Iceland, Reykjavík, Iceland

Background and aim: Previously only few studies have investigated postural control and sensorimotor development in young adults that have survived childhood cancer by means of chemotherapy during childhood. However, since these former patients are increasing in number, it is of interest to probe if the development of postural function may be impaired and if this correlate to perceived impairments. Methods: Sixteen adults (7 women and 9 males, mean age 26.1 years) who at least 5 years prior to this study (mean 16.1 years) had received chemotherapy during childhood for a solid tumor disease (outside the central nervous system) performed posturography with eyes open and eyes closed during unperturbed and perturbed standing by repeated calf vibration. The results were compared against 25 healthy age-matched controls (mean age 25.1 years). A questionnaire (The Vertigo Symptom Scale) was used to gauge subjective disability. Results: Postural stability was significantly poorer in treated subjects compared with healthy controls during balance perturbations ($p<0.001$). The treated subjects showed significant adaptation to repeated balance perturbations in the total, high and low frequency spectra with eyes open ($p<0.005$) but only in the total and low frequency spectra ($p<0.006$) with eyes closed. The quantitative improvements gained over time were often much poorer than in healthy controls. In the questionnaire, the treated subjects also reported a host of subjective disabilities that tended to worsen with increased time after treatment. Moreover, age at time of treatment significantly correlated with postural instability and with increased subjective disabilities, both the objective stability assessments and subjective questionnaire answers suggesting more deficits in those treated at a younger age. (in mean 16 y after treatment) Conclusion: There was poorer stability during balance perturbation, decreased adaptation, and percieved sensitivity to visual disturbance and light-headedness in subjects who had received chemotherapy at a young age. We conclude that young adult survivors of cancer may suffer long-term postural control deficits, which need further attention and treatment. It is important to recognize such remnant impairments that although easily overlooked, may have a profound impact on the future life and wellbeing of the individual.

P1-L-65 Effect of perturbation training on reactive stepping post-stroke: a prospective cohort study with historical control

Avril Mansfield[1], Jessica Bryce[1], Jennifer Wong[2], Lou Biasin[1], Vivien Poon[1], Elizabeth Inness[1]

[1]Toronto Rehabilitation Institute, [2]University of Toronto

BACKGROUND AND AIM: Individuals with stroke often show impaired control of reactive stepping following a postural perturbation, which increases the risk for falls [1]. Perturbation training, involving repeated exposure to postural perturbations, can improve control of reactive stepping among healthy older adults [2]. The purpose of this study is to determine if perturbation training can improve stroke-specific impairments in reactive stepping. METHODS: Five individuals with stroke (mean age: 63±10 years) completed at least three sessions (~30 minutes duration) of perturbation training during in-patient rehabilitation (PERT group). Perturbation training sessions were typically conducted in place of or during participants' 'regular' physiotherapy session. During each session, participants experienced at least 30 postural perturbations requiring a reactive step. Perturbations were delivered either externally (e.g. a push or pull from the physiotherapist) or internally (e.g. patient experienced a loss of balance

during a rapid 'agility' task). Participants completed a standardized 'lean-and-release' assessment of reactive stepping at admission and discharge from in-patient rehabilitation. Repeated-measures analysis of variance was used to compare admission-to-discharge changes in control of reactive stepping between the PERT group a historical control group (CON) who did not complete perturbation training (n=103; mean age: 67±13 years). Changes in measures related to increased fall rates during in-patient rehabilitation were compared between the two groups [1]. RESULTS: Individuals who completed perturbation training had a greater decrease in foot-off time (PERT: 18% decrease, CON: 10% decrease; p=0.039) and frequency of trials with inadequate foot clearance (PERT: 100% decrease, CON: 12% decrease; p=0.0012) than those who did not complete perturbation training. While individuals in the PERT group reduced frequency of external assistance (i.e. from the physiotherapist or support harness) from 50% of trials on admission to 0% of trials on discharge, this training effect was not statistically significant (CON: 19% of trials on admission, 8% of trials on discharge; p=0.13). CONCLUSIONS: Preliminary results indicate that perturbation training post-stroke improves features of reactive stepping that are linked to increased fall rates; thus, perturbation training could help prevent falls post-stroke. Additionally, this training is feasible to implement during in-patient rehabilitation for individuals with sub-acute stroke. Analysis based on a larger sample of individuals who complete perturbation training will be presented at the conference and may reveal further insights. REFERENCES: [1] Mansfield et al., Neurorehabil Neural Repair 2013;27(6):428-432; [2] Mansfield et al., Phys Ther 2010;90(4):476-491

P1-L-66 Lateral Balance Training after Total Knee Replacement Improves Functional Mobility

Brian Street[1], Aili Pare[2], Lauren Sergio[1], William Gage[1]

[1]York University, [2]Southlake Regional Health Centre

Background: Significant improvements in pain and function have been reported following total knee replacement; however, patients still demonstrate persistent proprioceptive deficiencies at the knee [1] and balance impairments [2]. Importantly, the patients demonstrate greater balance impairment in the frontal plane in comparison to the sagittal plane [3], and falls directed in this plane are more likely to result in injury than falls occurring in the sagittal plane [4]. The purpose of this project was to investigate whether a specific rehabilitation intervention designed to challenge side-to-side balance can improve balance control and function in patients after total knee replacement. Methods: 51 primary knee replacement patients (age: 65.5± 9.1 years, BMI: 31.6 ± 7.0 kg/m2, Female: 42) were randomly assigned into three separate groups; standard course of therapy (STA), balance exercise intervention (BAL) STA, and a hydrotherapy intervention (HYD) STA. Each therapy protocol occurred three times a week, over a six week time period and commenced four weeks post-surgery. Both adjunct interventions were 30 minutes in duration. Participants completed the Berg Balance Scale (BBS), Timed Up-and-Go (TUG) test, WOMAC survey, and the Activities-specific Balance Confidence (ABC) Scale prior to commencing therapy and again at the end of therapy (10 weeks post-surgery). Repeated measures analysis of variance was used to test for differences between group (STA, BAL, HYD) and at the two collection points, time (Initial, Final). Paired Students t-tests, with Bonferroni correction, were used to explore significant interaction effects or main effects differences in group and time. Results: A significant interaction effect of group x time ($F_{2,48}=3.89$, $p=0.027$) confirmed that the BAL group had a significantly higher score for the BBS at the post-intervention mark compared to the STA group ($p=0.024$), but STA and HYD groups and BAL and HYD groups did not differ significantly ($p=0.711$ and $p=0.158$, respectively). A significant interaction effect of group x time ($F_{2,48}=3.42$, $p=0.041$) revealed that the BAL and HYD groups had a significantly

lower time on the TUG test at the post-intervention mark compared to the STA group ($p<0.001$ and $p=0.002$, respectively), but BAL and HYD groups did not differ significantly ($p=0.226$). The WOMAC (pain, stiffness and function) and ABC showed no interaction or main effects for group ($p>0.05$). Across all groups a main effect of time was observed for all measures ($p<0.001$), demonstrating a significant improvement from the initial to final testing time. Conclusions: Lateral balance training after surgery significantly improves balance and functional mobility testing over standard therapy. Moreover, the balance exercise intervention produced similar or improved clinical outcomes to those observed with an adjunct hydrotherapy intervention, giving a cost-effective therapy option to clinics that do not have access to a pool.

P1-L-67 Lateral trunk lean gait modification increases the energy cost of walking in those with knee osteoarthritis

Judit Takacs[1], Amy Kirkham[1], Kristin Campbell[1], Michael Hunt[1]

[1]University of British Columbia

BACKGROUND AND AIM: Gait modifications such as increased lateral trunk lean walking have been shown to be biomechanically sound and clinically promising treatment options for those with knee osteoarthritis (OA). One issue that may limit the feasibility of increased lateral trunk lean walking in the clinical setting is the potential fatigue associated with this modified walking strategy, which could affect long term performance of the gait modification. Therefore, the purpose of this study was to compare the energy expenditure of increased lateral trunk lean walking to normal walking in a population of older adults with knee OA. METHODS: Participants 50 years of age and older with knee pain and radiographic evidence of medial compartment knee OA were invited to participate. Participants completed two randomly-presented treadmill walking conditions: 1) 15 minutes of normal walking and 2) 15 minutes of walking with ten degrees of peak ipsilateral lateral trunk lean. The amount of lateral trunk lean was displayed in front of the participant in real-time during treadmill conditions. Energy expenditure (VO_2 and metabolic equivalents (METs)) were measured using a metabolic cart, while HR was measured using a wireless HR monitor. Peak lateral trunk lean angle was measured using a ten camera motion analysis system. Knee joint pain was assessed using an 11-point numeric rating scale (0 = 'no pain', 10 = 'worst pain possible'), and physical exertion was measured using the Borg Rating of Perceived Exertion (RPE) Scale (6-20 scale). All outcomes were averaged over the final ten minutes of each condition to capture steady-state characteristics and differences between conditions were compared using paired t-tests with a Bonferroni correction. RESULTS: Twelve participants (5 males, mean (SD) age 64.1(9.4) years, BMI 28.3(4.9) kg/m^2) participated. All measures were significantly elevated in the lateral trunk lean walking condition except for knee pain ($p = 0.22$; see Table 1). Specifically, participants reached significantly different peak lateral trunk lean angles ($p < 0.001$), and exhibited increases in oxygen consumption ($p = 0.002$), METs ($p = 0.002$) and heart rate ($p = 0.008$) when walking with increased lateral trunk lean. These objective measures of energy expenditure were also supported by a significant increase in participants' rating of perceived exertion ($p = 0.001$). CONCLUSIONS: Increased lateral trunk lean walking resulted in significantly higher levels of steady-state energy expenditure, heart rate, and perceived exertion, but no difference in knee pain. While increased lateral trunk lean is considered a viable gait modification from a biomechanical perspective, it should be prescribed with caution given the significant increase in energy expenditure necessary to use it. This

increase in expenditure may lead to levels of fatigue that ultimately reduce the ability of individuals with knee OA to maintain the gait modification over the longer term.

P1-L-68 Effectiveness of the Wii gaming technology in stroke rehabilitation: A systematic review

Dawn Tan[1], Aiying Low[1], Linus Tan[1]

[1]Singapore General Hospital

Background and Aim: Interactive gaming such as the commercially available Wii has been introduced into stroke rehabilitation to make therapy more fun and enjoyable. The aim of this review was to investigate the effectiveness of the Wii technology in stroke rehabilitation. Methods: Seven electronic databases (Cochrane, Medline, Web of science, PsycInfo, Scopus, CINAHL and EMBASE) were systematically searched to source for full-text English Language studies published in peer-reviewed journals up to February 2010. Studies with a quantitative research design investigating the effectiveness of using the Wii in stroke rehabilitation were considered. Eligible studies were assessed for their methodological quality by 2 independent reviewers. Data pertaining to subjects, intervention received, outcomes and clinical effectiveness were extracted using a standardized data form and synthesized in a narrative format. Meta-analysis was not performed due to the large heterogeneity in the few studies included. Results: Five out of 75 studies screened, comprising of a total of 51 participants were included. Two studies were randomized controlled trials (RCT) (Level II) and the remaining were level IV studies. The median quality score was 10/17 (range of 7-12). The studies were heterogeneous in participants' characteristics, outcomes and interventions. All studies reported positive improvement in a range of outcomes for the groups using the Wii for rehabilitation. These included improvement in measures of gait (n=2), balance (n=3) and upper limb function (n=2). One RCT reported significant improvement in upper limb function quantified by the Wolf Motor Function Test in the group receiving Wii therapy as compared to recreational therapy at four weeks follow-up (mean improvement of 7.4 seconds; 95% CI, -14.5, -0.2). Conclusions: The Wii technology appears to have positive outcomes on gait, balance and upper limb function in stroke rehabilitation. However, results should be interpreted with caution due to the low quality of studies and small sample sizes. Future well-designed RCTs with larger sample sizes are required to establish the efficacy of utilizing the Wii in these patients.

P1-L-69 Auditory observation of stepping actions can cue both spatial and temporal components of gait in Parkinson's disease patients

William Young[1], Matthew Rodger[2], Cathy Craig[2]

[1]Brunel University, [2]Queen's University Belfast

BACKGROUND AND AIM: A common behavioural symptom of Parkinson's disease (PD) is reduced step length (SL). Whilst sensory cueing strategies can be effective in increasing SL and reducing gait variability, current cueing strategies conveying spatial or temporal information are generally confined to the use of either visual or auditory cue modalities, respectively. We describe a novel cueing strategy using ecologically-valid 'action-related' sounds (footsteps on gravel) that convey both spatial and temporal parameters of a specific action within a single cue. METHODS: The current study used a real-time imitation task to examine whether PD affects the ability to re-enact changes in spatial characteristics of stepping actions, based solely on auditory information. In a second experiment, these

procedures were repeated using synthesized sounds derived from recordings of the kinetic interactions between the foot and walking surface. A third experiment examined whether adaptations observed when participants walked to action-sounds were preserved when participants imagined either real recorded or synthesized sounds. RESULTS: Whilst healthy control participants were able to re-enact significant changes in SL in all cue conditions, these adaptations, in conjunction with reduced variability of SL were only observed in the PD group when walking to, or imagining the recorded sounds. CONCLUSIONS: The findings show that while recordings of stepping sounds convey action information to allow PD patients to re-enact and imagine spatial characteristics of gait, synthesis of sounds purely from gait kinetics is insufficient to evoke similar changes in behaviour, perhaps indicating that PD patients have a higher threshold to cue sensorimotor resonant responses.

P1-M-70 Postural motor learning in healthy older adults: changes in muscle activity with repeated exposure to continuous translations

Nicholas Frank[1], Karen Van Ooteghem[2], James Frank[2], Fay Horak[3]

[1]Nike Inc., [2]University of Waterloo, [3]OHSU

BACKGROUND:Healthy older adults demonstrate practice-related improvements in posture control with repeated exposure to continuous surface translations with limited predictability. Improvements are characterized by refinement of a preferred posture control strategy (typically a rigid, flexed knee posture), serving to improve postural stability and predictive control of the centre of mass (COM) (1, 2). The aim of this work was to examine adaptations in muscle activation patterns under these conditions to better understand neural strategies that may contribute to postural motor learning in older adults. We hypothesized that the observed improvement in posture control results from decreased co-contraction, increased phasic activation and a shift in phasic activation from a phase-lag to a phase-lead relative to reversal of platform direction. METHODS: Eleven healthy older adults were exposed to a 45-second, variable-amplitude (± 15 cm), constant-frequency (0.5 Hz) platform perturbation. Participants completed 63 trials in 9 blocks during a single practice session. EMG activity was recorded at 480 Hz from the Soleus (SOL), Tibialis Anterior (TA), Rectus Femoris (RF) and Biceps Femoris (BF). Platform kinematics were captured at 60 Hz. 100 ms integrated EMG (iEMG) windows were calculated before (Pre) and after (Post) each forward peak in platform motion (Fig. 1). iEMG was normalized to the first block of trials. A two-way repeated measures ANOVA was used to examine changes in iEMG for each muscle pre and post peak forward platform displacement across training blocks (1-9). RESULTS: iEMG across all lower limb muscles declined with practice. TA and SOL displayed decreased iEMG both before and after peak forward displacements of the platform ($P<0.05$). An interaction of training block and time relative to peak forward platform displacement occurred for BF and RF($P<.05$); with practice, iEMG declines were greater in the 100 ms post- versus pre-peak window. DISCUSSION: Healthy older adults reduce postural muscle activity with practice during repeated exposure to continuous platform perturbations with limited predictability. This finding suggests more energetically efficient control of upright posture with practice. The maintenance of higher levels of BF and RF activity prior to the reversal of platform displacement may reflect stiffening at the hips to reduce forward displacement of the head-trunk-arms. This would be consistent with our earlier reports of reduced COM displacement with practice. REFERENCES: 1) K. Van Ooteghem et al. (2009) Exp Brain Res. 199:185-193. 2) K. Van Ooteghem et al. (2010) Exp Brain Res. 204:505-514. ACKNOWLEDGEMENTS: This work was supported by the NIA/NIH and NSERC

P1-M-71 Effects of Transcutaneous Electrical Nerve Stimulation on Cortical Excitability in the Primary Motor Cortex

Jer-Junn Luh[1], Yi-Hsuan Liao[1], In-Leng Lam[1]

[1]National Taiwan University

Background and aim: Recently, non-invasive brain stimulation (NIBS) such as transcranical direct current (tDCS), transcranical alternating current (tACS) and transcranical magnetic stimulation (TMS) are widely applied both in research and clinical purpose. Recent researches revealed that non-invasive stimulation can modulate the cortical excitability in human brain and suggested that it can be used as a complementary tool to improve motor performance. Transcutaneous electrical nerve stimulation (TENS) is common equipment and widely used for pain control, muscle re-education and nerve stimulation. Cochrance stated that TENS can also be applied on head for improving cognition and behavior. So, TENS should be clarify as one kind of NIBS and it may have similar effect to other stimulators which we mentioned above. Compare to tDCS, tACS and TMS, TENS is much cheaper and easier to get. The purpose of this study was to investigate whether TENS could change the cortical excitability in primary motor (M1) cortex or improve the motor performance. The other purpose of this study was to investigate whether difference effect between different frequencies of TENS, 15Hz and 120Hz. Methods: Twenty-four healthy adults, mean age of 22.45±1.17 years old, were received 15Hz, 120 Hz of TENS and sham stimulation for 20 min in random order in different day within two week, TENS was applied over the scalp outside the M1 area. TMS was used to access the cortical excitability of primary motor cortex, including the motor-evoked potential (MEP), short-interval intracortical inhibition (SICI) and intracortical facilitation (ICF). A motor performance was measured by finger pinch task which ask the subjects to pinch the target as fast as possible. All measurements were performed before and immediately after the TENS intervention, and follow up 30 and 60 minutes after stimulation. Results: In 15 Hz stimulation group, MEP, normalized MEP, SICI (2ms) and ICF (15ms) were significant increased immediately after 20 minutes application of TENS on M1 ($p=0.029$, 0.002, 0.002, <0.001, respectively), MEP and normalized MEP were back to baseline in the 30 minutes follow up, SICI (2ms) and ICF (15ms) were back to baseline after 60 minutes. In 120 Hz group, normalized MEP was significant increased immediately after intervention ($p=0.007$) and back to baseline after 60 minutes in 120Hz group. There was no significant change of cortical excitability in the sham stimulation groups. There was no significant change of motor performance in all groups. Conclusions: Twenty minutes TENS stimulation applied on M1 could significantly change the cortical excitability. The effect of 15 Hz TENS stimulation was more significant than 120 Hz. The findings on the neurophysiological changes after TENS application on M1 may inform further research on this topic.

P1-M-72 Adaptations of Lower Limb Kinetics During Level and Obstructed Walking Under Limited Knee Range of Motion

Damjana Milicevic[1], Damjana Milicevic[1], Emily McIntosh[1], Nicholas Frank[1], Andrew Laing[1], Stephen Prentice[1]

[1]University of Waterloo

Introduction/Aim: Adaptability is a key aspect of gait as it allows flexible coordination of the various joints so that the same movement outcome can be achieved with different contributions of the joints. In

the lower limb, this facilitated due to a relationship that exists between the knee and hip joints 1 where 2 jointed muscles that have opposing actions at adjacent joints. Further during obstacle clearance tasks, it has been found that during clearance, active knee flexion causes passive hip flexion 2,3 As the execution of a multiarticular task can utilize a variety of contributions of involved joints, this flexibility permits the alteration of joint contributions to permit safe ambulation throughout a series of environments and conditions. However, little research has been done on this topic. The aim of the proposed study is to decrease knee range of motion (ROM) and quantify the compensatory adaptations that occur at the hip and ankle joints by examining joint moments and powers. Methods: Eight subjects (4 female, 23.0 ± 1.8 years, 1.7 ± 0.1 m tall, 69.6 ± 15.0 kg) with no history of knee or hip injuries completed over-ground walking and obstacle clearance trials (18 cm and 6 cm). Trials were performed while unbraced and while wearing a ligament stabilizing knee brace on their right side which restricted flexion to 30°, 50°, and 70° respectively. Ground reaction forces were measured from four embedded force plates and lower limb kinematics were collected at 60 Hz using six banks of Optotrak cameras (NDI, Waterloo, ON). 5 rigid bodies affixed to the pelvis, right thigh and shank, and both feet. The unbraced block was performed first to establish a baseline and then was followed by three randomized blocks for the brace conditions. These blocks consisted of three randomized conditions (unobstructed walking, 18cm obstacle, 6cm obstacle) which each had five trials. Results: Decrements in mechanical work at the knee during the K5 burst, that appears only during obstacle clearance, was a direct result of restricting knee ROM . In order to maintain successful toe clearance increases was seen in the mechanical work during hip pull off (H3). The largest changes were seen with 30° flexion blocks that reduced the knee motion the greatest. Pending individual differences larger knee flexion blocks may or may not impinge movement with level walking, low or high obstacle trials. Conclusions: Participants were able to successfully perform level walking and the 2 obstacle heights during braced and unbraced conditions. The knee brace was able restrict motion to 30°, 50°, and 70° and decrease the amount of joint power that could be delivered at the knee joint. Successful completion of level and obstructed walking required compensations at adjacent joints. 1. Winter, D.A. (1984) Human Movement Science, 3, 51-76 2. Patla, A., & Prentice, S.D. (1995). Exp Brain Res., 106, 499-504 3. Patla, A., & Rietdyk, S. (1993) Gait & Posture, 1, 45-60

P1-N-73 Feasibility of exoskeleton-based balance and gait training combined with somatosensory tongue stimulation in people with MS: a pilot study.

J. Megan Brousseau[1], Tania Lam[2]

[1]University of British Columbia/ICORD, [2]University of British Columbia/Vancouver Coastal Health Research Institute

Background and Aim: Multiple sclerosis (MS) is a neurodegenerative disease that can result in functional impairments in gait and balance. The Lokomat and Ekso are rehabilitation devices that enable task-specific standing and walking practice on a treadmill or overground, respectively. There has also been increasing evidence suggesting that task-specific training combined with sensory stimulation could enhance functional outcomes. The tongue is one of the most densely innervated areas of the body and previous imaging studies have shown that somatosensory stimulation of the tongue can result in enhanced activity in brainstem and cerebellar regions. The tongue is therefore an intriguing target for the application of somatosensory stimulation in combination with task-specific training. Here we aimed to investigate the feasibility of using the Lokomat and Ekso training combined with somatosensory

tongue stimulation in people with MS. A secondary aim was to develop a new protocol for the progression from treadmill- to overground-based gait training. Methods: Two male participants with MS were recruited. The intervention lasted 12 weeks, with daily training sessions alternating between balance and gait training (excluding weekends). During the training sessions, participants received continuous somatosensory stimulation of the tongue via the Portable Neuromodulation Stimulator (PoNS, Advanced NeuroRehabilitation LLC, Madison, WI). Balance training sessions consisted of 30 minutes of standing balance practice, with the goal to stand independently with eyes closed. Progression of gait training involved reducing body weight support and attempting more challenging stance positions (e.g. tandem stance). Gait training consisted of 30 minutes of Lokomat or Ekso training. Progression was determined by using the Borg rating of perceived exertion, increasing speed or decreasing the amount of assistance provided by the exoskeleton. Clinical assessments of balance and gait function were planned at baseline, during training (every 4 weeks) and post-training (at 16 weeks). Results: Results to-date indicate that the participants could tolerate the assessment and training procedures. Baseline assessments of standing balance demonstrated that the participants had difficulty standing independently with eyes open or closed. One of the subjects was not able to complete the 10-meter walk test. The initial balance and Lokomat gait training sessions were well tolerated by both participants. Conclusion: Results to-date indicate that it may be feasible to recruit and test individuals with MS to participate in an intensive balance and gait training program combined with somatosensory tongue stimulation. It is anticipated that this study will lead to larger-scale projects to confirm the efficacy of such combinatorial approaches on functional outcomes in people with MS. This work also contributes to continued developments of effective rehabilitation training protocols.

P1-N-74 Body synergy based exoskeleton control designed for hemiplegia

Modar Hassan[1], Hideki Kadone[1], Kenji Suzuki[1], Yoshiyuki Sankai[1]

[1]University of Tsukuba

AIM We introduce a method for motion intention estimation based on synergies of gait with cane for control of an exoskeleton robot to assist locomotion of individuals with hemiparesis. We developed a wearable system with instrumented cane to implement the system. The system utilizes the instrumented cane as a part of the interface between the user and the robot, together with other motion and ground contact sensors. We showed in previous research [1] that the cane reflects the motion of the unaffected upper limb and is possible to be used for exoskeleton control. The developed control system provides assistance for affected limbs in coherence with unaffected ones. The system also provides assistance for start and stop motions based on ground contact patterns of the feet and the cane. In this presentation, we show experiments with healthy subjects using this system equipped with wearable sensors for real-time motion intention estimation and exoskeleton control. METHODS The instrumented cane is equipped with inertial motion sensors and ground contact sensors. Wearable inertial motion sensors are also fitted on the unaffected leg, considering the case of hemiplegia. Ground contact patterns from force sensors in the shoe insoles of the exoskeleton are also used. The system is implemented with single leg version of Robot Suit HAL (Fig.a). EXPERIMENTS & RESULTS Function of the developed wearable system was verified with gait trials on treadmill using the wearable system and using a Motion Capture System for comparison. Gait trials on ground also verified the function of start-walk-stop support. The results show that it is feasible to use the proposed system for estimating and generating the intended limb motion (Fig.b). They also show comparable performance between the two

cases. The gait trials on ground demonstrated successful support of start-walk-stop sequence based on ground contact patterns. CONCLUSION We consider the instrumented cane as a tool for gait measurement. It enables capture of the arm motion, and therefore the user's intention, for real-time assistance of synergistically correlated limbs. It may also enable the benefits of light touch on balance and postural control [2]. The achievement contributes to finding an intuitive and feasible interface between human and robot through wearable gait sensors for practical use of assistive technology for physically challenged people. ACKNOWLEDGEMENTS This study was supported by the Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program). REFERENCES 1-Hassan, M.; Kadone, H.; Suzuki, K.; Sankai, Y. Exoskeleton robot control based on cane and body joint synergies. Intelligent Robots and Systems, 2012 IEEE/RSJ International Conference on, 2012, pp. 1609 -1614. 2-Boonsinsukh, R.; Panichareon, L.; Phansuwan-Pujito, P. Light Touch Cue Through a Cane Improves Pelvic Stability During Walking in Stroke. Archives of physical medicine and rehabilitation 2008, 90, 919-926.

P1-N-75 Effect of postural configuration on trunk responses to support surface tilt

Georg Hettich[1], Lorenz Assländer[1], Albert Gollhofer[1], Thomas Mergner[1]

[1]University Freiburg

BACKGROUND AND AIM: Standing humans presented with moderate support surface tilts in the sagittal plane show whole-body COM sway responses mainly in the ankle joints. These ankle joint responses increase with increasing tilt amplitude. The increase is not proportional to that of the tilt, but clearly smaller; a behavior known as amplitude non-linearity. Recently, we investigated the hip joint (trunk sway) response that tends to be associated with the ankle joint response in a hip-ankle coordination. The hip joint response differed from the ankle joint response in that it did not show the amplitude non-linearity. The aim of the current study was to investigate whether this absence of the amplitude non-linearity in the hip joint response reflects a local particularity or depends on postural configuration. METHODS: Six healthy subjects stood with eyes closed on a motion platform. The legs of the subjects were fixed to a mechanical setup on the motion platform such that the rotation axis of the tilt stimulus passed through the hip joints. The stimulus consisted of pseudo-random ternary sequences with a frequency range of 0.017 to 2.2 Hz. Three peak-peak amplitudes were used: 1, 2, and 4°. Angular excursions of the trunk segment (head, arms, torso) were calculated using optoelectronic measures with respect to the earth vertical (Trunk-space, TS). TS balancing was characterized by frequency response functions (FRFs) from platform tilt stimulus to TS responses (TILT-to-TS FRF) in terms of gain and phase curves. RESULTS: TS gain curves decreased with increasing stimulus amplitude, clearly reflecting the amplitude non-linearity. Furthermore, the shape of the three TS gain curves showed similar frequency characteristics as the gain curves of the previously obtained whole-body COM responses. The three TS phase curves essentially coincided with each other, developing a phase lag in the high frequency range, again similar to the gain curves of the whole-body COM responses. CONCLUSION: TS stabilization around the hip joints shows an amplitude non-linearity when rotation of the directly supporting leg segment represents the external tilt stimulus, whereas it is absent when the external tilt stimulus has impact indirectly via the ankle joints and the leg segment during rotation of the foot and its support (previous study). This finding is compatible with the 'down and up channeling' hypothesis [1]. This hypothesis suggests that sensory information from the visual or vestibular system is 'down-channeled' to estimate support surface rotation/orientation. The processed sensory information is then up-channeled for use in the 'upper' joints. With this hypothesis implemented into a posture control model,

the present and previous findings could be reproduced. [1] T. Mergner et al. (1997) J. Vestib. Res. 7:347-367.

P1-N-76 Postural sway evoked by head-turns in normal, vestibular-impaired and vestibular-impaired, prosthesis-assisted rhesus monkeys

Lara Thompson[1], Csilla Haburkacova[2], Wangsong Gong[2], Daniel Lee[2], Conrad Wall III[2], Daniel Merfeld[2], Richard Lewis[2]

[1]University of the District of Columbia, [2]Massachusetts Eye and Ear Infirmary, Harvard Medical School

BACKGROUND AND AIMS Although vestibular prosthetic stimulation has been extensively characterized in terms of eye movements, postural responses associated with this type of stimulation have not been rigorously investigated in neither animals nor humans. Several vestibular prosthesis studies focused on eye movement responses of severely vestibular-impaired animals have shown that the vestibuloocular reflex (VOR) can be partially restored with aid of prosthetic stimulation. However, the invasive vestibular prosthesis may be a viable solution to restore not only eye movements to those suffering from severe vestibular dysfunction but also their impaired balance. This invasive rehabilitative solution must be developed and fully characterized in non-human primates prior to, or in parallel with, human implementation. Aside from assessing the effects of prosthetic stimulation on posture, it also must be determined who may receive the most benefit from a vestibular prosthesis (i.e., patients with moderate versus severe vestibular dysfunction). METHODS During head-turns, humans (and cats) suffering from severe bilateral vestibular dysfunction can exhibit ataxic gait, imbalance, and falls. In this study, postural responses of two non-human primates (rhesus monkeys) were characterized while they made head-turns to illuminated targets. We investigated posture evoked by heads-turns of the animal (R2) in the normal and mild bilateral vestibular hypofunction (mBVH) states and of a rhesus monkey (R1) in a severe bilateral vestibular hypofunction (sBVH) state and severe bilateral vestibular hypofunction aided by prosthesis (sBVH STIM-ON) state. The prototype prosthesis used was a one-dimensional prosthesis that encoded angular head velocity (via electric stimuli delivered to the right posterior semicircular canal afferents). RESULTS In general, the animal in the mBVH state had trunk sway less than or equal to normal. It was hypothesized that, because the vestibular loss was only moderate, the mBVH animal was able to compensate for its loss. We observed that in the sBVH STIM-ON state trunk sway decreased compared to the sBVH state. We proposed that the partially restored head orientation information (derived from the integration of the partially restored head velocity cues via the vestibular prosthesis) enabled the severely-impaired animal to reduce its trunk sway. CONCLUSIONS Based on the above posture findings, it was implied that: 1) subjects with only mild vestibular loss may benefit from self-imposed postural compensation (either developed on one's own or with expert training) and 2) subjects with severe vestibular loss but an intact eighth nerve may benefit from electric stimulation provided by a vestibular prosthesis.

P1-N-77 Center of mass - center of pressure angle critically determines required friction at shoe-floor interface during straight walking

Takeshi Yamaguchi[1], Kei Masani[2]

[1]Tohoku University, [2]University of Toronto

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. Relation of RCOF with gait kinematics has gained researchers' attention, as it plays a key role in preventing slips during walking. Some studies reported that the center of mass (COM)-center of pressure (COP) angle shows strong correlation with the RCOF magnitude. However, the theoretical rationale for this correlation remains unknown. According to Eq. 3 derived from the analysis model using COM and COP shown in Figure 1(A), the traction coefficient (fh/fz) is equal to the summation of the COM-COP angle tangent and a term related to moment acting on the COM. The purpose of this study was to investigate the effect of the COM-COP angle and the moment on the traction coefficient and RCOF during straight walking. METHODS: The study involved four healthy young adult males with an average age of 24.3 yrs. The subjects were asked to walk straight on a dry floor surface. Eight 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 fourteen-segment model. COPs for left and right feet were collected using the force plates. The total of 24 steps obtained from the four subjects were analysed. The traction coefficient was calculated using horizontal and vertical force components. The temporal profiles of the COM-COP angle tangent (tanθ) and the moment term were calculated according to Eqs. 2 and 3, respectively. RESULTS: The temporal profile of COM-COP angle tangent strongly correlated with that of the traction coefficient (R2=0.97) from 10 to 90% of gait cycle. The moment term was extremely small as compared with the COM-COP angle tangent. The results suggest that the COM-COP angle tangent dominantly determines the magnitude of the traction coefficient, while it is affected by the moment acting on the COM only during heel contact and toe off phases. The RCOF magnitude (0.21±0.05) also correlated with the COM-COP angle tangent (0.22±0.06) (R2=0.56), suggesting that RCOF magnitude is mostly determined by the COM-COP angle. CONCLUSIONS: This study investigated the determinant of friction requirement at shoe-floor interface on the basis of analysis model using COM and COP. We demonstrated that that the COM-COP angle tangent is the dominant factor of the traction coefficient and RCOF during straight walking. The findings may ultimately be used to understand how people prevent slip and fall during walking.
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P1-O-78 Gait Characteristics and Turning Control Following Deep Brain Stimulation: A Case Study

Rebecca Reed-Jones[1], V.N. Pradeep Ambati[2], Nicholas Murray[2], Fabricio Saucedo[2], Caitlin Schneider[3], Douglas Powell[3]

[1]University of Prince Edward Island, [2]The University of Texas at El Paso, [3]Campbell University

BACKGROUND AND AIM: Deep brain stimulation (DBS) has been reported to improve gait characteristics and segment coordination in Parkinsonian patients. However, few studies have examined the effects of DBS on turning control. Turning is an important maneuver as it occurs in a number of daily tasks. In addition, risk of falling and the rate of fall related injuries are increased with this maneuver. The purpose of this study was to describe the effects of DBS on gait characteristics and steering co-ordination in a 59 year old male who has been living with Parkinson's disease (PD) for 10 years. METHODS: The participant performed a total of 15 walking trials in each of two laboratory visits. On the first visit (PRE) the

participant was on L-Dopa medication only. The second visit (POST) occurred 3 months after the first visit and following DBS implantation. Walking trials consisted of a maximum 5¬ meter path and included three possible tasks of 5 trials each: No Turn, a 90¬ degree right turn at the end of the path, or a 90¬ degree left turn at the end of the path. Directions on whether to continue straight, or turn left or right, were given in advance of each trial. Full body kinematic data were collected at 120 Hz during over ground walking using a Vicon motion capture system (Model 5.2.9, ViconPEAK, Oxford, UK). To examine steering control, rotation (about vertical axis) onset of the head, trunk and pelvis segments were calculated for the turning trials. To assess gait parameters, step width, step length, and gait velocity were calculated for the straight walking trials. All variables were compared between the PRE and POST DBS visits. RESULTS: Results of segment rotation onsets indicate that initiation of segment redirection towards the turn direction occurred earlier in the POST visit. In addition, the head segment led the trunk segment considerably more in the POST visit. Head-trunk onset time was 235 ms PRE and 363 ms POST. Gait parameters were also observed to improve POST. Mean step length increased and variability decreased from 806 ± 127 cm PRE to 881± 104 cm POST. While mean step width decreased PRE 83.5 ± 29.6 cm to POST 69.6 ± 24.9 cm. Gait velocity also increased as a result of DBS, 0.99 m/s PRE to 1.18 m/s POST. CONCLUSIONS: Overall, the results of this study support previous literature on the effects of DBS on parkinsonian gait with the addition of novel steering control data. Results of the steering data suggest that anticipatory control of redirections are also improved with DBS possibly increasing performance of these maneuvers and reducing the risk of falling or other events while turning. One important contribution of this study is that this study involved measuring the impact of DBS on a single subject PRE and POST surgery.

P1-O-79 Therapeutic potential of sensory tongue stimulation combined with rehabilitation therapy for balance and gait function in people with incomplete spinal cord injury: a pilot study.

Amanda Chisholm[1], Raza Malik[1], Jean-Sébastien Blouin[1], Jaimie Borisoff[2], Susan Forwell[1], Tania Lam[1]

[1]University of British Columbia, [2]British Columbia Institute of Technology

Background and Aim: There has been increasing interest in therapies that combine sensory stimulation with motor practice for persons with incomplete spinal cord injury (iSCI). The tongue contains a high density of sensory receptors and recent results from functional imaging studies indicate that sensory stimulation of the tongue can lead to increased activation of the brainstem and cerebellum, regions that are important in balance and gait. Thus, our purpose was to determine the feasibility and effects of a lab-and home-based program of sensory tongue stimulation combined with balance and Lokomat-based gait training on balance and functional ambulation in people with motor-iSCI. Methods: Two male participants with motor-iSCI were recruited. S1 suffered an injury at C5 9.5 years ago and S2 suffered an injury at T5-T6 12 years ago. The intervention consisted of 12 weeks of balance and gait training, with 3 laboratory and 2 at-home sessions per week. After the initial 12 weeks, participants continued daily at-home training for an additional 12 weeks. During the training sessions, participants used the Portable Neuromodulation Stimulator (PoNS) to electrically stimulate the tongue. Balance training consisted of 4 x 5 minute bouts of standing balance practice with eyes closed. Gait training on the Lokomat consisted of 6 x 5 minute bouts with rest as needed. At-home training sessions consisted of balancing with their eyes open and walking with parallel bars or a walker for up to 20 min each. Clinical assessments of balance and gait function were performed at baseline, post-training (at 12 weeks), and follow up (at 24

weeks). Results: Both subjects were able to complete a minimum of 83% of the training program, with no reports of adverse events. Standing balance with eyes closed for S1 improved from 0.2 min baseline to 2.0 min post-training and 4.0 min at follow up. While S2 was unable to stand without support and eyes open at baseline and post-training, he was able to progress to standing unsupported eyes open for 0.6 min and eyes closed for 0.2 min by follow up. Overground walking speed improved from 0.1 m/s at baseline to 0.24 m/s at follow up for S1 and 0.18 m/s at baseline to 0.25 m/s at follow up for S2. Overground walking distance improved by 33.3 m for S1 and 29.3 m for S2 from baseline to follow up. Total scores on the SCI-Functional Ambulation Profile test improved by 410 points for S1 and by 151 points for S2 from baseline to follow up. These scores indicate better skilled walking function (e.g. stairs/obstacles) by completing the tasks with a faster time and/or with less assistance. Conclusion: Sensory tongue stimulation combined with task-specific training may be a feasible method to improve balance and gait in persons with motor-iSCI. Further controlled studies are warranted to determine the benefits of combining tongue stimulation with task-specific training for people with motor-iSCI.

P1-O-80 Does weight-bearing asymmetry affect the threshold for reactive stepping in people after stroke?

Digna de Kam[1], Jip Kamphuis[2], Alexander Geurts[1], Vivian Weerdesteyn[1]

[1]Radboud University Medical Center, [2]ViaReva

BACKGROUND AND AIM: In people after stroke, weight-bearing asymmetry (WBA) in favor of the non-paretic leg is often observed [1]. Since greater WBA is associated with poorer balance in cross-sectional studies [1], WBA may be considered as a causative factor for postural instability. However, cross-sectional studies are vulnerable for confounding since both WBA and postural stability are affected by disease severity. Alternatively, moderate unloading of the paretic leg may be a compensatory strategy to improve the ability to sustain postural perturbations towards the paretic side and to reduce the risk of falling in that direction. Therefore, the aim of the present study was to determine the effect of WBA towards the non-paretic side on dynamic stability in people after stroke using a within-subjects study design. METHODS: Eight people in the chronic phase (> 6 months) after a unilateral supratentorial stroke were subjected to multidirectional support-surface translations at 3 levels of WBA (0, 10 and 20% of body-weight unloading of the paretic leg). The stepping threshold was determined iteratively for each condition and in four directions (forward, backward and towards the paretic and non-paretic side). The stepping threshold was defined as the highest perturbation intensity (m/s^2) that could be sustained with a feet-in-place response. Three attempts were allowed at each intensity. For each perturbation direction, a repeated measures general linear model (GLM) was used to identify whether stepping thresholds differed between WBA conditions. RESULTS: The stepping thresholds for forward and backward perturbations did not differ between WBA conditions ($p=0.078$ and $p=0.595$, respectively). For lateral perturbations, greater WBA tended to result in higher (better) stepping thresholds for perturbations towards the paretic side ($p=0.065$), in parallel with lower (poorer) thresholds towards the non-paretic side ($p=0.006$). CONCLUSION: Unloading of the paretic leg reduced dynamic stability towards the non-paretic side. However, as people after stroke are most likely to fall towards the paretic side [2] with an elevated risk of hip fractures, this disadvantage may be outweighed by the increased stepping thresholds towards the paretic side. On the other hand, following more intense perturbations, disproportionate WBA increases the likelihood of stepping with the paretic leg [3], which may be less effective to recover balance than taking non-paretic steps. Since stepping responses are crucial to

prevent a fall under critical circumstances, the optimal degree of WBA remains to be determined for subjects with various degrees of paresis. REFERENCES: 1. Kamphuis et al. 2013. 2. Hyndman et al. 2002. 3. Mansfield et al. 2012.

P1-O-81 Individuals with Minimal Disability and Multiple Sclerosis Display Similar Postural and Dynamic Balance Control Characteristics as Community-Dwelling Older Adults

Luke Denomme[1], Patricia Mandalfino[2], Michael Cinelli[3]

[1]University of Waterloo, [2]McMaster University, [3]Wilfrid Laurier University

Background & Aim: Individuals with Multiple sclerosis (MS) are thought to possess somatosensory-related deficits resulting in impaired static and dynamic balance control[1]. Evidence suggests that balance differences exist between 'individuals with MS with mild disability' (IwMS) and healthy controls during standing and walking balance tests in a laboratory setting[2]. The purpose of this study was to determine whether differences in static and dynamic balance control exist between IwMS and community-dwelling older adults (OA); a novel comparison population to IwMS which experiences balance impairments as a result of suspected somatosensory loss due to natural aging. Methods:Participants (N=24; IwMS (n=12, μ = 44 ± 9.4 years) and OA (n=12, μ = 68 ± 4.5 years) stood on a force platform with feet together and arms by their sides for 45s with either eyes open (EO) or closed (EC) to assess static control of balance (e.g., COPRMS displacement, COPRMS velocity, and Standing Index). Participants also performed a 9m walking task (6.2m straight 2.5m change in direction) to assess differences in gait characteristics (e.g., velocity, step length/width, double support time, trunk roll) and lateral temporal/spatial dynamic stability margin during single support. Results: Standing Task: Results revealed that OA displayed a much smaller COPRMS displacement than IwMS ($p<0.05$). However, there was no main effect of group for anterior-posterior (AP) or ML COPRMS velocity and Standing Index measures ($p>0.05$). A main effect of visual condition revealed that both groups displayed reduced postural control in both the AP and ML direction with EC than with EO (i.e., faster COPRMS velocity and higher Standing Index) ($p<0.01$). Steering Task: Gait characteristics and lateral dynamic stability margin were calculated and separated into three distinct walking task phases (approach (straight walking), anticipatory postural adjustment (2 steps prior to turn), and turning). Results revealed no differences between groups during each phase for all gait characteristics as well as lateral dynamic stability margin. Conclusions: Findings from this study demonstrate that individuals with less sensitive (OA) and less intact (IwMS) somatosensory systems performed similarly on both tasks despite differences in the nature of their somatosensory impairment. Both groups used various balance control strategies to help regulate their standing and walking balance (e.g., walked extremely slow during the walking task and shifted the pressure under their feet faster to regain control of their swaying trunk during eyes closed standing situations). These findings present novel insights which highlight that balance impairment arising from suspected contribution of somatosensory impairments in aging is similar to that experienced by individuals with isolated somatosensory impairments observed in IwMS. References: [1] Cameron et al., Somatosen Mot Res, 25, 2008; [2] Denomme et al., ISPGR (Akita), 2013

P1-O-82 Impact of physical guidance on learning a challenging walking task in adults with a history of stroke

Vincent DePaul[1], Laurie Wishart[2], Bashir Versi[3], Ramesh Balasubramaniam[4], Timothy Lee[2]

[1]Toronto Rehabilitation Institute - UHN, [2]McMaster University, [3]St. Joseph's Healthcare Hamilton, [4]University of California, Merced

BACKGROUND AND AIM: In motor learning research, the provision of guidance during practice typically improves immediate performance at the detriment of more permanent learning. While it is common for physiotherapists to manually guide patient movements during gait retraining following stroke, the impact of guidance and error experience has received little attention in the rehabilitation literature. The purpose of this pilot study was to evaluate the impact of manual guidance on the learning of a challenging walking task after stroke, and to the explore feasibility of research methods for use in future learning studies. METHODS: In this study, individuals with chronic stroke underwent 5 sessions of repetitive practice of a modified tandem walk task under 1 of 3 training conditions; 1) Constant manual-guidance (CG), 2) No-guidance (NG), and 3) Faded-guidance (FG) (guidance faded from 100% to 33% of trials over the 5 sessions). The GAITRite® walkway was used to evaluate modified tandem walk performance at baseline, during training, post-training, and at 1 week follow-up. To assess transfer of learning, participants also performed the tandem walk under an altered environmental condition (over a piece of foam), and under a dual task condition (counting backwards by 3's). Performance and learning on the modified tandem walk task were evaluated using accuracy (root mean square error - RMSE) and velocity measures. RESULTS: All study procedures were found to be feasible. Thirty-one individuals consented, one withdrew, and 30 participants (median age 66 yrs; min 46, max 90) with chronic stroke (median onset 39.5 months; min 6, max 314) completed all study activities. Following training, participants from all 3 groups improved accuracy and velocity of the modified tandem walk. During training trials, participants in the CG group tended to perform the task with less error and at greater velocity than the NG or FG groups. However, on immediate retention and delayed retention testing, participants in the NG group performed the Modified Tandem Walk task with greater velocity than the other two groups [$F(18, 243) = 2.49$, $p = 0.001$]. In contrast, there was a non-significant trend for participants in the CG group to perform the modified Tandem Walk task at retention testing with greater accuracy (RMSE) than participants in other groups. CONCLUSIONS: In this pilot study, individuals with chronic stroke were able to learn a challenging walking task following a brief, intensive task-specific intervention. In patients with stroke, learning walking-related skills under unguided and guided conditions may elicit unique learning benefits related to performance velocity versus performance accuracy.

P1-O-83 How does anxiety influence gait in Parkinson's disease?

Kaylena Ehgoetz Martens[1], Colin Ellard[2], Quincy Almeida[3]

[1]University of Waterloo/ MDRC, [2]University of Waterloo, [3]Wilfrid Laurier University, MDRC

BACKGROUND AND AIM: Anxiety affects up to 40% of people with Parkinson's disease (PD), and previous research has attempted to imply that anxiety and severe gait problems are related. However, no direct attempts have been made to manipulate anxiety and quantify its influence on spatiotemporal aspects of gait. Although anxiety is not expected to be driven by the dopaminergic system, research has hypothesized that patients in their OFF state experience greater anxiety as a result of their more severe symptoms. The aim of this experiment was to use virtual reality (VR) to gain a better understanding of the underlying mechanism that explains how anxiety influences gait control in PD, and whether this mechanism is related to their dopaminergic state. METHODS: Twelve Anxious-PD (PD-A) and 11 Non-anxious-PD (PD-NA) were instructed to walk in VR in two conditions: (i)across a plank that was located

on the ground (non-anxious); (ii)across a plank above a deep pit (anxious). All participants completed this experiment in the ON and OFF state. Anxiety levels were evaluated after every trial using Self-assessment manikins. Multiple synchronized OPTOTRAK cameras updated participants movement through the virtual environment in real-time, while their gait was recorded using a GAITRite carpet. RESULTS: PD-A reported higher levels of anxiety in both conditions ($p=0.047$) compared to PD-NA, however, all participants rated the anxious condition higher compared to the non-anxious condition ($p<0.001$). Dopaminergic medication significantly increased velocity ($p=0.02$) and step length ($p=0.009$) in all participants regardless of condition. Additionally, all participants walked significantly more slowly ($p<0.001$) and with smaller steps ($p<0.001$) during the anxious condition compared to the non-anxious. An interaction between group and condition for both step time (ST: $p=0.01$) and step time variability (STV: $p=0.01$) showed that PD-A increased their ST and STV in only the anxious condition, whereas the PD-NA reduced their ST and STV during the anxious condition (compared to the non-anxious condition). Most importantly, PD-A demonstrated greater step length variability (SLV) compared to PD-NA ($p=0.007$). An interaction between group and condition ($p=0.03$) showed that PD-NA significantly reduced their SLV during the anxious condition compared to the non-anxious condition. The PD-A did not change their SLV during the anxious and non-anxious conditions. CONCLUSIONS: Walking in an anxious environment caused all PD to slow their gait and reduce their step length, as expected. The most interesting finding from this study was that PD-A had a significantly smaller SLV compared to PD-NA during the non-anxious condition, and furthermore, during the anxious condition PD-NA reduced their SLV to be similar to PD-A. This might suggest that anxiety causes individuals with PD to employ a tighter control of gait, leading to reductions in gait adjustments.

P1-O-84 Coupling of gait and postural control in early Parkinson's disease

Brook Galna[1], Silvia Del Din[1], Alan Godfrey[1], Sue Lord[1], Lynn Rochester[1]

[1]Newcastle University

Background and aim: The ability to make small yet precise adaptations to step width is crucial in maintaining postural control during gait. Our earlier analysis showed that people with incident PD walk with a less variable step width, suggesting prodromal changes in postural control, although the mechanisms are unclear. Altered trunk rigidity in PD may influence step width variability however trunk motion is also coupled with step length which is reduced in PD. The aim of this analysis was to i) compare mediolateral (ML) trunk accelerations between people with incident PD and controls; ii) test the association between step width variability and ML trunk accelerations; and iii) examine whether the relationship between step width variability and ML trunk accelerations are mediated by hypometric step length in people with PD. Methods: Step length and step width variability (SD) of 39 people with incident PD (Mean(SD) Age:67(10)y; 11 females; UPDRS III:28(11)) and 36 controls (Age:68(6)y, 17 females) was measured over 4 x 10m walks using an instrumented walkway (GAITRite). ML trunk motion was measured using 3D accelerometers (100hz, 8g, 4th order Butterworth 20Hz low-pass filter) taped onto the skin above the xiphoid process (Chest) and lumbar spine (L5), and the following variables were calculated: peak accelerations, root mean square acceleration (RMS), Jerk and the zero-lag cross-correlation between the Chest and L5 sensors. PD participants were tested at peak dose of their medication. ANCOVA was used to test differences between group means. Partial correlations were used to test the association between step length, step width and trunk accelerations. Covariates included age, sex, height, mass and step time in both analyses. Partial correlations were rerun with the addition of

step length as an additional covariate. A p<.05 was used to guide interpretation. Results: Preliminary analysis showed trunk accelerations did not differ between groups. Trunk accelerations did not relate to the step length or step width variability in controls. For PD, a shorter step length was related to reduced peak (Chest: r=.534; L5: r=.483) and RMS (Chest: r=.435; L5: r=.503) accelerations, and Jerk (Chest: r=.435), and reduced step width variability was related to reduced peak (Chest: r=.366) and RMS (Chest: r=.377) accelerations. Step length was related to step width variability in PD (r=.388). After controlling for step length, step width variability was not related to ML trunk accelerations. Conclusions: Reduced step width variability in early PD may be partially explained by reduced size and variation of ML trunk accelerations, reducing the need to vary step width in maintaining postural control, which in turn is partially mediated by hypometric step length. Further analysis is required to parse out the direct role of trunk rigidity and indirect influence of hypometric step length on the coupling of gait and postural control in people with PD.

P1-O-85 Five Times Sit to Stand Test in high risk individuals for Parkinson's disease

Markus Hobert[1], David Weiss[2], Sandra Hasmann[2], Eva Schaeffer[2], Johannes Streffer[3], Inga Liepelt-Scarfone[2], Daniela Berg[2], Walter Maetzler[2]

[1]University of Tuebingen, [2]Center for Neurology, University of Tuebingen, [3]Janssen-Pharmaceutical Companies of Johnson & Johnson

BACKGROUND AND AIM: Parkinson's disease (PD) is a neurodegenerative disease which is based on occurrence of bradykinesia and at least one of the symptoms: resting tremor, rigidity and postural instability. In the long-lasting prodromal phase when the neurodegenerative process has already started, subtle changes may be detectable with quantitative and sensitive methods. This is relevant as an earlier diagnosis of PD would potentially enable earlier neuroprotective treatment. In this prodromal phase, differences of gait and sway have already been described by the use of accelerometers (Maetzler et al., 2012; Mirelman et al., 2011). However it is unclear to date whether changes during transfer movements may (also) indicate prodromal neurodegeneration. METHODS: We included 14 patients with PD (Hoehn&Yahr 1-2.5), 13 healthy controls and 38 individuals at high risk for PD (HR) in this cross-sectional analysis. HR had a hyperechogenicity of the substantia nigra by transcranial sonography and either one motor sign (e.g. slight bradykinesia) or two of the following characteristics: positive family history, depression, hyposmia, and one-sided reduced arm swing. The participants were asked to perform the Five Times Sit-to-Stand Test (FTSTS) at convenient speed. The test consists of five Sit-to-Stand as well as five Stand-to-Sit movements. Quantitative parameters were collected with a small sensor unit (Dynaport®, McRoberts, The Hague, The Netherlands) worn at the lower back with a belt. Mean and coefficient of variation (CV) of the five Sit-to-Stand and Stand-to-Sit movements, including flexion and extension phases were calculated. RESULTS: Total duration of the FTSTS and of respective movements (sit-to-stand, stand-to-sit) was comparable between all three groups. The maximum of angular velocity values of both the flexion and extension phases of Sit-to-Stand and Stand-to-Sit were significantly higher in HR compared with PD patients. Differences between HR and controls approached significance in the flexion phase of the Sit-to-Stand. PD patients and controls did not differ relevantly. The CV of the duration of Stand-To-Sit was higher in PD subjects than in the HR but not in controls. HR individuals did not differ from controls with respect to these parameters. CONCLUSIONS: As expected, quantitative analysis of single movements within the FTSTS enables differentiation of PD subjects from individuals without PD. Although we did not find significant differences between HR and controls, there

might be some potential of this approach to detect subtle differences between these two cohorts. Moreover, our results suggest that at least some parameters show an U-shaped behaviour, with highest values in the HR cohort and comparable values between controls and PD patients. Differences in maximum of angular velocity indicate a reduced smoothness of transfer movements. REFERENCES: Maetzler et al., PLoS One 2012;7: e32240 Mirelmann et al. Ann Neurol 2011,69: 193-7

P1-O-86 The effects of dual task on turning ability in stroke-survivors and older adults

Kristen Hollands[1], Deepak Agnihotri[1], Sarah Tyson[2]

[1]University of Salford, [2]University of Manchester

Background: Turning is an integral component of independent mobility in which stroke survivors frequently fall. Objective: To investigate the effects of competing cognitive demands on the stepping patterns while turning, of stroke survivors compared to healthy older adults (OA), as a possible mechanism for falls. Methods: Walking and turning (90º) was assessed under single (ST) (walking and turning alone) and dual task (DT) conditions using a pressure-sensitive walkway. The DT was subtracting serial 3s from a random number in the 100s while walking and turning. Dependent measures were time to turn, variability in time to turn, step length, width and single support time(SS) while turning. These parameters in ST and DT conditions were compared between 17 stroke survivors (mean time post-stroke=59±113 months; age=64±10 years; 6 right paretic) and age-matched OA (n=15). Results: All results presented as mean±SD. Both groups took longer ($p < 0.001$, 2.2±0.46s for DT and 1.92±0.34s for ST); were more variable ($p < 0.001$, 0.22±0.10s for DT and 0.12±0.06s ST); tended ($p=0.051$) to widen the second step of the turn (58.87±13.11cm for DT and 56.66±12.37cm for ST) and, crucially, increased SS ($p<0.001$; 0.52±0.10s for DT and 0.46±0.07s for ST) on the inside leg of the turn when distracted. OA prolonged SS more than stroke when distracted ($p<0.001$; 0.57±0.11s for OA and 0.47±0.09s for stroke), however there were no other differences between groups in response to distraction. Conclusions: Increased time in SS while turning and distracted may represent a biomechanical mechanism for increased risk of falls in both stroke survivors and OA.

P1-O-87 Do the hamstring muscles play a role in controlling the pelvis during unilateral internal perturbations in standing following stroke?

Kimberly Miller[1], Tanya Ivanova[1], Sue Peters[1], Michael Hunt[1], Jayne Garland[1]

[1]University of British Columbia

BACKGROUND AND AIM: Better performance on clinical measures of balance following stroke has been associated with anticipatory hamstring activation in advance of rapid unilateral forward flexion arm movements in standing. However, the role of the hamstrings in controlling the pelvis in this closed kinetic chain condition is not well understood. This study examined the associations between the position of the pelvis, anterior-posterior (AP) centre of pressure (CoP) and the timing of biceps femoris (BF) muscle activation during this arm perturbation task in people post-stroke. METHODS: Participants with unilateral paresis following stroke with combined Chedoke McMaster Stroke Assessment (CMSA) leg and foot motor impairment scores greater than 6/14 were recruited. They stood with each foot on a separate floor-mounted force platform and performed 10 trials of raising their non-paretic arm as fast as possible to shoulder height, holding, and then lowering it to the starting position. CoP, kinematic, and BF surface electromyography (EMG) data were collected from the paretic (P) and non-paretic (NP) sides.

The pelvic position was derived from the AP coordinates of the anterior superior iliac spine (ASIS) marker location. The pelvic position and the corresponding AP CoP were measured at 3 time points: baseline (BL-taken 500ms prior to arm movement initiation), peak anterior ASIS position after movement initiation, and peak posterior ASIS position after movement initiation. Associations within individuals between the pelvic position and AP CoP with the timing of onset of P and NP BF muscle burst (relative to arm movement initiation, BF-ONSET) were examined with Spearman Rank Correlation Coefficients. Associations between AP CoP and BF-ONSET data were similarly assessed. RESULTS: Figure 1A provides an example of the strong negative relationship between BL ASIS position and BL BF-ONSET seen with better motor recovery (CMSA > 11), demonstrating earlier BF activation with a more forward initial pelvic position on the NP side. Relationships between these variables were comparatively weaker on the paretic side (Fig 1C, D), and on the NP side with lower motor recovery (CMSA < 12, Fig 1B). Similar relationships were observed with the ASIS and AP CoP position at BL and at the other time points. Of note, those with less motor recovery demonstrated less inter-trial variability in BL ASIS position on the NP side, potentially indicative of a compensatory strategy to minimize pelvic movement (Fig 1B). The positions of the ASIS and AP CoP were moderately correlated (rs > 0.60). CONCLUSIONS: These findings demonstrate that the coupling between anticipatory activation of hamstrings and the position of the pelvis is strongest on the NP limb in people with better motor recovery post-stroke. Anticipatory hamstrings activation may act to control the forward position of the pelvis, contributing in part to minimizing CoP movement during internal perturbation balance tasks.

P1-O-88 Evidence for Sensory Contributions to Freezing of Gait in Parkinson's disease: Influence of Local muscle vibration on Freezing in Parkinson's disease

Marcelo Pereira[1], Quincy Almeida[2], Lilian Gobbi[1]

[1]UNESP - Rio Claro, [2]MDRC - Wilfried Laurier University

Background and Aim: Freezing of Gait (FOG) is one of the most severe symptoms in Parkinson's disease (PD). Impairments in proprioceptive integration were hypothesized to play an important role in the occurrence of this phenomenon. Thus, the aim of this study was to investigate how local muscle vibration, (well known to increase proprioceptive inflow) influenced the number and severity of FOG episodes. Methods: Nine PD patients who experience FOG (mean age: 72.00±8.93 years) walked on a computerized data-collecting carpet where participants were required to maintain small step lengths (15cm: corresponding to 27.22±3.10% of regular step length). Also, a narrow and cluttered space was created with the intention to induce FOG. A pair of cylindrical vibration devices (measuring 4.5cm x 2 cm x 2cm) was positioned on the belly of soleus muscles according to four vibration conditions: No vibration (OFF), vibration on both limbs simultaneously (BO), only on the less affected limb (LA), or on the most affected limb (MA). In the last three conditions the devices were turned on at the moment a FOG episode occured. In all cases, the devices were not turned off until the completion of the walk trial. The duration (time between initial and subsequent heel strike) and the number of FOG episodes (excluding the first FOG episode of each trial) were assessed. This method allowed us to investigate the acute vibration effects on FOG (duration of FOG) and pre-FOG vibration effects (the number of FOG). Results: A total of 40 FOG episodes were observed. FOG significantly decreased in both MA (2.62±1.24s - p=0.007) and LA (3.30±0.08s - p=0.01) in comparison to OFF (8.46±5.12s). No significant effect was observed for BO (5.66±4.14s). The number of FOG episodes were also lower in MA (0.4±0.55 - p=0.020) in comparison to OFF (2.12±0.64). No differences were observed for BO (2.00±2.92) and LA (2.2±2.28).

Conclusions: Based on the results of this study we conclude that the use of local muscle vibration is a promising technique to be used by PD patients who experience FOG. It can be used before the FOG episode, to reduce the chance of its occurrence and also after the FOG has occurred by reducing its duration. These results also suggest the likelihood of sensory deficits in FOG that cannot be explained by cognitive mechanisms, since increasing the proprioceptive information inflow reduced its occurrence and severity. These effects were seen only during unilateral application fashion and mainly when vibration was applied on the most affect lower limb.

P1-O-89 Post-stroke muscle activation in preparation for heel strike during gait

Sue Peters[1], Michael Hunt[1], Tanya Ivanova[1], S. Jayne Garland[1]

[1]University of British Columbia

BACKGROUND AND AIM: Improved gait is a frequently cited goal post-stroke. While reduced muscle strength and incoordination of muscle activity patterns have been commonly reported, the motor preparation of the knee for heel strike onto the paretic and non-paretic limbs is largely unstudied. This study examined activity of the knee musculature occurring in advance of heel strike during gait, and secondarily, examined whether motor preparation for heel strike changed with outpatient rehabilitation. METHODS: Participants were recruited shortly after discharge from in-patient rehabilitation post-stroke (n=8). Clinical evaluation of balance and mobility using the Community Balance and Mobility (CB&M) scale was performed prior to (Pre) and after (Post) 12 sessions of stepping training. Gait was evaluated using a laboratory-grade motion analysis system (10 digital cameras synchronized with wireless electromyography (EMG)). EMG data were recorded bilaterally from the biceps femoris (BF), and rectus femoris (RF) muscles as participants performed over ground walking at a self-selected speed. Heel strike (time "0") was defined as the lowest point of excursion of the heel marker. Muscle onset was determined as the point where rectified EMG activity was 3 standard deviations above baseline, within a 300ms window before heel strike. Five walking trials were measured to determine the onset and root mean square (RMS) of EMG activity. The difference between CB&M scores pre and post training were tested using paired t-tests while associations between onset times, RMS, and CB&M scores were explored using Pearson correlations using SPSS v. 20. RESULTS: At both the Pre and Post test, the BF led the RF by approximately 130ms in the paretic leg and 60ms in the non-paretic leg. Post-training, an earlier BF onset was associated with a lower BF RMS (r=0.64, p=0.09) suggesting compensation for low muscle activity by shifting the onset earlier. There was significant improvement on the CB&M scale following stepping training (p=0.01). The Pre CB&M score was not correlated with the Pre RMS of the paretic BF or RF (r=0.18 p=0.68, r=0.50 p=0.21, respectively) but did correlate with Post RMS of paretic BF and RF (r=0.73 p=0.04, r=0.85 p=0.01, respectively). This suggests that having better balance and mobility function before training influences motor preparation at the paretic knee following stepping training. Additionally, the Post CB&M scores remained highly correlated with the Post RMS paretic RF (r=0.72 p=0.04) lending further support for an influence of better motor preparation at the knee with functional balance and mobility. CONCLUSIONS: These results may indicate that stepping training promotes compensation for low EMG magnitude through earlier onset of muscle activity and this motor preparation for heel strike is associated with

P1-O-90 The Relationship Between Strength and Balance in Individuals with Parkinson's Disease

Amie Peterson[1], Morgan O'Connor[1], Hans Carlson[1]

[1]Oregon Health Sciences University

Background and Aim: There is a great deal of epidemiologic data that indicates that weakness in a risk factor for falling; however few studies examine the relationship between balance and strength. Studies in elderly fallers indicate an association between strength and balance with more difficult balance testing. Other researchers demonstrated that 10% of variance in static balance and 26% in dynamic balance were accounted for by strength. There is very little understanding of strength in Parkinson's or its relationship to balance. Because of this we decided to test the hypothesis that strength will have a stronger relationship with automatic postural responses than with dynamic balance or static balance in individuals with Parkinson's Disease (PD). Methods: This was a cross-sectional study using a convenient sample of baseline data collected for a vitamin D intervention study in PD. Twenty-seven individuals with a diagnosis of PD underwent sensory organization (SOT) and motor control (MCT) testing using computerized dynamic posturography. The SOT measures static balance (stable platform with eyes open, eyes closed, and moving visual surround) and dynamic balance (moving platform with eyes open, closed, and with moving visual surround). The MCT measures automatic postural responses. The platform makes small, medium, or large translations in backward or forward directions simulating tripping and measures the response strength and latency. Strength data was obtained by assessing knee flexion and extension on a computerized robotic dynamometer. Total work is calculated with this system and the measurement on the weakest side was used in the analysis. Results: Participants had a mean age of 67.6 years old (SD=6.8) and a disease duration of 7.7 years (SD=6.3). Dynamic balance and automatic postural responses were found to have significant correlations with strength. Dynamic balance showed the strongest correlations with work in extension (0.44, $p=0.02$) and work in flexion (0.59, $p<0.01$). Strength of automatic postural response in both forward (0.43, $p=.03$) and backward large translations (0.41, $p=0.03$) of the MCT correlated with work in extension. Conclusions: Knee flexion and extension strength do not appear to have a relationship with static balance in persons with PD. In contrast there was a relationship between strength and both dynamic balance and automatic postural responses. Interventions that effect strength may have beneficial effects on these aspects of balance in persons with PD.

P1-O-91 Split-belt locomotion modulates gait of patients with Parkinson's disease

Christian Schlenstedt[1], Alfonso Fasano[2], Jan Herzog[1], Meir Plotnik[3], Franziska Rose[4], Jens Volkmann[4], Günther Deuschl[1]

[1]University Kiel, [2]University of Toronto, [3]University Tel Aviv, [4]University Würzburg

AIM: To investigate the spatiotemporal adaptation of gait during different split-belt conditions in patients with Parkinson's disease (PD). METHODS: Twenty patients with PD participated in this study and walked on a split-belt treadmill under the following conditions: NC1 (normal condition): 5 min. walk normal condition (both belts running at the same speed); BSR/WSR: 10 min. walk either best-side-reduction (BSR: 25% reduction of the belt speed of the leg with the longer step length) or worst-side-reduction (WSR: 25% reduction of the belt speed of the leg with the shorter step length); NC2: 5 min. NC1. 2 min. break was given between NC1, BSR/WSR and NC2. Spatiotemporal parameters were recorded during gait analysis at the end of NC1, at the immediate begin (early adaptation) and at the end of BSR/WSR (late adaptation) and at the immediate begin of NC2 (after effect). Patients were tested

in the medication OFF-state. RESULTS: During the after-effect (NC2) of BSR a significant (p<0,01) improvement of bilateral coordination (phase coordination index, PCI), number of sequences (defined as the progressive reduction of step length for at least 6 consecutive steps) and gait asymmetry (GA) was found in comparison with baseline (NC1). GA improved due to a significant (p<0,01) longer step length of the leg with the shorter step length at baseline. The after-effect (NC2) of WSR resulted in a significant (p<0,01) worse PCI-value, whereas number of sequences and GA remained constant in comparison with NC1. CONCLUSIONS: PD patients are able to adapt to split-belt walking and - like healthy people - retain after-effects when walking on belts running at the same velocity. Interestingly, gait is modulated differently according to the reduction of the best or worst leg velocity. Bilateral coordination, GA and sequence effect were significantly improved after 10 min. walk under split-belt condition reducing the velocity of the best leg. As poor inter-limb coordination, GA and sequence effect are currently discussed to be the major contributors leading to freezing of gait episodes during walking, split belt gait may be a useful therapeutic tool to improve parkinsonian gait and to reduce the occurrence of freezing of gait. Whether long-term effects of split-belt treadmill training can be translated in a clinical and sustained improvement is currently investigated in another ongoing study.

P1-O-92 Subcortical activity during tonic neuromuscular behavior in healthy and PD populations: An fMRI study

W. Geoffrey Wright[1], Tyler Rolheiser[1]

[1]Temple University

BACKGROUND AND AIM: This study examined the neural correlates of tonic neuromuscular processes in the cortex, subcortical nuclei, brainstem, and cerebellum using functional MRI. Tonic neuromuscular processes are essential to normal posture and gait, and loss of normal tonic neuromuscular control can be associated with certain neurodegenerative conditions, such as Parkinson's disease (PD). METHODS: A total of 11 healthy young subjects, 3 healthy older adults and 5 individuals with PD completed a series of two experiments. The first experiment measured EMG recordings of the tibialis anterior (TA) muscle before, during, and after a period of isotonic contraction as well as during volitional ankle movements. The second part of the experiment involved the same task in an fMRI setting to map out the neural substrate of volitional and tonic processes. RESULTS: Volitional movement and isotonic contraction about the ankle joint recruited a broad network of cortical and subcortical sites including the sensorimotor cortex, the supplementary motor area (SMA), the striatum, the brainstem, and the cerebellum. The post-contraction rest period (the tonic neuromuscular phase), however, was associated with significant activity predominantly confined to the striatum and mesencephalic nuclei, while in PD subjects far greater activation was present in cortical sites, a diminished level of BG activity, and complete absence of brainstem activity. During isotonic contraction, healthy adults showed SMA activation while PD subjects showed only bilateral cerebellar activation. In the volitional ankle movement condition, the controls showed activity in the standard motor circuits including the sensorimotor areas, BG (striatum), and cerebellum. In the PD group, striatal activity was attenuated to almost nothing and M1 activity was diminished, but cerebellar activity was significantly increased possibly to compensate for decreased BG-cortical excitation. CONCLUSIONS: The results of this study are consistent with a hypothesis of a common motor network that is modulated based on the tonic or volitional demands of the task. The greater reliance of the tonic network on the basal ganglia and brainstem is consistent with recent evidence from deep brain stimulation studies that see

improvements in tonic muscular responses in PD. These current findings support the hypothesis that changes in BG-brainstem and cortico-BG pathways affected by PD may contribute to disease-induced plasticity in tonic descending drive. In addition to providing evidence that tonic muscle activity is driven by supraspinal processes, it also shows forebrain structures such as SMA and BG are involved. These structures have established connectivity to likely targets for PD rigidity, e.g. substantia nigra and pedunculo pontine tegmental nucleus, which our preliminary results from white matter connectivity (DTI) also support.

P1-P-93 Gait adaptations of the intact leg in transfemoral amputees. Influence of a microprocessor controlled prosthetic knee.

Erik Prinsen[1], Marc Nederhand[1], Johan Rietman[1]

[1]Roessingh Research and Development

BACKGROUND AND AIM: After transfemoral amputation different options for a prosthetic knee joint exist, including non-microprocessor controlled prosthetic knees (NMPK) and microprocessor controlled prosthetic knees (MPK). NMPKs are limited in changing damping properties of the prosthetic knee, which contributes to profound bipedal gait adaptations.[1] MPKs are able to change the damping properties of the prosthetic knee and it is believed that these will lead to more natural and stable gait. The majority of previously conducted trials studying MPKs have focused on biomechanics of the prosthetic knee. While this is a valid approach, it would be of clinical significance to see whether a transition towards a MPK will lead to a decrease of gait adaptations which are predominantly found in the intact leg. The aim of the present study is to determine whether a MPK reduce gait adaptations of the intact leg. METHODS: For this randomized within-subject cross-over trial nine participants were recruited from a convenience sample. Participants were measured twice: once with their own NMPK and once with the Rheo Knee (a MPK). Participants walked with the Low-Profile VariFlex EVO foot in both prosthetic knee conditions. Measurements were performed using a CAREN platform, consisting of an instrumented treadmill and a 12 camera Vicon system. Participants walked at preferred walking speed. Data were analyzed using Vicon Nexus software. Subsequently data were loaded into custom built Matlab software to obtain the required gait parameters. Preliminary data of six participants are presented. RESULTS: Preferred walking speed showed no differences between knee conditions. In three out of six participants, walking with the Rheo Knee reduced kinematic gait adaptations of the intact leg. In the other three participants little differences were seen. In the participants in whom adaptations were reduced, two showed decreased 'yielding' of the intact knee when walking with the Rheo Knee. In addition, in two participants of this group 'vaulting' of the intact ankle (assessed by determining the vertical position of the ankle joint centre during mid-stance with respect to the vertical position of the ankle joint centre during quiet stance) was reduced. Finally, two participants of this group showed reduced plantar flexion of the intact ankle at the stance to swing phase transition. CONCLUSIONS: These preliminary data show that the influence of a transition from a NMPK to the Rheo Knee has variable results on gait adaptations of the intact leg. Future analysis will include a larger sample of participants which will enable statistical analyses. [1] Prinsen EC, Nederhand MJ, Rietman JS. Adaptation strategies of the lower extremities of patients with a transtibial or transfemoral amputation during level walking: a systematic review. Arch Phys Med Rehabil 2011;92:1311-25.

P1-P-94 Brain activation differs between people with and without knee osteoarthritis during movement of the knee, but not other leg joints: an fMRI study

Camille Shanahan[1], Tim Wrigley[2], Kim Bennell [2], Paul Hodges[3], Michael Farrell [4]

[1]University of Melbourne, The Florey Institute of Neuroscience and Mental Health, [2]University of Melbourne, [3]University of Queensland, [4]The Florey Institute of Neuroscience and Mental Health

BACKGROUND AND AIMS: Changes in motor and sensory function are common in knee OA. These include quadriceps muscle weakness, altered muscle activation patterns, and impaired proprioception. Altered availability or processing of sensory information could underlie these changes. Although compromised sensorimotor processing in the brain has been found in musculoskeletal conditions, few studies have investigated activation of sensorimotor regions of the brain in OA, and if changes are present, whether they are specific to tasks involving the affected joints or are more generalised. This study aimed to assess differences in activation of brain regions involved in sensorimotor processing between people with knee OA and painfree controls during force matching tasks of the knee (quadriceps femoris), ankle (tibialis anterior) or hand (grip). METHODS: fMRI data were collected while 11 OA (6 male 69±6yrs) and 8 painfree control (5 male 64±6yrs) participants performed quadriceps, tibialis anterior and hand muscle isometric muscle contractions (random order). Participants lay supine with their leg supported on a custom-made apparatus that isolated contractions to the quadriceps or tibialis anterior. A force measurement apparatus placed over the ankle (for quadriceps) or dorsum of the foot (for tibialis anterior) or between the thumb and fingers (for hand muscles) recorded and displayed muscle forces. The block design alternated between rest (0% MVC; 27-s epoch) and 5%MVC isometric contractions (36-s epoch) that consisted of 3 cycles of a sinusoidal pattern of force modulation (range 0-5% MVC). Target and generated forces were displayed in an overlayed manner with instructions to match the target force as accurately as possible. FSL software tested for areas of activation that differed between groups across the whole brain. Root mean square (RMS) of the difference between target and generated forces (RMS error) during contraction quantified task accuracy. Independent t-tests compared RMS error between groups. RESULTS: During quadriceps contraction, activation was greater for the control participants across a range of cortical and subcortical brain areas involved in sensorimotor function (e.g. premotor, basal ganglia, associative cortex and visual areas). For the tibialis anterior task, small areas of greater activation were present for the controls in the frontal and parietal lobes, and for the OA group in the temporal lobe. Groups did not differ for the hand task. RMS error of force matching did not differ between groups for any task. CONCLUSIONS: Although participants performed tasks with equal accuracy brain activation differed extensively for the quadriceps task, suggestive of reorganisation of sensorimotor processing in the brain in knee OA. The absence or minor differences in brain activation during the hand and ankle tasks, respectively, indicate differences in sensorimotor processing are largely specific to the knee and not a generalised phenomenon.

P1-P-95 The effect of toe contact with the ground on knee and trunk movement during walking: A preliminary study

Daisuke Uritani[1], Takahiko Fukumoto[1], Chinatsu Sakamoto[2]

[1]Kio University, [2]Yamamoto Hospital

BACKGROUND AND AIM: Reduced toe function may change the walking pattern and increase mechanical stress on the knee and trunk. This study aimed to investigate the effect of toe contact with

the ground on knee and trunk movement during walking METHODS:Participants were 9 healthy volunteers (6 men and 3 women; age, 21.2 ± 0.7 years). They were asked to walk barefoot at a preferred but constant speed along a linear pathway under 2 conditions, and accelerations of the knee (Kn) and lumbar (Lx) spine were measured using triaxial accelerometers. The accelerometers were applied on the right fibular head and the third lumbar spinous process. Acceleration vectors were oriented such that the cranial, anterior, and right-sided deviations were positive in the vertical, forward, and lateral axes, respectively. Pressure sensors were applied under both heels to confirm heel strike. The control condition was normal gait. The intervention condition was walking with inhibited toe flexion to prevent weight bearing on toes. Kinesiology tape was applied along the toe extensors at the terminal extension position to inhibit toe flexion. Reduced weight bearing on the toes was confirmed using a force platform. The same protocol was repeated 3 times for each condition. Walking was started with the left foot. Data from the sixth and eights steps, which were the stance phase on the right, were recorded. The sampling rate was 1 kHz. Peak acceleration in the positive and negative directions (vertical: Avp/Avn, forward: Afp/Afn, lateral: Alp/Aln) and the root mean square (RMS; vertical: RMSv, forward: RMSf, lateral: RMSl) were calculated. The mean values of these parameters were calculated over the 3 trials for each condition. Between-condition differences were assessed using the Wilcoxon signed rank test. The local ethics committee approved the study. RESULTS:LxRMSl and LxRMSv in the intervention condition (0.06 ± 0.02 m/s^2 and 0.06 ±0.05 m/s^2, respectively) were higher than those in the control condition (0.05 ±0.01 m/s^2 and 0.03 ± 0.01 m/s^2, respectively; $p = 0.04$ and 0.07, respectively). The LxAfn (6.90 ± 4.06 m/s^2), KnRMSl (0.06 ± 0.05 m/s^2), and KnAfp (7.32 ± 2.38 m/s^2) in the intervention condition were higher than those in the control condition (5.13 ± 3.02 m/s^2, $p = 0.04$; 0.04 ± 0.01 m/s^2, $p = 0.07$; and 5.01 ± 2.17 m/s^2, $p = 0.05$, respectively). CONCLUSIONS: Our results indicated that insufficient toe contact resulted in increased perturbation of the low back and impaired propulsion of the trunk during walking. These results suggest that reduced toe flexor function leads to increased mechanical stress on the facet joints and low back muscles and might cause low back pain. Further, insufficient toe contact may cause increased lateral thrust of the knee and anterior glide of the tibia at the knee joint. These results may provide information on the factors associated with osteoarthritis.

P1-Q-96 Visual improvement of human tilt responses relates to lower position and velocity thresholds in multi sensory integration

Lorenz Assländer[1], Georg Hettich[1], Albert Gollhofer[1], Thomas Mergner[2]

[1]Albert-Ludwigs-University of Freiburg, [2]University Clinics Freiburg

Background and Aim: Vision is known to improve (reduce) sway responses to external disturbances. This study deals with the integration of the visual cues with vestibular and proprioceptive cues. It is argued that the integration involves lowering of central detection thresholds that reduce sensory (mainly vestibular) noise at low disturbance levels. The thresholds explained in previous studies a non-linear (under-proportional) increase in sway response with increasing stimulus magnitude ('amplitude non-linearity'), using a velocity threshold in the feedback compensation of support surface tilt [1] as well as position thresholds, e.g. for gravity compensation in model simulations. Using eyes-open, eyes closed and/or a reduction of visual velocity information by stroboscopic illumination, we investigated how visual cues affect the amplitude non-linearity of tilt responses and sway variability (as a measure of noise). Methods: Seven adult subjects balanced on a tilting platform during the visual conditions: 'Eyes closed' (EC), 'eyes open with continuous illumination' (CONT), and 'eyes open with stroboscopic

illumination' (STROB; strobe frequency, 4 Hz, velocity cues strongly diminished [2]). The tilt stimulus consisted of six repetitions of a 60.5-s pseudo-random sequence with a position and velocity amplitude characteristic that allowed in combination with the visual conditions a distinction of position and velocity effects [2]. Sequences with peak-peak tilt amplitudes of 1, 2, 4, and 8° were applied. Subjects' sway responses were measured opto-electronically and expressed as gain and phase over frequency, while sway variability was characterized by the variance of position and velocity data over frequency and by coherence functions. Results: Across all frequencies amplitude non-linearity effects were clearly smaller with CONT as compared to those with EC. The non-linearity effects in STROB were similar to EC at mid tilt frequencies where stimulus velocity effects prevailed, and they were similar to CONT at low tilt frequencies where stimulus position effects prevailed. Moreover, position variability was similar in STROB and CONT and significantly higher than in EC. In contrast, in the range of tilt frequencies where stimulus velocity effects were prevailing, velocity variability in STROB was similar to EC and a strong reduction was found in CONT. Conclusions: The results confirm that the visual contribution to balance control consists of a position and a velocity component. The observed reduction of sway variability indicates that visual cues in STROB reduced the noise level in the position domain, and in CONT in the position and the velocity domain. The characteristic reduction of both, sway responses and sway variability in relation to the visual conditions compares favorable to our hypothesis of lowered thresholds. [1] Mergner et al. (2009) J Physiol Paris 103, 178-194 [2] Assländer et al. (2011) Exp Brain Res 228: 297-304

P1-Q-97 Improved sitting posture of upper body at rest and working personal computer induced by tactile information via closing special underwear

Yoriko Atomi[1], Tomoaki Atomi[2], Kazuya Tanaka[2], Noboru Hirose[2], Miho Shimizu[1], Yoshiro Koyama[3], Suzuki Hidetoshi [4]

[1]Tokyo University of Agriculture and Technology, [2]Teikyo University of Science, [3]RenYou Co. Ltd., [4]Toray Industries, Inc.

BACKGROUND AND AIM: Recently working time to use personal computer (PC) is extraordinary increasing. Long sitting using PC is apt to bring posture round-shouldered, induce eyestrain, and neck shoulder region (NSR) ache, resulting in the onset of "Repetitive Stress Injury (RSI)". We have previously developed and reported tactile information via closing special wear is effective to improve standing and walking posture. Our aim is to examine the effect of new inner for PC work (PC-inner, with attached patch on the back) , based on the hypothesis to help the function of tholacolumber fascia and to decrease COG change of upper body, and the balance of NSR muscle activities, to avoid NSRA and RSI. METHODS: Kinematic, kinetic and electromyography analyses were performed to determine effects of posture-support underwear at quiet rest and during PC-work by using 3D motion analysis system (VICON-MX, Oxford Matrics Inc.) , force plate (OR6-WP, AMTI Inc.) and surface electromyography (Noraxon Inc.). Quiet sitting posture with wearing PC-wear or control wear (with special patches and normal underwear) was evaluated using Vicon. The effect of PC wear during typing for continuous 5 minutes PC work was evaluated by the difference of right and left electromyography (EMG) of NSR (muscles of scalene, sternocleidomastoid, splenius cervicis, and trapezius). Subjects are 10 healthy adults students ages between 20-25 years old. RESULTS: PC-inner significantly brought quiet sitting posture to decrease trunk flexion angle (more extended position of trunk). PC-inner wearing influenced the gradual decrease of laterality difference of EMG of muscles of scalene, sternocleidomastoid, splenius

cervicis during 5 min typing. Interestingly, EMG trapezius with control wear linearly increased during 5 min, while laterality ratio of trapezius EMG wearing PC-inner conversely decreased and attained to 1.0 (no difference of left and right) . CONCLUSIONS: Our new developed PC-inner wear is effective underwear to help promote a more extended or straight position of the trunk, and to possibly avoid NSR ache in sitting positions.

P1-Q-98 Contribution of foot afferents to soleus EMG activity during postural reactions

Dorothy Barthelemy [1], Annie Pham[1], Zoé Miranda[1]

[1]Université de Montréal

BACKGROUND AND AIM: Spinal mechanisms underlying balance reactions to perturbation are not fully understood. Several studies suggest that corrective reactions to perturbations may be mediated by plantar muscle afferents projecting to leg and thigh muscles: these afferents are the first to be activated following a perturbation and they also project to motoneurons of more proximal muscles of lower limb and trunk. However, their role during postural reactions is still not clear. The goal of the current study was to assess the contribution of foot afferents in corrective postural reactions. METHODS: Electrical stimulation to the right posterior tibial nerve (PTN) was applied at different delays during unexpected forward and backward tilts in 8 healthy subjects. EMG activity of right flexor digitorum brevis, soleus (SOL) and tibialis anterior muscles were recorded before and during the perturbation. Subjects were standing on a force platform that was tilted forward or backward in randomly selected trials. A single-pulse stimulus of the PTN (2-2.5 x motor threshold; level of the internal malleolus) was applied during quiet standing, prior to and 50, 100, 150, 300 and 800 ms after the onset of tilts. EMG responses in SOL to this stimulation were assessed in terms of latency, sign (facilitation or suppression) and amplitude in all conditions tested. RESULTS: 1) During quiet standing, SOL was tonically active. PTN stimulation induced a short-latency suppression (53±6 ms), a medium-latency facilitation (67±6 ms) and a long-latency facilitation (92±5 ms) in SOL. 2) During standing between perturbations, the latency of the short-latency suppression in SOL was significantly decreased (difference = -9.1 ms, Student's t test, $p<0.01$) and amplitude of inhibition was increased compared to quiet standing (mean increase = 35%, $p<0.01$). 3) During backward tilt, latency of responses to PTN stimulation in SOL did not change but the suppression observed at a short latency became a facilitation when the stimulation was delivered 100 and 150 ms after the onset of tilt (185% vs 64% during quiet standing; $p<0.001$) and the facilitation observed at long-latency became an inhibition (57% vs 141% during standing; $p<0.01$). 4) During forward tilt, the amplitude of the short-latency suppression observed in SOL during quiet standing increased but insignificantly. The responses observed at longer latencies were variable, but mainly remained facilitatory. DISCUSSION: Preliminary data show that responses to PTN stimulation induced in SOL muscle are modulated in preparation to the upcoming perturbation, most likely in an anticipatory way. Furthermore, PTN-induced responses in SOL are modulated in a task-specific way. These modulations precede the onset of postural EMG activity and thus may contribute to induction of postural reactions. Supported by NSERC, REPAR

P1-Q-100 Interlateral asymmetries in quiet and perturbed unipedal body balance

Luis Teixeira[1], Daniel Coelho[1], Osvaldo Vieira Jr.[1]

[1]University of São Paulo

BACKGROUND AND AIM: Interlateral performance asymmetry has been extensively studied in manual tasks, but scarce knowledge has been cumulated on interlateral asymmetries of lower limbs control. Particularly in the control of body balance, clinical evidence from studies comparing lesions to the right versus left cerebral hemisphere has suggested a functional specialization of the right hemisphere for upright stance control. This investigation aimed at evaluating interlateral performance asymmetry in body balance control. METHODS: Right-handed/footed male university students (n=12) were assessed on unipedal balance control tasks, while the opposite leg was kept motionless, hip and knee flexed. Evaluation was made in quite stance on rigid and malleable surfaces, and in recovery of stance stability following postural perturbation. For the rigid surface task, participants supported their foot directly on a force platform with the aim of maintaining stable unipedal stance during a time interval of 30 s. For the malleable surface task, a viscoelastic piece of foam recovered the platform surface; the aim on that task was to maintain stable unipedal stance during a time interval of 15 s. The task of recovery of stance stability consisted of a reactive response to unpredictable load release pulling participant's trunk backward (7% of the participant's weight), leading to a forward body sway. These tasks were performed under full vision (eyes open) or visual occlusion (eyes covered). RESULTS: Analysis of body sway was based on root mean square of center of feet pressure on the support surface (CoP). Results for the mediolateral direction showed lower values for the right than for the left leg. Full vision led to decreased CoP sway in comparison with visual occlusion. Analysis of CoP sway in the anteroposterior direction showed reduced values under full vision in comparison with visual occlusion. For the task of recovery of stance stability no significant effect was found either for CoP sway or latency of activation of the gastrocnemius lateralis muscle is response to postural perturbation. CONCLUSIONS: These results indicate that slow feedback-based adjustments of unipedal postural control are performed more proficiently with the right leg. More vigorous fast reactions to postural perturbation, on the other hand, were similar between legs. Vision improved quiet stance stability but not reactive responses to postural perturbation. Our results suggest that the neural circuitry controlling automatic small adjustments of the right leg is more effective in maintaining a stable upright posture than the circuitry controlling the nonpreferred left leg.

P1-Q-101 Visual planning in young children's locomotion

Dorothy Cowie[1], Oliver Braddick[2], Janette Atkinson[3]

[1]Durham University, [2]Oxford University, [3]University College London

BACKGROUND AND AIM: During a step younger children (3 years) are more reliant than older (4 years) on short-range, proximal information (Cowie, Braddick & Atkinson, 2010). Young children (3 - 6 years) are also less influenced than adults by long-range, distant visual information for route planning (Cowie, Smith & Braddick, 2010). The current task compares children's use of short- and long-range information more directly, using a task where children are required to make a locomotor response to a visual target which appears either two or five steps ahead of them. METHODS: Nine 3 year olds (mean age 3.46, s.d. 0.04 years, 4 males), nine 4 year olds (mean age 4.42, s.d. 0.04 years, five males), and nine 5 year olds (mean age 5.48, s.d. 0.07 years, five males) took part. The experiment was presented as a river crossing game. On every trial the task was to cross the 'river' (a blue mat) from the start to the opposite bank, by stepping on a series of stepping stones. Children were specifically asked to step on a stone with a star picture projected on it. In test trials the star moved from one side to the other during the trial. We varied within-subjects the distance between subject and star when the star moved ('jump distance': 2

steps / 5 steps); and the distance walked from the start when the move occurred ('trigger distance': short, 1 step / long, 3 steps). To prevent participants from anticipating a star-jump on every trial, we introduced control trials in which the star did not move. RESULTS: For test trials, success rates showed main effects of jump distance ($F[1,24] = 29.0$, $p < 0.001$) and age ($F[2,24] = 7.1$, $p < 0.005$), but no main effects or interactions of trigger distance. Thus children responded to the star's movement more often when it was 2 steps ahead than when it was 5 steps ahead; older children responded more often than younger; and response patterns did not depend on how long the subject had been walking when the star-jump occurred. ANOVA of the 2-steps-ahead condition revealed no effects or interactions. In contrast for the 5-steps-ahead condition there was an effect of age ($F[2,24] = 12.9$, $p < .001$), with older children responding to star-jumps 5 steps ahead significantly more than younger. CONCLUSIONS: Older children responded significantly more often than younger to visual information during locomotion. Crucially, this was particularly true when the target jump was distant (5 steps ahead): on these trials three-year-olds responded on less than half of trials while five year olds responded on around 80% of trials. In contrast children of all ages responded well to visual information presented two steps ahead. This experiment therefore showed a significant development in long-range locomotor planning across the age range, complementing recent mobile eye-tracking work which also suggests significant developmental changes in visual planning during locomotion (Franchak & Adolph, 2010).

P1-Q-102 Balance is affected in trans-tibial amputees during single-legged standing on the sound limb.

Nancy St-Onge[1], José Garcia Escorcia[1]

[1]Concordia University

BACKGROUND AND AIM: Amputees have been shown to have reduction of sensation, strength and balance performance. This reduction not only affects the amputated side but also the non-amputated side, at least for proprioception and cutaneous sensation. However, it is not clear whether strength and balance are also affected on the non-amputated side. The aim of this research was to study the effect of amputation on the non-amputated side in trans-tibial amputees (TTA). METHODS: Seven TTA individuals (age = 36 ± 12.8 yrs, 6 males/1 female) and seven able bodied controls (age = 39.9 ± 8.1 yrs, 6 males/1 female) matched for sex, age and level of physical activity participated to the experiment. Exclusion criteria for both groups were: older than 60 years of age , major visual deficiency, impaired balance or middle-inner ear pathology or any medical condition that can affect mobility (diabetes mellitus, peripheral vascular disease, major cardiac or respiratory disease, nervous deficiency, motor or cognitive impairment). Balance (center of pressure velocity - COPv) was evaluated under both static (quiet standing) and dynamic (following squats) conditions in a random order. The number of trials and the duration of the assessments were set at 3 trials of 45 seconds for each condition. During recording, the hands were maintained on the hips and eyes were open. Both static and dynamic balance was evaluated while standing on one leg. Amputated individuals stood on the sound limb and controls stood on a randomly selected limb. Cutaneous pressure sensation (CPS), proprioception (threshold detection of passive motion - TDPM), strength (peak torque to body weight - PTBW) were also evaluated on the same limb. CPS thresholds were determined on two sites: tibial and plantar. TDPM was measured while bearing body weight. The apparatus displaced the lower limb at a speed of 0.7°/second until the subject perceived the movement. Knee and ankle strength were evaluated using six concentric flexion/extension repetitions at a speed of 60°/sec. T-tests were performed to compare variables

between groups. RESULTS: There was a significant difference for COPv in the mediolateral (ML) direction between amputees and controls during standing assessment ($p < 0.05$) with lower values in amputees (Fig.1). Despite reporting non-significant differences ($p = 0.07$) similar results were observed for COPv in the ML direction for dynamic assessment. However, there was no significant differences for COPv in the AP direction for both dynamic and static conditions. No significant differences were observed for CPS, TDPM and strength when comparing amputees to able-bodied participants. CONCLUSIONS: Previous studies have reported an increase in sway in amputees during double-legged stance. It is possible that the reduction of the COPv in ML direction that we observed is due to the fact that amputees may rely more on their sound limb on a day-to-day basis during ambulation and standing.

P1-Q-103 Modulation of cutaneous reflexes during overground walking in the absence of vision

Andreas Miller[1], Kim Lajoie[1], Daniel Marigold[1]

[1]Simon Fraser University

BACKGROUND AND AIMS: Sensory information from the foot plays an important role in modulating muscle activity, regulating responses to perturbations and controlling foot placement during walking. Studies in humans and animals have highlighted the phase-dependency of such cutaneous reflexes and the differential pattern of responses evoked by stimulation of the various cutaneous nerves transmitting information from different regions of the foot. Since precise foot placement requires supraspinal involvement as well as information about the environment and limb position, it seems likely that the amplitudes of cutaneous reflexes can be modified on the basis of vision. Indeed, we have recently demonstrated that the amplitude of cutaneous reflexes is modulated based on the increased need for precise foot placement in a visually challenging walking task. It is not clear, however, to what extent visual information affects these reflexes. This study sought to determine whether the absence of vision during walking would impact the amplitude of cutaneous reflexes. METHODS: Ten university-aged adults walked across a 6 m pathway under two visual conditions (eyes open/normal vision or eyes closed/no vision) while the superficial peroneal (SP) nerve at the level of the ankle was electrically stimulated. In each condition, stimulation was manually triggered once per walking trial at different phases of the gait cycle and in the same area of the walkway. Bilateral muscle activity was recorded from the tibialis anterior (TA), medial gastrocnemius (MG), vastus lateralis (VL) and biceps femoris (BF). A motion capture system was used to measure changes in ankle/knee joint angles and footswitches were used to determine heel contact and toe-off events. Cutaneous reflexes that were identified as occurring between 50 and 120 ms post stimulation were sorted into ten bins, each spanning ten percent of the gait cycle. Subsequently, the average reflex amplitude for each bin was calculated and compared between visual conditions. RESULTS: Reflexes resulting from cutaneous stimulation of the SP nerve were present in all muscles tested. Significant phase differences were found in ipsilateral TA, MG and VL, as well as in contralateral TA, which resembled previous work investigating cutaneous reflexes on a treadmill. We found significantly higher mean reflex amplitude across the gait cycle for the no vision condition only in the contralateral TA. CONCLUSION: Phase-dependent modulation of cutaneous reflexes while walking persists with eyes closed. However, our results suggest that the absence of vision has minimal effect on the amplitude of cutaneous reflexes during a simple walking task. Our previous findings show that the precision aspect is critical in modulating cutaneous reflexes. Thus, it is possible

that despite the added threat of walking with eyes closed, the results can be explained by the lack of required precision in this study.

P1-Q-104 In-phase and anti-phase entrainment between periodic optic flow and postural sway

Masahiro Shinya[1], Masashi Susawa[1], Daichi Nozaki[1], Kimitaka Nakazawa[1]

[1]The University of Tokyo

BACKGROUND AND AIM: It has been well-known that visually-evoked postural sway was observed when people were exposed to a periodic optic flow. If postural responses to the optic flow are controlled as a reaction to the visual perturbation, the phase relationship between the optic flow and postural sway should be in an anti-phase relationship (i.e. backward sway against approaching visual stimuli, and vice versa). In fact, almost all of the research papers in this field have reported this phase relationship between visual stimuli and postural sway. In this study, we report a different stable state of visuo-postural entrainment during standing METHODS: Participants wore a head-mounted display (HMD) and viewed a 0.2 Hz antero-posterior optic flow during standing. The HMD has two lenses in front of the left and right eyes, which enables the subjects to view the stereoscopic virtual reality. Real-time position and angle of the head-mounted display were captured and we compensated the effect of participants' head motion on the perspective in the virtual reality. Three different amplitudes of the optic flow were tested: Small (0.3%), Large (3 %) and Extra large (10% of each participant's height, respectively). They were instructed to look at a fixation cross and stand for 4 minutes. The first 1 minute was quiet standing without any visual perturbation and a 3-min optic flow session was followed. RESULTS: In addition to the reactive anti-phasic coupling pattern, we observed an in-phasic coupling between the optic flow and postural sway (i.e. participants were swaying forward against approaching visual stimuli). CONCLUSIONS: The observed anti-phase entrainment might be understood as a result of sensori-motor integration. The central nervous system integrates multiple sensory modalities and efference copy to estimate the current state of the body and controls the body equilibrium. One of the principles of the sensor-motor integration system is to minimize the mismatch between these information. If one is swaying in an in-phase manner under the predictable periodic optic flow, there would be no mismatch between visual, somatosensory and vestibular afferent information and efference copy of their motor commands. Although it is hard to identify what determines the phase of the visuo-postural entrainment because of a big inter-subject variability, we will discuss potential factors at the conference.

P1-Q-105 Motor equivalency during reaching in healthy people

Yosuke Tomita[1], Anatol Feldman[2], Mindy Levin[1]

[1]McGill University, [2]Université de Montréal

BACKGROUND AND AIM: Previous studies indicate that the hand trajectory and endpoint precision remain invariant when trunk movement is unexpectedly blocked during reaching to a target within arm's reach from a sitting position, thus manifesting motor equivalency in the external workspace. This is achieved by the system automatically specifying appropriate changes in arm joint angles to compensate for the involvement of the trunk during the movement (compensatory arm-trunk synergy). We investigated motor equivalency in a more challenging task - in reaching movements beyond the arm's reach in standing subjects. We compared motor behavior when subjects reached without perturbation,

while they took a step voluntarily or took a step involuntary in response to perturbation, to prevent falling. We addressed the question of whether or not the hand trajectory and movement precision during standing reaches are preserved despite involuntary or intentional changes in the number of degrees of freedom involved in the task. METHODS: Seven healthy subjects (36.7±17.8yrs) reached from a standing position toward a target beyond the arm's reach (130% arm length) with their right arm. Subjects were instructed to remember the position of the target in advance and reach toward the remembered target with their eyes closed (Free-Hip condition). Arm, trunk and lower limb kinematics during reaching were recorded. In 40% of randomly chosen trials, hip flexion was unexpectedly prevented by an electromagnetic device, forcing the subject to take a step to prevent falling while reaching the target (Blocked-Hip condition). Furthermore, in order to investigate the influence of the step independently from the blocked-hip condition, reaching movements were repeated when subjects intentionally made a step (Intentional-Step condition). Hand, trunk and ankle trajectories were compared between trials. RESULTS: In all trials, trunk displacement occurred before or simultaneously with arm movement onset. Precision of the endpoint was preserved in all three conditions, suggesting that subjects adjusted inter-joint coordination in a condition-specific way. Endpoint trajectories between Intentional-Step and Blocked-Hip conditions were identical whereas those between Free-Hip and Intentional-Step conditions were different. CONCLUSIONS: Recruitment of additional degrees of freedom during reaching from a standing position did not affect endpoint precision in healthy subjects. Preservation of endpoint precision was achieved by rapid adjustments of endpoint trajectories when perturbations occurred. Compensatory inter-joint coordination may be responsible for maintaining endpoint precision during reaching when additional degrees of freedom are recruited.

P1-Q-106 The cerebral correlates of 3D representation of space in humans

Andreas Zwergal[1], Florian Schöberl[1], Günter Kugler[1], Stefan Kohlbecher[1], Phillip Werner[1], Guoming Xiong[1], Christian la Fougere[2], Thomas Brandt[1], Marianne Dieterich[1], Klaus Jahn[1]

[1]University of Munich, [2]University of Tübingen

Background and aim: Previous studies mostly investigated orientation in 2-dimensional space, i.e. in the horizontal plane. However, in everyday live humans have to find their way in 3-dimensional environments. Animal experiments suggest potential neurobiological differences in encoding horizontal and vertical space. In the present study, we attempted to depict and compare brain activation patterns during a predominantly vertical and horizontal real navigation task in humans. Methods: 14 healthy persons (7 women, mean age: 51 years) performed a navigation paradigm in a 15-level-staircase of our hospital. Five different items were placed hidden on different levels. During the exploration period the location of each item was shown to the subjects starting on a mid-level. Importantly, subjects did not get information on the starting point or the number of levels. All potential clues were avoided by covering labels of levels ect. During the navigation period, [18F]-FDG was injected and subjects had to find the items in a pseudo-randomized order over the next 10min. As a control condition, in a second visit all persons performed a stereotyped vertical up-and-down locomotion in the staircase for 10min without spatial orientation challenge. Brain activation patterns of vertical navigation vs. locomotion were analysed by means of SPM. In a second step brain activation during the vertical navigation paradigm was compared to brain activation of an age- and sex-matched control group during a comparable horizontal navigation paradigm. Results: During vertical navigation (as compared to vertical locomotion) a prominent increase of regional cerebral glucose metabolism (rCGM) was found in the

anterior hippocampus and the cerebellar hemispheres bilaterally. Comparison to real navigation in the horizontal plane showed no difference of rCGM in the hippocampus, but a significant increase of rCGM in the right insular cortex during vertical navigation. Conclusions: Our data suggest that the hippocampal formation plays a central role for both horizontal and vertical representation of the space in humans. Anisotropy was found in the cortical activation pattern, where the insular cortex was more active during vertical as compared to horizontal navigation. This may represent an increased input of vestibular information during vertical navigation. Further studies need to be done to clarify the importance of different sensory systems (visual, vestibular, somatosensory) for 2- and 3-dimensional navigation in humans.

P1-R-107 Trunk movement in frontal plane during gait in adults with hemiplegia after stroke

Yumi Aga[1], Koji Ohata[1], Kaoru Sakuma[1], Ryosuke Kitatani[1], Yu Hashiguchi[1], Natsuki Yamakami[1], Sayuri Osako[1], Reiko Honda[2], Kumi Nagata[2]

[1]Graduate School of Medicine, Kyoto University, [2]Kyoto University

BACKGROUND AND AIM: Trunk and pelvic movements during walking are considered essential components of effective gait. Impaired trunk movements during gait are critical for gait recovery in adults with hemiplegia after stroke. In previous studies, the asymmetry of the trunk movements, measured using accelerometers, in the frontal plane was increased in adults with hemiplegia. However, details of the trunk movements corresponding to the gait cycle are unclear. This study aimed to investigate the characteristics of the trunk movements in the frontal plane using accelerometers and the relationship between the trunk movements and lower limb muscle strength on the paretic side. METHODS: Thirteen subjects with hemiplegia after stroke (S group) and ten healthy subjects (H group) performed the 10-m walking test at a self-selected speed. Trunk acceleration and pelvic acceleration in the mediolateral direction were measured using accelerometers attached to the C7 and L5 spinous processes, respectively. The rotational acceleration of the trunk in the frontal plane was calculated by subtracting the pelvic acceleration from trunk acceleration in the mediolateral direction. The peak value of the rotational acceleration was identified during each gait cycle event--initial contact (IC), double stance (DS), and single limb stance (SLS)--of the paretic and non-paretic sides. In the S group, the lower limb muscle strength of the paretic side (hip flexor, knee flexor and extensor, and ankle dorsiflexor and plantar flexor) was measured using a hand-held dynamometer. The accelerometer variables were compared between the two groups using the Mann-Whitney U test. The relationship between the accelerometer variables and lower limb muscle strength was assessed using Spearman's rank correlation coefficient. RESULTS: The directions of trunk rotational acceleration and trunk and pelvic acceleration at each gait cycle event were the same in both groups. Although there were no significant differences between the two groups in the trunk acceleration, the pelvic acceleration at IC and during DS after IC on both sides was significantly decreased in the S group compared with that in the H group ($p < 0.05$). The trunk rotational acceleration during DS after IC on the non-paretic side in the S group was significantly reduced compared with that in the H group ($p < 0.05$). In the S group, the pelvic acceleration at IC and during DS after IC on the paretic side was significantly associated with the muscle strength of the knee extensor ($r = 0.74$, $p < 0.01$) and knee flexor ($r = 0.81$, $p < 0.001$), respectively. CONCLUSIONS: Reduced pelvic acceleration caused by muscle weakness on the paretic side was the characteristic change in the trunk movement of adults with hemiplegia.

P1-R-108 Control of locomotor heading during obstacle avoidance in individuals with visuospatial neglect

Gayatri Aravind[1], Anouk Lamontagne[1]

[1]McGill Univeristy

Post-stroke sensorimotor impairments can lead to altered ability to control locomotor heading and avoid obstacles while walking. The presence of visuospatial neglect (VSN) may further hamper the control of walking trajectories due to impairments in the uptake & utilisation of visual information from the contralesional side of space. We examined how participants with post-stroke VSN control their heading to avoid collisions in response to moving obstacles while walking in a virtual environment(VE). Methods: Twelve post-stroke VSN subjects were tested in a VE consisting of a target & 3 obstacles, one of which randomly approached from head-on or 30° to the contralesional/ipsilesional side including control trials with no obstacles. Participants walk towards the target while avoiding a collision with the obstacle..We examined the spatial relationships (heading, heading onsets) maintained by the participants in space and in relation to the obstacle and target. Results: The participants showed a preference to deviate towards the ipsilesional side (positive values) for all four obstacle conditions (from 9.0°±4.2 to 9.9°±5.9; mean±1SD). Subjects also showed preference to rotate their heads ipsilesionally for head-on(11.5°± 9.4), ipsilesional(6.4°±6.1) contralesional obstacle approaches(12.4°±6.6) and control trials(9.2°±6.1). The ipsilesional head rotation and deviation of trajectory continued to be observed even after the obstacle passed the subject. Five participants collided with the contralesional obstacle while eight collided with the head on obstacle. Contralesional colliders showed larger heading reorientations(12.2°±3.8) compared non-colliders(6.6°±4.1), whereas head-on colliders obstacles showed smaller heading reorientations (9.6°±6.9) compared to non-colliders (11.2°±5.7). The colliders also showed delayed onsets of heading reorientation compared to non-colliders for both contralesional (2.6 s±0.5 vs. 2.2 s±0.6) & head-on (4.7s±1.6 vs. 4.0±1.6) obstacles. Discussion: The persistence to veer and reorient the head towards the ipsilesional side is consistent with ipsilesional bias commonly observed in VSN[1] and contrast with the behaviour of healthy individuals reported in a previous study where deviation was observed to occur in the direction opposite to the obstacle approach[2]. The delayed initiation of heading reorientation observed in the colliders may have translated into reduced time and distance available to execute an avoidance strategy. Additionally, the smaller heading reorientation in colliders with head-on obstacles may have kept the participants in the path of collisions, while the larger heading reorientation observed in contralesional colliders may have been an attempt to compensate for the delay in onset of reorientation. Conclusion:Persons with post-stoke VSN collide with obstacles approaching from the contralesional side and from head-on. Control of heading could be a determinant in the risk of collision with moving obstacles

P1-R-109 Number of trials required to accurately evaluate spatiotemporal gait variability data using instrumented mats

Chitra lakshmi K Balasubramanian[1], Joe Stoecklein [1], David Eldridge[1], Robert Page[1], Amit Sethi[2]

[1]University of North Florida, [2]University of Pittsburgh

BACKGROUND AND AIM: Gait variability in spatiotemporal gait parameters is increasingly reported as a marker of gait performance in clinical populations such as older adults at risk for falling and persons with

neurologic diagnoses. The most common tool used to capture SpatioTemporal Gait Variability (STGV) is an instrumented mat. However, a recent study highlighted the lack of standardized testing procedures for STGV measurement when using instrumented mats. Specifically, it is unclear regarding the number of trials that need to be collected for an accurate measurement of STGV. Therefore, our aim was to determine the number of trials that can provide an accurate estimate of STGV when using instrumented mats. Furthermore, since recent work suggests that STGV might differ based on the walking protocol chosen, we determined the minimum number of trials required for an accurate estimation of STGV using different walking protocols. METHODS: Twenty-eight healthy young adults (22 ± 2.5 years) completed four walking protocols (of 10 trials each) presented in a random order: interrupted-walking at self-selected speed - SISS; interrupted-walking at fastest-safe speed - SIFS; continuous-walking at self-selected speed - CONTSS; and continuous-walking at fastest-safe speed - CONTFS. Data were collected on a 20' instrumented walkway (GAITRite) and the standard deviation in steps quantified STGV in 7 spatiotemporal gait parameters. We used the algorithm proposed by Stergiou (2004) to compute the minimum number of trials. First, one-quarter standard deviation of all the trials (criterion value) was computed followed by the cumulative mean, standard deviation, and mean deviation values. The minimum trial was determined as the trial number for which all successive mean deviations were smaller than the criterion value. This computation was repeated in succession for all trials for each participant in each condition. Descriptive statistics were computed to calculate the average number of trials required for an accurate estimation of STGV across all participants. RESULTS: The average number of trials required to accurately evaluate STGV ranged between 6 - 8 trials for all spatiotemporal variables in the four walking protocols (Table 1). The maximum number of trials (8) required for an accurate estimation of STGV was for pre-swing time in the CONTSS protocol. Seven trials were sufficient for an accurate estimation of STGV across all four walking protocols for swing time, stance time and step width. CONCLUSIONS: Based on our results, it is suggested that at least 6 - 8 walking trials be included when designing STGV data collection procedures using instrumented mats. Future work should investigate if the minimum number of trials required for STGV data collection is similar in clinical populations. Nonetheless, our results demonstrate preliminary efforts to standardize STGV data collection procedures.

P1-R-110 An inexpensive, versatile, and user-friendly system for assessing postural steadiness during standing: Software module

Albert Vette[1], Quinn Boser[1], William McIlroy[2]

[1]University of Alberta, [2]University of Waterloo

BACKGROUND AND AIM: In light of over 180,000 injurious falls per year in Canadian seniors, it is not surprising that falling is a major health problem and an immense economic burden on our health care system. To reduce the risk of falling in the elderly, the detection of age-related changes in postural control prior to the first incidence of falling would be highly beneficial. In this context, posturographic measures such as medial-lateral (ML) postural sway have been shown to be strong predictors of fall risk. Ongoing developments of low-cost hardware are promising to facilitate the use of center-of-pressure (COP) measures outside of laboratories and larger clinical centers. However, software that can provide a clinically meaningful summary of such posturographic data is still lacking. Motivated by this limitation, the objective of this work was to develop a no-cost software module for posturographic assessment that is versatile and user-friendly. METHODS: The overall system consists of two components: a hardware

and a software module. Since the software module was envisioned to also function in conjunction with existing laboratory-grade force platforms, it was developed in the first stage of the project. In order to meet the overall objective of this work, the software module had to: (1) accept digitized hardware measurements (ground reaction forces) via USB port; (2) automatically calculate the COP time series in the anterior-posterior (AP) and ML directions; (3) identify measures of postural steadiness in time- and frequency domain as well as atypical events in the COP time series; and (4) present outcome measures in a clinically relevant and user-friendly manner. RESULTS: Although the software module has been developed in Matlab, it runs as a stand-alone program with graphical user interface on any Windows-based computer with USB port. The time series data received through that port (digitized voltages) were converted into vertical ground reaction forces using the calibration constants of the utilized hardware. The software calculated the COP fluctuations and identified a range of time- and frequency-domain measures of postural steadiness that cover previously reported correlation groups. In addition, excerpts from the COP fluctuations (AP and/or ML) are displayed that significantly deviate from average signal properties in terms of range, velocity, and frequency. The performance of the software module was tested with data from 14 young and healthy individuals who stood quietly on a Kistler force platform for 30 seconds. CONCLUSIONS: A no-cost, versatile, and user-friendly software module has been developed that, in combination with prevalent force platforms, can quickly identify and present a range of measures of postural steadiness. Current efforts are focused on facilitating wireless data acquisition (Bluetooth) and evaluating the performance of an inexpensive hardware module in comparison to laboratory-grade force platforms.

P1-R-111 Age-associated changes in head jerk measured by accelerometers

Matthew Brodie[1], Hylton Menz[2], Stephen Lord[1]

[1]Neuroscience Research Australia, [2]La Trobe University

Background: Many older people have impaired dynamic stability and up to one in three people over 65 fall each year (1). The cause and effect relationship between gait speed, stride time variability, and dynamic stability is debated. Older people may walk more slowly to compensate for reduced capabilities (2) yet, walking slower may increase variability (3), but not always stability (4). Here we investigate if head jerk, the first time derivative of acceleration, can further our understanding of age-associated changes in dynamic stability and might reveal aspects of motor control which are reportedly 'camouflaged by preferred walking speed' (5). Methods: Gait parameters including cadence, step length, walking speed, harmonic ratios, step-time variability, and jerk were measured in 43 young and 100 older people using accelerometers securely attached to the head and pelvis. Results: Older people presented significantly ($p \leq 0.004$) more mediolateral (ML) head jerk, but significantly less vertical (VT) head jerk. For both older people (dark squares, see Figure) and younger people (light stars) ML head jerk was highly correlated ($r \approx 0.8$) with increased walking speed, but at any observed walking speed, the older group had higher average ML head jerk. The dimensionless log ratio, ML/VT jerk, demonstrated superior ability (89% accuracy) in differentiating older from younger people, it was highly reliable ($ICC(2,1) \geq 0.9$), normally distributed, and relatively unaffected by walking speed ($r=-0.25$). Principal component analysis revealed four constructs explained 78% of the variance observed: 1) Gait Vigour. 2) Pelvic Stability. 3) Head Stability. And, 4) Stature. ML/VT jerk represented Head Stability, and was distinct from Gait Vigour which included single measures of jerk and walking speed. Conclusions: In older people, reduced VT head jerk may indicate reduced gait vigour, but the increased ML head jerk may indicate age-associated

changes to dynamic stability. The smoother head movements evident in our younger group may be because they were more able to rely on automatic control and the dynamic (pendulum-like) stability of their systems. Further research might investigate if such age-associated changes result in safer movements at the expense of being less economical. 1. Masud T, Morris RO. Epidemiology of falls. Age Ageing. 2001;30 Suppl 4:3-7 2. Menz HB, Lord SR, Fitzpatrick RC. Age-related differences in walking stability. Age Ageing. 2003;32:137-142 3. Beauchet O, Annweiler C, Lecordroch Y, Allali G, Dubost V, Herrmann FR, et al. Walking speed-related changes in stride time variability: effects of decreased speed. J Neuroeng Rehabil. 2009;6:32 4. Kang HG, Dingwell JB. Effects of walking speed, strength and range of motion on gait stability in healthy older adults. J Biomech. 2008;41:2899-2905 5. Helbostad JL, Moe-Nilssen R. The effect of gait speed on lateral balance control during walking in healthy elderly. Gait Posture. 2003;18:27-36

P1-R-112 A new gait analysis tool for the assessment of fall risk in older adults

Marina Brozgol[1], Holger Arndt [2], Stefan Burkard [2], Jeff Hausdorff[1], Anat Mirelman[1]

[1]Sourasky Medical Center, [2]Spring Techno GmbH & Co. KG

Background and Aim: About 30% of older adults aged +65 fall at least once each year. Older adults who fall often suffer from a variety of fall related consequences such as fear of falling, social isolation, and injuries. While many tools have been developed to assess fall risk, optimal prediction and assessment methods have not yet been achieved. This work introduces a new software tool designed to assess the risk of falls of elderly people. The proposed tool is an all-in-one software. It covers the whole process of gait analysis, offering the following functionalities: 1) raw data input in different data formats; 2) raw data filtering with flexible filter settings; 3) gait parameter definition via an editor; 4) automatic pattern extraction; 5) customizable evaluation matrix (the Fall risk index) which helps classify an individual's fall risk; 6) individual subject fact sheets. Methods: A core building block of the system is an intelligent pattern recognition algorithm. The algorithm compares a data population of known fallers with one of known non-fallers. Relevant classifiers are then extracted, using self-learning algorithms, which are based on a modified Pearson Correlation method. The modification adds a non-linear component that weights elements of the recent past in a stronger way. A Fall Risk Index which aggregates multiple gait parameters and gait pattern recognition has been defined. The fall risk index provides quantitative information on possible gait trends and risk of fall. The tool is equipped with a user interface consisting of several sections, each one responsible for a specific functionality. This section facilitates an up to milliseconds study of data values, data filtering and gait parameter extraction. In the fall risk index definition section, weighted clusters of selected patterns (classifiers) can be built and be applied to the data. The result is a classification of each data set into a Fall risk index, that ranges from zero (reflecting no fall risk) to 100 (reflecting a high risk of falls). Results: For preliminary evaluation of this tool, a data set of fallers/non-fallers was used as input to the tool. The software extracted a distribution of values of specific gait parameters, such as stride time, single support time, swing time, double support time, and cadence. The preliminary results show that with an evaluation method that combines patterns from three gait parameters, the tool classified an out-of-sample population with an accuracy of above 85%. Conclusions: This work proposed a software tool able to assess the risk of falls of elderly people. The tool consists of several building blocks to cover the whole gait analysis process from raw data input to the classification of fall risks. Preliminary results demonstrated feasibility and satisfactory performance.

Future work will further evaluate the potential of this system. This work was supported in part by the European Commission -FP7 contract no. 288878

P1-R-113 Inertial Measurement Units for Monitoring Spatio-Temporal Gait Parameters in Parkinson's Disease: Validation in a Clinical Setting

Alberto Ferrari[1], Pieter Ginis[2], Laura Rocchi[3], Lorenzo Chiari[3]

[1]University of Bologna, [2]KU Leuven , [3]Universita' di Bologna

BACKGROUND and AIM: Gait disturbances in Parkinson's disease (PD) have been associated with loss of independence and reduced quality of life [1]. Standard instruments able to estimate spatio-temporal gait parameters require laboratory-based settings. However, PD is associated with relevant fluctuations occurring both within and across days. Inertial measurement units (IMUs) allow for unobtrusive, objective, and ecologically valid data collection, hence for a new era of opportunities in patients' care and treatment [1]. In particular, pedestrian zero-velocity-update-aided (ZUPT-aided) inertial navigation systems (INSs) constructed around foot-mounted IMUs, have recently shown the potential to carry out accurate, robust, and infrastructure-free gait analysis [2]. The aim of the present study is to verify the accuracy of this approach in stride length and duration estimation on subjects with PD. METHODS: Fifteen PD patients (13 male mean 65 (SD 12) years old; H&Y: 1-3) walked 5 times at comfortable, 2 at increased and 2 at decreased gait speed over an 8.80-metre instrumented GAITRite (GR) walkway (100Hz, CIR Systems Inc, PA). Newly developed wireless IMUs fastened at the top of the participants' shoes (Exel, IT) were used to implement an offline ZUPT-aided INS similarly to [2]. A set of six IMUs with the same components was casually used to verify the influence of hardware performances. Sampling frequency was set to 200Hz for 6 patients, to 100Hz for the other 9. Initial contact and foot-off events were determined by processing the feet angular velocities similarly to [3]. IMU data collection was performed via Bluetooth by means of a custom smartphone application. For each of the 9 trials the total duration and length of the strides was obtained both from IMUs and GR. RESULTS: One patient (both sides) and a single side of another patient were excluded from the analysis since the accelerations produced were always above the Full Scale of the IMUs (±6g). Figure 1 shows, in Bland-Altman plots, the differences in percentage between steps durations and lengths estimated with IMUs and GR. Filled black dots represent patients acquired at 200Hz. CONCLUSIONS: The results obtained show a good agreement between IMUs and GR method, with a bias close to 0 and a SD within 4% for both stride duration and length. The performances obtained among subjects are consistent, revealing good inter-subject and inter-hardware reliability. The sampling frequency at 200Hz produced better results in step length estimation. The accelerometer full scale should be set higher than ±6g. ACKNOWLEDGEMENTS: EU-FP7/2007-2013 grant agreement n°288516 (CuPiD project). REFERENCES: [1] Maetzler W et al. (2013) Movement Disorders, 28(12):1628-37. [2] Nilsson JO et al. (2012) PLANS, 2012 IEEE/ION:140-145. [3] Ferrari A et al, Gait Posture 2013, 37(S1): S27.

P1-R-114 Gait dynamic stability in children

Ann Hallemans[1], Paula Lobo da Costa[2], Evi Verbecque[1], Luc Vereeck[1], Peter Aerts[1]

[1]University of Antwerp, [2]Federal University of Sao Carlos

BACKGROUND & AIM: Dynamic stability in human gait is the ability to respond to external and internal perturbations without falls [1]. The task of maintaining stability during walking is different than that of

standing, because the stability is not continuous, but periodically discrete in each step, which may require a different mechanism to integrate the sensorial information [2] to effector commands. Functional assessments for static balance correlate well with posturographic measures but are not appropriate to evaluate gait dynamic stability [1]. There seems to be no consensus on which parameters adequately quantify gait dynamic stability, especially in small children. In children under the age of six, gait stability is characterized most often by spatio-temporal parameters [3].Thus the purpose of this study is to explore different methods for the quantification of gait dynamic stability in young children. Convergent validity of each parameter measured with a functional assessment of balance will be explored. METHODS: So far, 12 children (mean age 47 ± 17 months) participated in this study. A biomechanical gait analysis was performed in the M²oCeAn-lab. While walking, kinematic data were collected by a Vicon system (8 cameras, 100 Hz.) using the Plug-In-Gait model. The parameters collected within this study are: stride length (m), double support time (%), walking speed (m/s), cadence (steps/min), heading angle (°), medio-lateral displacement of the center of mass (mm) and performance on the Ghent Development Balance test (GDBT)[5]. Spearman rank correlations were calculated between the score on the GDBT and the step-time parameters of gait. RESULTS: A strong correlation is observed between the GDBT and stride length ($r= .888$; $p < 0.01$) and age ($r= .993$; $p < 0.01$). A moderate to strong correlation can be perceived between the GDBT and walking speed ($r= .750$; $p < 0.01$), double support time ($r= -.600$; $p < 0.05$) and heading angle ($r= -.641$; $p < 0.05$). A weak to moderate correlation is revealed between the GDBT and cadence ($r= -.329$) and medio-lateral center of mass displacement ($r= -.497$). DISCUSSION: In our preliminary data set, moderate to strong correlations are observed between several step-time parameters of gait and the performance on the functional balance test, suggesting they are potential candidates for evaluation of gait dynamic stability in children. Age also seems an important determining factor in balance performance during locomotion. Therefore, additional data will be collected in order to investigate the sensitivity of different gait parameters to developmental levels of balance control. 1. DINGWELL, JB.; KANG, HG. Journal of Biomechanical Engineering, v. 129, n. 4, p. 586-593, 2007 2. O'CONNOR, SM.; KUO, AD. Journal of Neurophysiology, v. 102, n. 3, p. 1411-1419, 2009 3. KUBO, M.; ULRICH, BD. Journal of Motor Behavior, v. 38, n. 3, p. 229-237, 2006 4. DE KEGEL, A. et al. Physical Therapy, v. 92, n. 6, p. 841-852, 2012

P1-R-115 Functional Reorganization of the Locomotor Network in Parkinson patients with Freezing of Gait

Brett Fling[1], Rajal Cohen[2], Damien Fair[1], John Nutt[1], Fay Horak[1]

[1]Oregon Health and Science University, [2]University of Idaho

Freezing of gait (FoG) is a transient inability to initiate or maintain stepping that often accompanies advanced Parkinson's disease (PD) and significantly impairs mobility. The neural mechanisms underlying FoG remain poorly understood. The current study uses a multimodal neuroimaging approach to assess differences in the brain's functional and structural locomotor network in PD patients with and without FoG and relates these findings to measures of FoG severity. Twenty-six patients with PD and 15 age-matched control subjects underwent resting-state functional magnetic resonance imaging and diffusion tensor imaging along with self-reported and clinical assessments of FoG. After stringent movement correction, 15 PD patients and 14 control participants were available for the analysis. We assessed functional connectivity strength between the supplementary motor area (SMA) and the following locomotor hubs: 1) subthalamic nucleus (STN), 2) mesencephalic and 3) cerebellar locomotor region

(MLR and CLR, respectively) within each hemisphere. For those locomotor hubs demonstrating group differences in functional connectivity, we also quantified structural connectivity strength and assessed relationships with metrics of FoG. FoG patients showed greater functional connectivity between the SMA and bilateral MLR and between the SMA and left CLR compared to both FoG- and HC. Importantly, greater functional connectivity between the SMA and right MLR was positively correlated with both clinical and self-reported ratings of severity of freezing in FoG , suggesting that the observed increases in communication may contribute to FoG. In addition, FoG showed significantly reduced functional connectivity between the SMA and right STN compared to FoG-, although both freezers and nonfreezers demonstrated similar reductions in structural connectivity of this hyperdirect pathway. The current findings demonstrate a reorganization of functional communication within the locomotor network in FoG patients whereby the higher-order motor cortex (SMA) responsible for gait initiation communicates with the MLR and CLR to a greater extent than in FoG- patients and HC. The observed pattern of altered functional connectivity in FoG may indicate that these changes contribute to FoG rather than serving a compensatory role. We suggest that this may coincide with increased cognitive control of gait as a result of the observed decreases in functional and structural connectivity between the STN - SMA in FoG patients.

P1-R-116 Postural influence between 4 modalities to immediately test the postural influence of foot orthotics

Edouard Ceccaldi[1], Marc Janin[1]

[1]Applied Podiatry College

Postural influence between 4 modalities to immediately test the postural influence of foot orthotics Janin M, 1,2 Ceccaldi E 1,3, 1 Applied Podiatry College, 7 Treguel, 86000 Poitiers, France. 2 Podiatrist, PhD, Clinic, 7 Treguel, 86000 Poitiers, France. 3 Podiatrist, Office, 35 rue Sermonoise,77380 Combs-la-Ville, France. Aim: Foot Orthotics (FO) induces variations on balance (1); dynamics (2,3), and posture (4). To realise FO, podiatrists evaluate functions and morphologies of the foot through baropodometry, posturography, analysis of dynamics, clinical tests (1-5). Based on all of those examinations, they decided the position of stimulations and manufacture the FO. Only, the FO influences are never tested directly on the patient. The aim of this study is to evaluate postural variations induced by situations used to place and test FO under subjects' feet. Methods: To related postural modifications, 25 adults underwent posturodynamic clinical test (6) under normal foot positions (C) and four conditions to test FO under subjects' feet: walk and stay-on (WSO); sit and stand (SS); one leg off (OLO) and stamp on toe (ST). Scores were performed and compared between conditions. Mann-Whitney statistical test were undertaken. Significant findings into control and 3 situations WSO; SS; OLO (p= .01, p=.005, p=.05), and if subjects starting with left or right legs for WSO and OLO (p= .01, p=.02) were revealed. No differences were observed for ST (p= .13). Results: Results suggest that modalities to test FO effects can produce different postural variations. Situations WSO; SS; OLO induced postural variations (reduction of posturodynamic score). Their effects on postural tone distribution are different from the initial position. If podiatrist used those tests for testing FO, they could have observed modifications induced by situations and not only by orthotics corrections. However, results indicated that ST produced no differences. Conclusion: This clinical evaluation may, possibly assist podiatrist to observe FO effects. We hypothesize to use this situation to test directly FO effects. Bibliographies 1.Gross et al. Effects of foot orthoses on balance in older adults. J Orthop Sports Phys Ther.2012;42(7):649-657. 2.Telfer et al. Dose-

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P1-R-117 Comparison of Standard and Poincare Measures of Stride Time Variability

Isabelle Killane[1], Niall Cosgrave[1], Niamh McDevitt[1], Tim Foran[2], Katie Jane Sheehan[3], John Gormley[4], Rose Anne Kenny[4], Richard Reilly[1]

[1]Trinity College Dublin, [2]St James' Hospital, Dublin, [3]Technology Research for Independent Living (TRIL), [4]St James' Hospital

BACKGROUND AND AIMS: Poincare analysis, a method used in non-linear dynamics, has been used for some time in cardiovascular research to represent the nature of variations in intervals between heartbeats. Though not fully understood, variations in gait are also thought to reflect intrinsic disruptions, for example the higher temporal gait variability in neurological disease[1]. This study compared the ability of standard and Poincare measures of stride time variability (STV) to discriminate between gait conditions. METHODS: The CODAmotion system (Charnwood Dynamics, England) recorded STV from 12 healthy female adults (age mean±sd: 26.0±4.0yrs) while they performed a single and two dual gait tasks (serial sevens, reach) on a treadmill at 3.5 km/hr. Standard (Coefficient of variation (CoV), Standard Deviation (SD)) and Poincare (SD1, SD2) measures of STV were calculated. SD1, a measure of short term variability, and SD2, a measure of long term variability, were calculated from the width and the length of the Poincare plot respectively. CoV, SD, SD1 and SD2 were calculated using Matlab [MathWorks, Cambridge]. One-way ANOVA tables were used to compare the ability of standard and Poincare measures to discriminate between STV in the three gait conditions using SPSS V21.0 [IBM, USA]. RESULTS: Battery failure resulted in complete data being acquired for a total of 8 participants. Participants walked with statistically significantly ($p<0.05$) lower CoV, SD, SD1 and SD2 during the serial sevens gait condition compared the reach gait condition (Tukey HSD, $p>0.05$). Both SD1 and SD2 were statistically significantly correlated with CoV and SD (Pearson's <0.94, $p<0.001$). All measures were able to detect differences in group means between gait conditions ($p<0.05$) with SD1 having the greatest significance (CoV: $p = 0.010$; SD: $p=0.018$, SD1: $p = 0.008$; SD2: $p = 0.029$). DISCUSSION:The novel measures of gait variability, SD1 and SD2, are at least comparable with standard gait variability measures. They may represent a more descriptive measure in select populations or in other tasks. Using such analysis in future research may highlight intrinsic neurological disruption seen episodically or continuously through gait, thus enhancing our understanding of the higher neurological control of gait. REFERENCES: 1. Horak FB, Mancini M. Objective biomarkers of balance and gait for Parkinson's disease using body-worn sensors. Movement Disorders. 2013;28(11):1544-51. ACKNOWLEDGEMENT: The contribution of the study participants, Trinity Centre for Bioengineering, Trinity College Dublin and the Discipline of Physiotherapy and Geriatric Medicine at St James' Hospital.

P1-R-118 Postural control and cognitive efficiency following concussion

Laurie King[1], Fay Horak[1], James Chesnutt[1], Sara Walker[1], Julie Chapman[2]

[1]Oregon Health & Science University, [2]Veterans Affairs Medical Center

BACKGROUND: After concussion, individuals are frequently affected by changes in postural control and cognitive functioning. We recently reported postural control deficits in a group of athletes with prolonged recovery from concussion. However, findings from this subset with known and persisting balance problems may not accurately reflect postural control among the larger population of athletes who have sustained concussion. The specific aims of this study were to determine if 1) impaired postural control was detectable in the acute and post-acute period after concussion and 2) if the recovery timeframe for postural control was similar to that of cognition. METHODS: We measured eleven athletes (age 20±1; 9 men, 2 women) who had sustained sports-related concussion and seventeen age-matched students athletes with no history of concussion participated in the study. Athletes were tested at Portland State University, Lewis & Clark University, George Fox University, and Oregon Health & Sciences University. After concussion, participants were serially tested on postural control at approximately days 2, 5, 9, and 14. Cognition was assessed at baseline (pre-season) and approximately days 2, 5, and 9. The primary outcome was the measurement of two dimensional sway area during the Instrumented Modified Balance Error Scoring Scale (BESS) test from one inertial sensor on the belt. Sway area was averaged over three 20-second trials (feet together, single limb stance, and tandem on firm surface; eyes closed). The secondary outcome measures cognition, using the ImPACT screening tool (preliminary data are based on the Cognitive Efficiency Index). RESULTS: The Instrumented Modified BESS revealed differences (p= 0.047) in postural control between acutely concussed (2 days post-injury) and controls. At 2 days post-injury, our case group was divided between those with normal (54%) and abnormal (45%) balance. Preliminary results indicated that 40% remained abnormal 9 days after injury, 20% at 16 days and 1 person at day 23. Of note, at day 5, 80% of the athletes with abnormal balance had returned to baseline cognitive efficiency and were returned to play. Cognitive recovery post-injury was not consistently associated with balance scores. The Cognitive Efficiency Index from ImPACT did not correlate with balance measures at any of the post-injury measurement times (Day 2: r=0.09; p 0.79; Day 5: r-0.45, p=0.19 and Day 9 r= 0.10, p=0.78). CONCLUSIONS: Athletes with abnormal postural control and prolonged return to normal balance had minimal overlap with the individuals who had prolonged return to cognitive baseline measure. Different neural pathways may recover at different rates after concussion warranting objective evaluation of both domains.

P1-R-119 Assessment of the sit-to-stand performance power in older persons by linear encoder

Jochen Klenk[1], Clemens Becker[1], Parvis Farahmand[2], Konstantinos Blatzonis[1], Ulrich Lindemann[1]

[1]Robert-Bosch Hospital, [2]Klinikum Leverkusen

Background and aim: Standing up from a sitting position is the prerequisite for any kind of mobility and in older persons associated with falls. Therefore, measures are needed to objectively assess the sit-to-stand performance of older persons. The aim of this study was to investigate construct validity of the linear encoder measurement of the sit-to-stand performance power in older persons by showing associations with relevant functional performance and with physiological parameters. Methods: In this cross-sectional study including 88 community-dwelling, cognitively unimpaired older women (mean age 78 years), sit-to-stand performance power and leg power were assessed using a linear encoder and the

Nottingham Power Rig, respectively. Gait speed was measured on an instrumented walkway. Maximum quadriceps and hand grip strength were assessed by dynamometers. Mid-thigh muscle cross-sectional area of both legs was measured using magnetic resonance imaging. Results: Associations of sit-to-stand performance power with the Nottingham Power Rig, maximum gait speed, and muscle cross-sectional area were r=0.646, r=0.536, and r=0.514, respectively. A linear regression model explained 50% of the variance of sit-to-stand performance power including muscle cross-sectional area (p=0.001), maximum gait speed (p=0.002), and power assessed by the Nottingham Power Rig (p=0.006). Conclusions: Construct validity of the sit-to-stand power assessment by a linear encoder was shown on a functional level as well as on a morphological level for older women. This measure could be used in the clinical routine as well as in large scale studies.

P1-R-120 Support surface acceleration affects tibialis anterior onset latency during support surface translation perturbations

Kimberly Lang[1], Lena Ting[2], J. Lucas McKay[2]

[1]Emory University, [2]Emory University and Georgia Institute of Technology

BACKGROUND & AIM: We use electromyography (EMG) to compare sensorimotor control of reactive balance in healthy and clinical populations, and to assess changes in sensorimotor control associated with rehabilitative interventions. Although different perturbation intensities may be used with participants of different balance abilities, it is not clear that the EMG responses are directly comparable. Previously, the velocity and amplitude of support-surface translations were shown to affect the amplitude, but not timing, e.g. onset latency, of the evoked EMGs (Diener et al. 1988). However, we demonstrated that the amplitude and time course of muscle activity is scaled with both perturbation acceleration and velocity (Welch and Ting 2009), but the effects on EMG onset latency were not explicitly examined. Here, we hypothesize that perturbation acceleration affects the onset latency of the representative muscle tibialis anterior (TA). METHODS: 7 healthy subjects (2 female, mean age 19±1 y [mean±SD]) maintained their balance during anterior-posterior translation perturbations of the support surface delivered in random order. Peak velocity (25, 30, 35, and 40 cm/s) and peak acceleration (0.2, 0.3, and 0.4 g) of 12 cm perturbations were varied independently. Surface EMGs were recorded from trunk and leg muscles. EMG onset times were identified in each subject for 5 trials at each combination of velocity and acceleration. Three-way ANOVA (acceleration, velocity, and subject) with Holms-Sidak post-hoc tests and multiple linear regression were used to quantify the effects of perturbation characteristics on TA onset latency. RESULTS: Increased platform acceleration was associated with decreased TA onset latency ($F(2, 421)=153.746$; $p<0.001$) at all velocities. Average onset latency decreased from 127±16 ms (mean±SD; n=7) at 0.2g to 108±15 ms at 0.4g. Significant differences were found between all acceleration levels ($p<0.001$). Increased platform velocity was associated with a small increase in TA onset latency ($F(3,421)=4.207$; $p=0.006$). Average onset latency increased from 115±15 ms at 25 cm/s to 119±16 at 40 cm/s. Significant differences were found between some but not all velocity levels, potentially due to interactions between acceleration and velocity ($F(6,421)=2.712$; $p=0.014$). Accordingly, a regression model that considered only acceleration (onset = 0.147 ms - .0979 (ms/g)*[Acceleration (g)]) accounted for most of the variance in onset latency (adjusted $R^2 = .716$; $F(8,430)=138.898$; $p<0.001$). CONCLUSIONS: Perturbation acceleration must be considered when identifying muscle onset latency, whereas the effects of perturbation velocity are relatively small. These results are consistent with the idea that a common sensorimotor transformation governs the timing and

amplitude of postural responses to perturbation based on scaling sensory information related to center of mass acceleration, velocity, and displacement 100 ms prior (Welch and Ting 2009).

P1-R-121 Knee stability during walking in elderly with and without knee osteoarthritis

Armaghan Mahmoudian[1], Sjoerd Bruijn[2], Hamidreza Yakhdani[3], Sabine Verschueren[1], Jaap van Dieen[2]

[1]KULeuven, [2]VU University Amsterdam, [3]University of Yazd

Knee stability during walking in elderly with and without knee osteoarthritis BACKGROUND:One of the most worrying threats to mobility in the elderly is knee OA. Instability of the knee is one of the major symptoms in knee OA and has a major ipact on physical function. In a previous study on dynamic stabaility during gait, our group found that the short-term Lyapunov exponent, λs, of knee kinematics was significantly higher, indicating reduced stability in the unaffected leg but not the affected leg of elderly with knee OA compared to healthy peers. This study used the conventional method of calculating dynamic stability, while recent studies suggest that dynamic stability changes within a stride cycle. Therefore we reanalyzed the dataset reported previously by our group using a novel phase dependent stability measure. METHODS:We investigated treadmill walking in knee OA, focusing on angular velocity of sagittal plane knee movements. 16 patients with knee osteoarthritis waitlisted for replacement surgery were recruited. Moreover, 12 age and BMI-matched healthy peers along with 15 young healthy subjects were measured. All subjects walked on a treadmill at increasing speeds. To quantify stability, we calculated time-dependent local stability λ(t) (the exponential rate of divergence, in state pace, of trajectories originating from nearest neighbors), in which positive values imply divergence, that is, instability, with higher positive values revealing more instability. After inspection of these curves, we found a clear maximum between 30-60% (MaxStance λ(t)), a second clear maximum (MaxSwing λ(t)) between 85-100% and a minimum between 70-85% (MinSwing λ(t)) of the stride cycle. These maxima and minima were detected and used for statistical analysis. RESULTS:The MaxStance λ(t) of sagittal plane knee movements of both legs were significantly higher (indicating lower stability) in the OA group than in the young. Also the MaxStance λ(t) was higher in the affected than in the unaffected leg of the patients. In the healthy elderly group, the MaxStance λ(t) was higher than in the young, but it was not significantly different from the young nor from the OA group. The observed Maximum λ(t) occurred around 60% of the gait cycle, which is known as the transition from double to single support. CONCLUSIONS:Our results underline the recent findings that suggest local dynamic stability changes within each stride cycle together with the transitions between single and double support phases. While decreased stability of knee movement was found only in OA, the bilateral changes in OA and the tendency towards a decreased stability in the healthy elderly may also suggest a non-specific impairment of gait.

P1-R-122 A novel biomechanical measure to quantify post-stroke locomotor stability

Alison Oates[1], Claire Perez[2], Valeri Goussev[2], Bradford McFadyen[1], Joyce Fung[3]

[1]University of Saskatchewan, [2]Jewish Rehabilitation Hospital, [3]McGill University

BACKGROUND AND AIM: Locomotor stability is important to quantify in impaired populations and when assessing interventions. A cane improves stability by providing mechanical support and additional sensory information through haptic input. Haptic input via light touch alone improves postural stability during standing [1] and may be a useful intervention to improve locomotor stability. Time spent in

double support is used clinically [2] while the coefficient of variation of the centre of mass (COM) can be used as a biomechanical measure of locomotor stability. Biomechanical modeling may also provide useful information about dynamic stability during walking. Our aim is to quantify stability using a novel biomechanical model and its validation with conventional biomechanical or clinical measures in a post-stroke population under varying challenging conditions. METHODS: 10 adults (66.4 +/- 6.5 y) who have had a stroke and 10 control participants (66.4 +/- 5.5 y) walked on a self-paced treadmill in a virtual environment on a level, upslope, or downslope pathway. Participants walked in the three slope conditions under three touch conditions: Without any assistive device, using a cane, or lightly touching an instrumented railing. Kinematic data was collected using a Vicon motion capture system (Oxfordmetrics, UK). The cane was fixed with a ball joint to the side of the treadmill [3]. Relative time spent in double support was calculated as a percentage of the total stride (%DS). The coefficient of variation of the medial-lateral COM (COMcv) was calculated over steady-state walking. A novel stability index (SI) was computed based on an inverted compass pendulum model. This model overcomes the ill-posed problem of inverse dynamics by filtering the acceleration of the COM and decomposing the calculated ground reaction forces into two separate legs to describe the support forces maintaining stability. The SI considers both the gait phases and COM movements, showing promise as a highly responsive stability measure. Analysis includes a repeated measures ANOVA for each method of stability assessment. We hypothesize that locomotor stability will be enhanced with the use of the cane and light touch and challenged during slope-walking. RESULTS: Preliminary analysis with the SI suggests decreased stability in the stroke group compared to controls, corresponding to changes in %DS and COMcv. Locomotor stability increases more with haptic touch than cane-use during downslope walking. CONCLUSIONS: The SI is a relatively simple method to infer postural stability during gait without force measurements. It is potentially useful to discriminate locomotor stability under challenging conditions and may be responsive to various clinical interventions. REFERENCES: 1. Jeka. Phys Ther. 77(5): 476:87, 1997 2. Krasovsky et al. J Neurophysiol 109(1): 77, 2013 3. Perez & Fung. Phys. Ther. Ed., 25: 37, 2011

P1-R-123 A new method to identify gait pattern changes before Freezing of Gait

Luca Palmerini[1], Laura Rocchi[2], Jeffrey Hausdorff[3], Lorenzo Chiari[2]

[1]University of Bologna, [2]Universita' di Bologna, [3]Tel-Aviv Sourasky Medical Center

BACKGROUND AND AIMS: Freezing of gait (FOG) is a disabling gait disturbance that is common among patients with advanced Parkinson's Disease (PD). FOG can manifest as an impairment of the initiation and termination of gait and as a sudden interruption of walking [1]. FOG episodes are often overcome using attention or external cues. Hence, identification of the pre-FOG phase (i.e., a few seconds before the FOG happens) may be very effective to improve mobility in PD patients. Although previous work has suggested that there are changes in the gait pattern just prior to freezing [1], only few works [2] explored the possibility of automatically identifying these characteristic motor patterns. The aim of the current study is to discriminate the motor patterns characterizing pre-FOG from the ones characterizing normal activity (i.e., walking, mostly, and standing with no FOG). METHODS: We analyzed the acceleration signals from sensors worn by eight patients with Parkinson's disease who experienced freezing while doing different types of walking tasks [3]. We translated windows of different durations (1,2, and 3 seconds) of the raw signals from the ankle, thigh, and trunk sensors in sequences of symbols by using the SAX (Symbolic Aggregate approximation) algorithm [4,5]. The K-nearest neighbour classifier was then applied, with a leave-one-subject out cross-validation, to estimate sensitivity and specificity of

the proposed method. RESULTS: Sensitivity of 66.5% and Specificity of 73.9% in discriminating the two classes (pre-FOG vs normal activity) were obtained by using the acceleration signals from the thigh sensor. CONCLUSIONS: These preliminary findings support the idea that the gait pattern changes prior to freezing and demonstrate that there is a subset of motor patterns characteristic of the pre-FOG phase which can be automatically identified by using wearable sensors. A set-up with more sensors and improvements of the proposed techniques could possibly improve both sensitivity and specificity. ACKNOWLEDGEMENTS The research leading to these results has received funding from the European Union - Seventh Framework Programme (FP7/2007-2013) under grant agreement n°288516 (CuPiD project). REFERENCES: [1] Nieuwboer A et al, Brain. 2004 Jul;127(Pt 7):1650-60. [2] Mazilu S et al, MLDM, Lecture Notes in Comp Science (LNCS), Springer 2013. [3] Bächlin M et al, IEEE Trans on Inf Tech in Biomed, 14(2), March 2010, 436-446. [4] Lin J et al, proc of the 2nd Workshop on Temporal Data Mining, 8th ACM SIGKDD Int Conf on Knowledge Discovery and Data Mining. Edmonton, Alberta, Canada. July 23-26, 2002 [5] Lin J et al, proc of the 8th ACM SIGMOD Workshop on Research Issues in Data Mining and Knowledge Discovery. San Diego, CA. June 13, 2003.

P1-R-124 The Paradigm of Complexity Analysis of Physical Activity Patterns: Concept validation for single-sensor configuration

Anisoara Paraschiv-Ionescu[1], Petra Benzinger[2], Ulrich Lindemann[2], Christopher Moufawad el Achka[1], Clemens Becker[2], Kamiar Aminian[1]

[1]Ecole Polytechnique Federale de Lausanne (EPFL), [2]Robert Bosch Krankenhaus

Background and Aims The complexity of physical activity (PA) has been recently examined as an attractive measure of physical wellbeing, movement independence and treatment effectiveness [1]. The concept has been formalized based on the following hypothesis: (1) PA has many dimensions (type, intensity, duration) that can be combined into various PA states; (2) the pattern of various states (called 'barcode') embeds behavioral features; (3) these features, related to variety and temporal dynamics of various states (movement ability and flexibility) can be quantified in terms of 'complexity' metrics; (4) improved functional status is reflected by increased complexity. The concept has been initially validated to assess chronic pain conditions, with PA data classified using 3 inertial sensors [1]. The accuracy of PA states appeared to be an important issue, therefore several questions emerged: How to formalize the concept using a more practical sensor configuration (e.g. single sensor on trunk)? Are the complexity metrics still efficient to assess other clinical conditions? This study aims to investigate these aspects. Methods 55 patients participating in an inpatient rehabilitation program after hip-fracture, were monitored 24 hours using a single inertial sensor on trunk. The monitoring was performed at admission (T1), after two weeks (T2) and four months later after patients had returned home (T3). This sensor configuration allows accurate estimation of walking (Wk) and lying (Ly) but cannot reliably distinguish between sitting (Si) and standing (St). However, the former barcode definition includes 2 states for Si/Ly, 4 states for St, and 12 states for various aspects of Wk (cadence, duration of episodes). To avoid spurious complexity values due to limited performance of the single-sensor configuration, we define the barcode sequence as follows: classify PA type as non-locomotion (Si/St/Ly) and locomotion (Wk) then, define 3 states for non-locomotion (according to movement intensity) and 12 states for locomotion [1]. The complexity of obtained barcodes was quantified using entropy metrics. Results Statistical analysis indicated gradual and significant increase of PA complexity during the rehabilitation program: significant at T2 compared to T1 ($p=0.03$), very significant at T3 compared to T2 ($p=0.008$) and extremely significant

at T3 compared to T1 (p<0.001). The new concept of PA barcode complexity could detect increase in movement complexity as improvement during recovery after hip fracture. Conclusions The concept of 'PA barcoding for complexity analysis' allows a comprehensive assessment of movement related behavioral features. The results of this study indicate that the methodology can be adapted for various sensor configurations and population studies. This ongoing study will be extended to investigate other conventional sensor configurations for PA monitoring (single low-back sensor, lower limbs). [1] A. P-I, PlosOne, 2012

P1-R-125 Achilles tendon vibration shifts the center of pressure backward in standing and forward in sitting

Dominic Pérennou[1], Guillaume Barbieri[1], Vincent Nougier[1]

[1]Academic Hospital Grenoble

Objective: An Achilles tendon (AT) vibration is known to disrupt the postural control in standing (the so-called "vibration-induced falling", VIF) and to lead to a backward tilt of the postural perception of vertical in restrained sitting position, suggesting a link between AT vibration and modulation of internal representations involved in postural control. A recalibration of some troubles in body orientation (after a stroke or in elderly) by oriented sensory manipulations appears to be of a great interest. In order to use the VIF paradigm in a procedure suitable for a rehabilitation context, AT vibration deserves to be more investigated in sitting, for security reasons, and first in young participants. Method: In 12 healthy participants (6 men/6 women; 23.3±1.9yrs), posturographic data to AT vibrations (85Hz) were recorded over 30sec standing and 40sec sitting trials: 10sec without vibration, 8sec standing or 20sec sitting with vibration, and 12sec standing or 10sec sitting without vibration. Results: This study confirmed the rapid and powerful backward shift of the centre of foot pressure (CoP) as soon as the vibration started in standing (peak vibration: CoP=-54.6±11.3mm, p<0.001 with respect to the baseline in no vibration) and revealed a surprising systematic forward shift of the CoP throughout the duration of AT vibration in sitting (peak vibration: CoP=27.9±18.9mm, p<0.05 with respect to the baseline in no vibration). Conclusions: The present study invalidates our idea to extend in sitting the VIF paradigm but the unexpected result obtained opens a new window about the basic mechanisms underlying muscle vibration effects.

P1-R-126 Motion sequencing of rising from the floor - A model of recovery from falling

Lars Schwickert[1], Clemens Becker[1], Jochen Klenk[1], Ulrich Lindemann[1]

[1]Robert-Bosch-Krankenhaus

Background & Aims Injurious falls and reduced muscle function in elderly people often provoke hazardous long lying periods. In the literature, increased difficulty, prolonged time or even inability to rise from the floor was observed in elderly subjects [Alexander et al. 1997]. Understanding strategies of older persons to rising from the floor could be helpful to further develop sensor-based fall detection algorithms [Schwickert et al. 2013]. The aim of this study was to analyse age-related differences in the motion patterns and define common movement strategies for rising from the floor. Methods Younger subjects between 20 and 50 years of age (n=12) and healthy older subjects (60 ; n=12) without cognitive impairment or neurologic and orthopaedic diseases limiting the ability to stand up, were included into this experimental study. Common movement strategies and key-points of different recovery phases

were defined from video analyses starting in different lying positions. Leg power (Nottingham power rig) and flexibility (minimal knee angle, ROM) were assessed as possible explanatory variables. Results 24 gender- and age matched subjects participated in the trial. Median values of sum maximum power (457W vs. 276W, p<0.001) and mean minimal knee flexibility (52° vs. 60.5°, p=0.007) were significantly lower in older subjects. Independent of age and initial- and end-position (Tab.1), overall median lie-to stand transfer time was significantly longer in older subjects compared to younger subjects (5.72s vs. 3.71s, p<0.001). From video analyses, seven different phases were defined for the lie-to-stand transfer (Fig. 1, i.e. lying, initiation, positioning, supporting, elevation, stabilization and quiet stance or walking). The architecture of the phase model as well as individual movement strategies (i.e. order and number of phases) varied considerably between young and old subjects. Time for rising from lying supine was associated with maximum power and minimum knee angle and time for rising from lying on side was associated with maximum power. Conclusions & Perspectives > A phase model containing seven different phases and individual key points was established > Ability to rise was significantly reduced in older subjects, which was associated with reduced power and flexibility > Next steps will include enhanced protocols and further analyses of sensor based signals to support start and end point detection of motion analyses Lit.: · Alexander, Ulbrich, Raheja, Channer 1997 - Rising from the floor in older adults. · Schwickert, Becker, Lindemann et al. 2013 - Fall detection with body-worn sensors - A systematic review.

P1-R-127 Retest reliability of the Dikablis eye-tracker when sitting, standing and walking

Samuel Stuart[1], Lisa Alcock[2], Brook Galna[2], Sue Lord[2], Lynn Rochester[2]

[1]Institute for Ageing and Health, [2]Institute for Ageing and Health/Newcastle University

BACKGROUND: Visual sampling (VS) is an active and dynamic process which is driven by task-orientated behavioural and cognitive activity. An integral component of VS is the ability to redirect the eyes to stimuli relevant to the task being undertaken. Measurement of eye movements during real-world activities has become increasingly popular and devices capable of tracking eye movements during such activity have recently been developed. However, to date the reliability of these devices has not been measured. AIM: To evaluate the retest reliability of a Dikablis mobile eye tracker to measure saccadic activity in healthy older adults whilst sitting, standing and walking. METHODS: A Dikablis (Erogneers, GmbH) mobile head-mounted eye tracker (sampling at 50Hz) was used to measure saccadic activity in 20 older adult subjects (≥50 years old) who were assessed on two occasions a week apart. Participants had normal or corrected to normal (via contact lenses or glasses) vision. Subjects were required to make guided eye movements between two visual targets at predetermined horizontal and vertical distances (i.e. 5°, 10° and 15°) in time to an auditory cue (a 60bpm metronome). This was performed while seated with restricted head movement, standing and while walking on a treadmill at 80% of comfortable gait speed. Data were analysed using custom MatLab (Mathworks, Natick, MA) software. Saccades were classified using specific characteristics such as velocity, acceleration, amplitude and duration. Data were inspected using Bland & Altman plots for this preliminary analysis on five subjects. RESULTS: Saccadic accuracy was variable between sessions (range 0.3°-3.7°). Between-session saccadic accuracy was also variable depending on the task e.g. for walking compared to sitting and standing, and standing compared to sitting. Vertical saccades were less accurate than horizontal, particularly at 15°. Increased variability was observed in the vertical direction during all tasks. Overall saccadic accuracy was within ~4°, with limits of agreement ~5°. CONCLUSIONS: The Dikablis mobile eye-tracker is capable of

measuring saccades in older adults with 5° error. Eye-tracker reliability may be influenced by a number of factors including error derived from calibration quality, eye vs. field camera positioning, head unit movement and the ability to track the pupil through glasses or contact lenses. Further work on a larger sample is underway and will provide more definitive results.

P1-R-128 Analysis of different positions by posturography in elderly. Are there differences among recurrent fallers, single fallers and no fallers?

Erika Tanaka[1], Paulo Ferreira[1], Marcela Silva[1], Patricia Silva[1], Priscila Botelho[1], Natalia Rodrigues[1], Mathues Gomes[1], Renato Moraes[1], Daniela Cristina de Abreu[1]

[1]University of São Paulo

BACKGROUND AND AIM: The occurrence of an episode of falling increases the vulnerability of new falls in elderly. The aim of this study was to analyze the postural sway of elderly without falls, with a single fall and recurrent falls to identify deficits in postural control. METHODS: This study was approved by the Ethics Committee in Brazil (5372/2010). Participated 27 community-dwelling elderly (mean age 65.37?± 3.26 years, height 1.58?± 0.08 meters , weight 69.23 ± 12.11 kg) with both sexes. Three groups were formed according to history of falls occurred in the last 6 months: recurrent falls (n = 9); single falls (n = 9) and without falls (n = 9). We used a force platform (EMG System of Brazil ®) to assess postural sway by means of static posturography in one leg positions eyes open, tandem position right leg in front of left, left leg in front of right with eyes open and closed . We analyzed the area of center of pressure (COP) by the average of 3 trials of 30 seconds each. Statistical Analysis were performed through one-way repeated-measures analyses of variance (ANOVAs) and Tukey as post-hoc test for normal data, and Mann-Whitney test for unnormal data ($p \leq 0.05$). RESULTS: Subjects with recurrent falls showed significative high values on sway area compared with non-fallers elderly in positions: left one leg stance ($p = 0.01$), in tandem positions with the right leg in front of left eyes closed ($p = 0.018$), tandem position with the left leg in front of the right leg eyes open ($p = 0.008$) and closed ($p =0.02$) . Elderly with single falls had no differences in sway area compared to the elderly with recurrent falls or the elderly without falls. CONCLUSIONS: The recurrent fallers presented lower postural control than not fallers elderly. The deterioration in postural control observed by posturography is perceptive only in elderly patients with recurrent falls.

P1-R-129 Orthotic-induced changes in rearfoot biomechanics during gait are not reflected in below shoe pressure measurements

Scott Telfer[1], Mandy Abbott[1], James Woodburn[1]

[1]Glasgow Caledonian University

BACKGROUND AND AIM: Objective measurement of changes in foot and ankle biomechanics caused by the use of orthoses is challenging, and generally requires access to a motion analysis laboratory [1]. Floor mounted plates designed to measure plantar pressures are simple to use, require little space and can provide greater accuracy and reliability compared to in-shoe systems [1]. The aim of this study was to determine if orthosis induced changes in rearfoot biomechanics could be detected from dynamic below shoe pressure footprints. METHODS: Previously we demonstrated that by varying the level of rearfoot posting on foot orthoses, linear "dose-response" effects occur for rearfoot kinematics, ankle kinetics and rearfoot plantar pressures [2,3]. Briefly, 24 participants were split into equal age and gender

matched groups of pronated and normal foot types. The participants were prescribed customised foot orthoses. The base design of these orthoses was altered using a computer aided design program to produce 9 variations with different rearfoot posting levels from 6° lateral to 10° medial in 2° steps. Participants underwent instrumented gait analysis for each orthotic condition. In the same experiment, we also recorded dynamic below shoe pressure footprints for all participants and conditions. For the present study, we used this pressure data to determine if the changes in kinematics and kinetics were reflected in the below shoe pressure distribution. The heel section of the shoe footprint was divided into lateral and medial masks with peak and mean pressures being determined for each condition. The ratio between the mask pressures in different conditions and between foot type groups was tested using two way mixed effects analysis of variance with contrasts for linearity. RESULTS: No significant effects were found using between groups or conditions using either the peak (p=0.461) or mean (p=0.223) below shoe pressure ratios. High levels of variability were present between both groups and conditions. DISCUSSION: It is possible that the cushioning effect of the footwear used in the study reduced the effect of any changes caused by the orthoses to below detectable levels. Using the approach described here, the use of below shoe pressure measurements does not appear to be a feasible method for quantifying orthosis-induced changes in rearfoot biomechanics during gait. REFERENCES: [1] Urry SR. Plantar pressure-measurement sensors. Meas Sci Technol 1999;10:16-32. [2] Telfer et al., Dose-response effects of customised foot orthoses on lower limb kinematics and kinetics in pronated foot type. J Biomech 2013;46:1489-95 [3]Telfer et al., Dose response effects of customised foot orthoses on lower limb muscle activity and plantar pressures in pronated foot type. Gait Posture 2013;38:443-9

P1-R-130 Decomposition of the Turn-to-Sit subtask in community dwelling older adults: what can it tell us about functional performance, cognition, and parkinsonism?

Aner Weiss[1], Anat Mirelman[1], Aron Buchman[2], David Bennett[2], Talia Herman[1], Jeffrey Hausdorff[1]

[1]Tel Aviv Sourasky Medical Center, [2]Rush University Medical Center

Objective: Community-based cohort studies of aging have generally relied on simple measures (e.g., timed walk) to quantify gait and mobility. We hypothesized that more precise spatial-temporal measures of gait derived from a body-worn sensor (accelerometer on the belt) could enhance standard gait testing in participants' homes. Methods: 317 participants of the Rush Memory and Aging Project, a community-based cohort study (mean age 83.30±6.94 yrs, 76.34% female), participated in the Rush Memory and Aging Project. Subjects performed 2 Timed Up and Go (TUG) trials while wearing a small, light-weight 3-D accelerometer on their lower back. The turn-to-sit subtask of the 2nd TUG was analyzed. We stratified between the participants who separated their turning and sitting movements by at least 0.8 seconds (Sep), and between those who performed these two movements concurrently (No-Sep), and compared their cognitive, parkinsonian, functional performance and gait measures using the Mann-Whitney U test. Results: Both groups were similar with respect to age (p=0.326) and gender (p=0.942). Cognition- The No-Sep group had higher global cognitive score (No-Sep: 0.11+/-0.61, Sep: -0.12+/-0.71, p=0.002), and more specifically showed improvement in: semantic memory (p=0.001), working memory (p=0.002), perceptual speed (p=0.001), and a tendency in visual spatial ability (p=0.054). Episodic memory was not significantly different (p=0.243). Mobility- The No-Sep group had better motor scores: lower time to walk 8 feet (as measured by a stopwatch) (No-Sep: 5.44+/-1.45, Sep: 7.42+/-2.90 sec, p<0.0001), more hours-per-week of physical-activity-(No-Sep:3.59+/-4.07, Sep: 2.81+/-3.26, p=0.035), higher mean-daily activity (No-Sep: 2.28+/-1.22, Sep: 1.87+/-1.06, p=0.012), higher

activity per-active-hours (No-Sep: 0.24+/-0.08, Sep: 0.21+/-0.08, p=0.006) and lower mobility disability scores (p<0.0001) in the Rosow-Breslau Scale, Instrumental Activities Of Daily Living (IADLs) and Katz measure of disability scales. Parkinson-signs: The No-Sep group had a lower total parkinsonian-score (No-Sep: 5.69+/-5.13, Sep: 9.51+/-5.94, p<0.0001). More specifically, bradykinesia sum-score (p=0.003) and gait sum-score (p<0.0001) were lower in the No-Sep group. They tended to show better tremor sum-scores (p=0.148). Interestingly, no group difference was seen in the rigidity sum-score (p=0.87). Conclusion: Older subjects who separate between their turning and sitting movements when they turn-to-sit also have worse motor and cognitive performance. Turn-to-sit analysis using a body-worn sensor in the community-setting provides a sensitive marker that may enhance the identification of older persons at risk for developing cognitive impairments and mobility disability.

P1-R-131 Investigating spatial orientation: comparing the test-retest reliability of 3 protocols

Fang Zhang[1], Nandini Deshpande[1], Elsie Culham[1]

[1]Queen's University

Background and Aim: Spatial orientation describes the senses of heading and self-motion used to specify the motor commands required to steer locomotion(1). The optic flow provides information of the targets in our path and speed and direction of our movement. When vision is not available, the central nervous system may depend on vestibular input for spatial orientation due to its ability to detect head movement in space during both linear locomotion and turning(1). Fukuda Stepping test (FST), triangle walking test (TWT) and straight walking test (SWT)(2-4) have been used to study the role of vestibular input in spatial orientation during stepping, changing directions during walking and linear walking, respectively. FST of 50 steps produced moderate reliability(2); however, little is known about the reliability of TWT and SWT. Therefore, this study was to evaluate the test-retest reliability of these three tools. Methods: 15 healthy adults (age=20-35, 7F 8M) were recruited and asked to finish 6 trials for each test with eyes blind-folded. For FST, the participants were required to step in place for 50 steps. Distance of displacement (DD) from the initial location, angles of displacement (AD) and self-rotation (AS-R) were measured. For TWT, the participants were asked to complete a triangular path with two 3m-long segments at 90°. Distance errors (DE) (the difference between the length of a segment and actual distance completed), arrival errors (AE) (the distance of each actual turning point to the corner of the triangle) and directional errors (DiE) (difference between the actual angle of turning at each corner and the required angle of turning) were assessed. For SWT, the participants were asked to walk straight for 6m, and the angle of deviation (AD) from the straight path was recorded. ICC and the coefficient of variation (CV) were calculated for every variable. Results: The ICCs of 9 variables in the three tools were higher than 0.5 and significant (p<0.01). The CVs were all higher than 15%, with the lowest in the DD in FST (22.06%) (ICC=0.83). The average range of each variable throughout the participants was large, with the smaller ranges in the AD in SWT (3.81°) (ICC=0.51 CV=39.14%), and the DiE at the first corner in TWT (12.54°) (ICC=0.53, CV=46.81%). Also, the means of the two variables were low, which were 3.14° and 12.41° with those of others higher than 19. Conclusion: The DD in FST demonstrated comparatively low CV and high ICC. Additionally, the reliability of the AD in SWT and the DiE in TWT could be moderate, revealed by their ICC rather than high CV due to their low means and small ranges, as ICC may reflect the true reliability when the range of the variable is small, while CV tends to exaggerate the variability when the mean is low. Therefore, the DD in FST, the AD in SWT and the DiE in TWT might be selected as

moderately reliable variables to represent the ability to achieve spatial orientation in young healthy people.

P1-S-132 Own body transformation and spontaneous task performance in subjects with chronic balance deficits.

John Allum[1], Marina Sleptsova[1], Dagmar Schmid[1], Flurin Honegger[1], Tanja Schatz[2], Cecile Biner[2], Wolf Langewitz[1]

[1]University Hospital Basel, [2]FHNWS

Background: Normal balance cognition involves a percept of how our body moves in space. The question is whether body percepts are changed in patients with chronic balance disorders due to vestibular loss, phobic vertigo or neck problems. If it can be shown that such percepts are changed, then attempting to bring these back to normal could form the basis for a rehabilitation therapy. Furthermore quantifying changes could help document effectiveness of the therapy procedures. Methods: Based on the work of Thirioux et al (J Neuroscience 2010) on other-self interactions, subjects were asked to replicate the movements of a gym instructor facing them in a life size video - leaning in roll, with arms abducted 90°, 11 times in randomly specified directions when the instructor leant - spontaneous copying (SPO). For the same task subjects were then asked to lean as if their body was translated into that of the instructor (OBT). That is lean to the left when the instructor leant to the left. Lean angle of the upper trunk was measured with a SwayStarTM gyroscope system mounted with a back harness between the shoulders. Directions of movement, whether correct or not in direction for the OBT mode, onset (exceeding 3°/s), rise time to maximum lean angle amplitude and lean amplitude were analysed for 6 patients (age 62 /-8 yrs, 1 male) with chronic balance deficits (CBD) and pathological results for stance and gait posturography. These data were compared with those a group of 7 healthy age- and gender-matched healthy controls (HC). Results: Both CBD and HC subjects performed the SPO task with mirror image movements to those of the instructor. All CBD subject except one had one or more errors in the OBT mode, often with corrections. Only one HC had more than 1 error in the OBT mode. Errors for the HC were for the first OBT lean. When the OBT leans in the correct direction were compared to those of SPO in the CBD subjects, onset latencies were longer (0.36s), rise times shorter (0.51s), and amplitudes greater in the OBT mode but still less than those of the instructor. In constrast HC had no differences in latencies and lean amplitudes between SPO and OBT modes. However rise times were reduced for the OBT mode but not as much as for the patients. The amplitude of lean was equal to that of the instructor in both test modes for HCs. Conclusions: These results indicate that CBD patients have a different concept of movement of body placement when asked to consider their body in the position of another compared to HC. When required to perform an OBT mode of movement they take longer to commence moving, then perform the movement more rapidly with greater movement amplitudes. This OBT compared to SPO procedure may help quantify the central processing deficit of those with CBD. Furthermore, incorporating these different movement concepts into rehabilitation programmes may help those with CBD.

P1-S-133 Validity and reliability of dynamic visual acuity (DVA) measurement during walking

Nandini Deshpande[1], Brian Peters[2]

[1]Queen's University, [2]Human Performance & Engineering Division, Wyle Laboratories

BACKGROUND AND AIM: DVA is primarily subserved by the vestibulo-ocular reflex mechanism. Individuals with vestibular hypofunction commonly experience highly debilitating illusory movement or blurring of visual images during daily activities possibly, due to impaired DVA. Even without pathologies, gradual age-related morphological deterioration is evident in all components of the vestibular system. We examined the construct validity to detect age-related differences and test-retest reliability of DVA measurements performed during walking. METHODS: Healthy adults were recruited into 3 groups: 1. young (20-39years, n=18), 2. middle-aged (40-59years, n=14), and 3. older adults (60-80years, n=15). Randomly selected seven participants from each group (n=21) participated in retesting. Participants were excluded if they had a history of vestibular or neuromuscular pathologies, dizziness/vertigo or >1 falls in the past year. Older persons with MMSE scores <29/30 were excluded to minimize cognitive errors. Participants' age, height, weight and normal walking speed were recorded. The binocular DVA was measured while walking on a treadmill1 at 0.8 m/s, 1.0 m/s and 1.2 m/s speeds. The walking speeds chosen represent a range of slow to moderate walking speeds for adult life span in participants who have no current mobility problems. The monitor that displayed Landolt 'C' optotypes was placed at 50 cm from the eyes for nearDVA (primary compensation by otolith organs) and at 3.0 m for farDVA (primary compensation by semicircular canals). A mixed factor ANOVA (age group x speed) was performed separately for the Near and FarDVA for detecting group differences. Intraclass correlation coefficients (ICCs) were calculated for each condition to determine test-retest reliability. RESULTS: The three age groups were not different in their height, weight and normal walking speed ($p>0.05$). The post hoc analyses for DVA measurements demonstrated that each group was significantly different from the other two groups for Near as well as FarDVA ($p<0.001$-$p=0.031$). The effect of speed was significant for both NearDVA ($p=0.012$) and FarDVA ($p=0.014$), however, there was no age group x speed interaction (FarDVA $p=0.607$, NearDVA $p=0.343$). The ICCs for Near and FarDVA ranged between 0.85-0.88 and 0.71-0.87, respectively. CONCLUSIONS: Differences in DVA between the three age groups were detected by using both Near and FarDVA protocols irrespective of the walking speed. Therefore, age group-specific reference values should be used for detecting malfunction. Further, consistency in walking speed is critical for comparing between studies. NearDVA at all walking speeds and FarDVA at the speed of 1.2 m/s demonstrated excellent test-retest reliability. FarDVA at 0.8 m/s and 1.0 m/s demonstrated good test-retest reliability (ICCs 0.71 and 0.77, respectively). REFERENCES 1. Peters BT, Bloomberg JJ. Acta Otolaryngol 125(4):353-7, 2005

P1-S-134 Vestibular and Functional Outcomes in Children with Cochlear Implants

Kristen Janky[1], Diane Givens[1]

[1]Boys Town National Research Hospital

BACKGROUND AND AIMS: In children who receive a cochlear implant (CI), 50% have some degree of vestibular loss. The effect of vestibular loss on motor function and development in children with hearing loss has yet to be elucidated, despite the potential for increased prevalence compared to peers with normal hearing. The purpose of this study was to 1) quantify function of the entire peripheral vestibular system in children with CI; 2) determine if degree of vestibular loss correlates with gross motor and visual acuity outcomes compared to normal age-matched children and, 3) generate normative data on the new video head impulse test (vHIT) in children. Data were also compared to young adults to examine the presence of development and age related changes. METHODS: Participants: Control adults

(n = 15), Control children (n = 12), Children with CI (n = 12). All participants completed vestibular function testing. Each component of the vestibular system (utricle, saccule, and 3 semicircular canals) was assessed via ocular and cervical Vestibular Evoked Myogenic Potential (VEMP) and the vHIT in the plane of each semicircular canal. Vestibular function was then categorized as either normal or abnormal for a total of 10 components [Right and Left: 1) utricle, 2) saccule, 3) posterior canal, 4) superior canal, and 5) horizontal canal], with 0 and 10 representing abnormal and normal function, respectively. All participants completed the following gross motor performance measures: Dynamic Gait Index (DGI), Single Leg Stance (SLS) eyes open and eyes closed, Sensory Organization Test (SOT); and the following Visual Acuity measures: Active and Passive Dynamic Visual Acuity (DVA), Static Acuity, and the Gaze Stabilization Test (GST). RESULTS: To investigate mean differences, data were analyzed using one-way ANOVA. Regression was used to investigate the relationship between vestibular loss severity and performance. Children with CI performed significantly worse compared to control adults and children on SLS eyes open and closed and also had significantly worse static acuity. All children performed significantly worse compared to adults on active DVA, passive DVA, GST, and SOT. There was no difference between the two pediatric groups. There was no difference between groups on DGI. Children with a CI had a significantly lower vestibular loss severity rating (mean: 5.8) compared to normal control adults (mean: 7.8) and children (mean: 9.3). Vestibular loss severity rating was significantly correlated with active DVA ($r = -0.559$, $p < 0.001$), passive DVA ($r = -0.642$, $p < 0.001$), SLS eyes open ($r = -0.447$, $p = 0.005$), SLS eyes closed ($r = -0.54$, $p = 0.001$), and SOT ($r = -0.304$, $p = 0.037$). CONCLUSIONS: Children with CI have significantly higher rates of vestibular loss. Severity of vestibular loss has a negative relationship with both gross motor and visual acuity outcomes. Interestingly, children with CI also noted worse static visual acuity.

P1-S-135 Are the balance responses to vestibular stimulation modulated after depression of the cerebellum?

Chris Lam[1], Gagan Gill[1], Richard Staines[2], Craig Tokuno[3], Leah Bent[1]

[1]University of Guelph, [2]University of Waterloo, [3]Brock University

BACKGROUND AND AIM: The vestibular system reports on accelerations of the head and this information can be manipulated using Galvanic Vestibular Stimulation (GVS). GVS is the application of a current that alters the firing of the peripheral vestibular afferents. This results in distinct short (SL,40-70ms) and medium (ML,70-120ms) latency reflex responses in leg muscles, and a full body postural sway when standing with eyes closed. The amplitude of the SL and ML response is related to the direction of postural sway and reliant on feedback from other sensory sources, such as somatosensation and vision[1]. While both SL and ML responses are vestibular in origin, it is thought that the variable latency could be due to transmission through different pathways or structures, such as the cerebellum[2]. The cerebellum helps to regulate motor control. It receives input from all sensory sources and generates appropriate output to coordinate balance. With the use of continuous theta burst stimulation (cTBS), it is possible to temporarily depress the function of the cerebellum [3]. The aim of the study was to determine if the SL or ML responses to GVS are modulated after the depression of the cerebellum. METHODS: Five healthy subjects (age 23-29) participated. Pre TMS trials were collected where subjects received 300 GVS pulses (500ms at 1.5mA, 4-6s interstim rest, eyes closed). Electromyography (EMG) was collected bilaterally from the soleus as well as forceplate data (centre of pressure calculated, COP). Following control trials subjects received cTBS (three stimuli at 50Hz, repeated every 200ms, total

600stim[4]) over the vermis of the cerebellum. Following cerebellar depression the same GVS protocol was repeated to evaluate changes in EMG and COP (Post cTBS trials). Onset latencies and amplitude (normalized to background activity) of SL and ML responses were examined. RESULTS: cTBS had variable effects on the function of the cerebellum. Post cTBS 3 subjects of 5 demonstrated an increased amplitude in the ML ranging from 2 to 6% of background EMG; 2 of 5 showed no change. On average the ML amplitude increased from 11.1% to 14.3% post cTBS; a 3.2% increase overall. The SL response was not shown to change. Latency did not change for either the SL or ML response. Force plate data were consistent with the ML EMG response, whereby an increased CoP sway was observed after cTBS in a subset of participants. CONCLUSION: The observation of an increase in ML amplitude following cerebellar depression in a subset of participants identifies the cerebellum as a possible link in the pathway of the ML reflex response; and therefore may in fact account for the delay seen in the ML response. This research supports the idea that SL response involves more direct pathways, whereas the ML response is dependent on modulation via the cerebellum. [1]Fitzpatrick, Day (2004) J Appl Phys, [2]Cathers et al (2005) J Phys, [3]Popa et al (2010) Brain Stim, [4]Huang et al (2005) Neuron

P1-S-136 Gait characteristics of patients with phobic postural vertigo: effects of fear of falling, attention, and visual input

Klaus Jahn[1], Roman Schniepp[1], Max Wuehr[1], Sabrina Huth[1], Cauchy Pradhan[1], Thomas Brandt[1]

[1]University of Munich

Background: Phobic postural vertigo (PPV) is the most common cause of chronic dizziness in middle-aged patients. Many patients report symptoms during gait. We investigated the gait performance and its relationship to the fear of falling and attention of PPV patients. Material and Methods: Prospective study of 24 patients with PPV (12 females, 49 ± 15 years) and 24 healthy subjects (HS) (12 females, 48 ± 16 years) using a pressure-sensitive mat (GAITRite®). Subject walked at three different speeds (slow, preferred, fast), during cognitive dual task (DTc), and with eyes closed (EC). Fall efficacy and balance confidence were rated by the Falls-Efficacy Scale-International (FES-I) and the Activities-specific Balance Confidence Scale (ABC). Results: PPV patients walked slower with reduced cadence (all $p<.01$), stride length ($p<.05$), and increased double support ($p<.01$) compared to HS. These changes correlated with FES-I ($R=-.528$, $p<.001$) and ABC ($R=.481$, $p<.01$). Walking deterioration under DTc did not differ between PPV and HS, but patients showed a reduced processing speed ($p<.05$). When walking with EC, gait speed decreased more in PPV compared to HS ($p<.05$). Discussion: Patients with PPV show gait changes which correlate with the fear of falling and balance confidence. Absent visual feedback led to more pronounced gait deteriorations in PPV than in HS, indicating a higher reliance of the patients on visual information during gait. Conclusion: These findings support the view that the gait characteristics of PPV can be attributed to an inadequate, cautious gait control.

P1-S-137 Visual orientation cues are used to calibrate vestibular information during quiet standing

Adam Toth[1], John Zettel[1], Leah Bent[1]

[1]University of Guelph

Background and Aim: To create an accurate spatial representation for postural equilibrium, the integration of feedback from our visual, vestibular and somatosensory systems is required with visuo-

vestibular interactions being particularly important. The vestibular system provides feedback of head position and movement and, when integrated with other sensory feedback, enables spatial awareness of the body relative to gravity [1, 2]. The visual system aids the perception of gravitational vertical through visual references in the environment [3]. It has recently been shown that the orientation of vestibular input is calibrated to a visual reference frame during a gait navigation task [4]. It is yet to be determined whether visual cues can be used to calibrate the orientation of vestibular information during the maintenance of balance during upright standing. The objective of the current thesis project is to determine whether vestibular information is calibrated to a visual reference frame for the maintenance of a balanced upright standing posture. Methods: Galvanic Vestibular Stimulation (GVS) was used to alter vestibular afferent firing. GVS was delivered at 2X and 4X minimum sway threshold while subjects wore visual occlusion spectacles (Translucent Technologies Inc.). A force plate (AMTI, USA) was used to capture ground reaction forces, from which centre of pressure (CoP) displacement was calculated. An Optitrak 3D motion camera system (Natural Point Inc., USA) was used to record centre of mass movement. Control conditions involved subjects receiving either a 2X or 4X stimulus in the absence of vision. During test conditions, subjects first received a 2X stimulus for 4 seconds in the absence of vision. Under continued stimulation, vision was restored for 8 seconds allowing the use of visual vertical cues for the realignment of subjects' altered body position (recalibration). After which, vision was re-occluded and GVS increased to 4X. Peak sway responses to GVS were recorded. Results: Peak sway significantly increased from the 2X (CoP, 2.2±0.87cm) to 4X conditions (CoP, 3.11±1.60cm) ($F_{2,1} = 4.29$ $p < 0.0167$). During visual recalibration, subjects were also able to realign themselves to their upright pre-stimulation values ($F_{2,1} = 38.25$ $p < 0.0001$). A significant reduction in sway in response to a 4X stimulus was observed after visual recalibration (Cop, 1.67±0.76cm) compared to trials where visual recalibration did not occur (CoP, 2.52±1.61cm) ($F_{2,1} = 2.47$ $p = 0.041$). Conclusions: These results suggest that visual information providing spatial orientation cues contributes toward calibrating vestibular input and that GVS-induced postural responses are adjusted in accordance with this visuo-vestibular interaction. References: [1] Inglis T et al. (1995). J Neurophysiol 73 (2). [2] Fitzpatrick R et al. (2004). J Appl Physiol 96. [3] Dearing R, Harris L. (2011). Vision Research 51. [4] Sturnieks et al. (2005) Gait and Posture 21(Suppl 1) S30

P1-J-138 Mechanical loading Characteristics of the Medial Compartment of the Knee Joint during Tai Chi Gait

Wei Liu[1], Jonathan Wolfe[2], John Kovaleski[2]

[1]Auburn University, Rehabilitation Biomechanics Lab, [2]University of South Alabama

BACKGROUND AND AIM: Tai Chi Chuan (TCC) is a multi-beneficial exercise of improving strength, balance and flexibility in both young and older participants. TCC is also a popular therapeutic exercise intervention for chronic pain reduction. Treatment strategies to reduce medial knee load have been shown to benefit patients with knee OA for reducing pain, which include gait modification. Gait modification strategies reported include walking with increased toe-out angle, lateral trunk lean and the use of cane. TCC incorporates continuous, slow and rhythmic weight-bearing movements using various gait-like loading and unloading patterns. It is unclear that TCC could reduce medial knee load. Additional measurements that quantitatively characterize joint loading patterns at knee joint during TCC are needed. In this case, examining a surrogate indicator of medial knee load measured as external knee adduction moment (EKAM) could be important. The aim of this study is to make an initial and important

step to quantify EKAM during Tai Chi Gait (TCG), a very common form of TCC compared to walking. METHODS: Ten healthy volunteers with a minimum 2 years' experience in performing TCC and knowledge of the 24 simplified Yang Style forms of TCC were recruited for participation in the study: (5 females, age: 25-70 years). Seven VICON high-speed infrared motion analysis cameras with a sampling rate at 60 Hz, and synchronized with two AMTI force plates at 1000 Hz recorded each participant during the stance phase of the walking and TCG. Reflective markers were attached to bony landmarks on the pelvis, thigh, tibia and foot. A traditional inverse dynamics approach computed EKAM. Student paired T-test were used to compare differences in peak EKAM. Significance was set a priori at $P < .05$. RESULTS: No significant ($P=0.501$) peak EKAM difference was found for the entire stance phase between NW (0.313 ± 0.036 Nm/kg) and TCG (0.367 ± 0.097Nm/kg). The EKAM of TCG showed a tri-modal pattern with three peaks during the entire stance phase. A subsequent comparison was made and peak EKAM was significantly ($P=0.024$) reduced by 47% between the NW stance phase (0.313 ± 0.036 Nm/kg) and the TCG double support phase I (0.165±0.077 Nm/kg). Although not significantly different, the peak EKAM of TCG double support phase II (0.234 ± 0.099 Nm/kg) was approximately 25% lower than waking (0.313 ± 0.036 Nm/kg). CONCLUSIONS: This is an important attempt to quantify EKAM during TCC, these results indicate that TCC can be a beneficial intervention for reducing the medial mechanical load at the knee joint particularly during the first double support phases of TCG compared to walking.

P2-A-1 Drivers of change in physical activity over 18 months in incident Parkinson's disease

Gillian Barry[1], Sue Lord[1], Brook Galna[1], David Burn[1], Lynn Rochester[1]

[1]Newcastle University

BACKGROUND AND AIM: Physical activity (PA) is important to maintain a healthy lifestyle. Beneficial effects of activity have been reported for people with Parkinson's disease (PD), and there is evidence to suggest it may be neuroprotective. Most people with PD do not achieve the recommended levels of PA, although the reasons for this are unclear [1]. It is important to understand the drivers of PA especially in the early stages of the disease before the secondary effects of PD are established. The aim of this study was to examine change in PA over 18 months in an incident cohort of PD and to identify possible drivers of PA. METHODS: For this preliminary analysis 35 people with PD [mean (SD) age 67.4 (10.4) years; 14 females; UPDRS III 23(10)] were recruited through an ongoing longitudinal study (ICICLE-PD). PA was measured for 7 days at baseline and 18 months, using a uniaxial accelerometer (ActivPal TM1,10Hz). PA outcomes included: 1) pattern of accumulation of activity (alpha); 2) number of steps accumulated in walking bouts of <20 steps (short), 20-100 steps (moderate) and > 100 steps (long); and 3) variability of stepping bout duration. A range of cognitive, motor, affective and quality of life outcomes were measured, including PD questionnaire (PDQ), the Geriatric Depression Scale (GDS), UPDRSIII and the Activities Balance Self- Confidence Scale (ABC). Multiple regression analysis was used to identify independent predictors of change in PA. RESULTS: At 18 months, there was a non-significant trend for people with PD to accumulate more steps in shorter bouts and fewer in longer bouts. Results from multiple regression showed that younger age, less severe PDQ stigma and lower PDQ mobility scores were independent predictors of a decrease in the number of steps accumulated in long bouts ($F (5, 34) = 7.00$, $p < 0.001$), with the model explaining 47% of the variance. In addition, more severe PDQ stigma and mobility scores were independent predictors of a decrease in steps accumulated in moderate bouts, total time spent walking and alpha. Post-hoc analysis showed these findings were independent of change in working status and medication. There were no significant independent predictors of change in

variability of bout duration or number of steps accumulated in short bouts. CONCLUSION: Age, stigma and mobility are significant drivers of change in PA in early PD. This behavioural change reflects an early response to PD, even in those whose levels of physical activity should arguably be least affected. Future analysis will be performed on a larger cohort and compared with aged-matched controls to gain a greater understanding of the motor and non-motor drivers of PA in PD. Reference: 1. Lord, S., Godfrey, A., Galna, B., Mhiripiri, D., Burn, D., and Rochester, L. (2013). Ambulatory activity in incident Parkinson's: more than meets the eye? Journal of Neurology DOI 10.1007/s00415-013-7037

P2-A-2 Physical Behaviours model and Event based analysis ? an approach to producing patient-centered outcomes

Malcolm Granat[1]

[1]University of Salford

BACKGROUND AND AIM: Physical Behaviour can be defined as the pattern of all free-living physical activities. By quantifying these patterns we can produce objective measures of a subject's free-living physical behaviour. These measures can help us generate new, patient-centred, clinical outcomes and can also quantify how interventions affect free-living behaviour. A Physical Behaviour model will be presented, which incorporates all free-living activities from lying to vigorous activity. Specific examples will be given on how, using event-based analysis, patterns of these events can be analysed to produce new clinical outcomes. METHODS: Continuous seven-day recordings of actvity monitor data were obtained from a number of populations. All data was classified into the primary events of upright and sedentary. Upright events were further classified into standing and walking events and sedentary events classified into sitting and lying events. In addition the average cadence of each separate walking event was calculated. Using event-based analysis the patterns of these events were quantified and groups compared. RESULTS: Event-based analysis demonstrated that aspects of Physical Behaviour could be quantfied revealing differences in populations, and the effects of interventions on these populations, that are not apparent when looking at volumetric data. In addition by robustly distiguishing lying events from sitting events it is possible to automatically seperate out an individual's "waking" day and also to generate outcome measures related to sleep and sleep disturbances. CONCLUSIONS: A Physical Behaviour model can provide a unified model which can incorporate different aspects of Physical Activity and Sedentary Behaviour research. Using event-based analysis it is possible to quantify these behaviours and tailor our outcomes to for clincal research questions.

P2-A-3 3-day activity monitoring confirms inter-ictal alterations in patients with Freezing of Gait

Jeffrey Hausdorff[1], Aner Weiss[1], Talia Herman[1], Marina Brozgol[1], Ariel Tankus[1], Nir Giladi[1]

[1]Tel Aviv Sourasky Medical Center

Background and Aim: Current approaches for evaluating Freezing of Gait (FOG) are generally based on testing in the lab or clinic or self-report. However, FOG often occurs at home and in the community setting. We tested whether long-term, continuous monitoring identifies changes in activity / gait in freezers, irrespective of the freezing episode per se. Methods: 72 PD patients (age: 65.7+/-8.8 yrs; UPDRS Motor-Sum "Off": 43.8+/-12.7; Hoehn & Yahr "Off": 2.7+/-0.7; 22.2% women) wore a 3D accelerometer on the lower-back for 3-days. The FOG-Questionnaire (FOG-Q) quantified severity of FOG.

Quantity-measures derived from the 3-day recordings included total-activity (%) and step count. Gait quality measures included stride-regularity, harmonic-ratio, and frequency-measures (amplitude, width and slope of the power spectral density (psd) which reflects gait variability and consistency. Results: Based on the FOG-Q, 28 patients were classified as freezers and 44 as non-freezers. The groups did not differ with respect to age, gender, or disease duration ($p>0.19$). Step counts and total-activity were similar in the two groups. Freezers had increased gait variability, as exhibited by the larger width of the vertical and anterior-posterior psd ($p<0.011$), and less gait-consistency, as depicted by t lower vertical, anterior-posterior and medio-lateral stride-regularity ($p<0.031$). Freezers also showed a less smooth vertical, anterior-posterior and medio-lateral gait-patterns, as exhibited by their lower vertical and anterior-posterior and higher medio-lateral harmonic-ratio ($p<0.023$). Conclusions: These findings suggest that a 3-day worn body-fixed sensor can assess FOG susceptibility as patients carry out routine daily-living activities in their natural-settings and support the idea that the gait pattern is altered even between the Freezing of Gait episodes. The research leading to these results has received funding from the European Union - Seventh Framework Programme (FP7/2007-2013) under grant agreement n°288516 (CuPiD project); and by the Michael J. Fox Foundation for Parkinson's Research.

P2-A-4 Quantifying transitions in patients with Parkinson's disease in the home and community setting

Eran Gazit[1], Tal Iluz [2], Aner Weiss[2], Talia Herman [3], Marina Brozgol [2], Moran Dorfman [2], Nir Giladi [4], Anat Mirelman [2], Jeff Hasdorff [5]

[1]TLVMC, [2]Laboratory for Gait and Neurodynamics, Tel-Aviv Sourasky Medical Center, [3]Sackler Faculty of Medicine, Tel-Aviv University, [4]Sagol School of Neuroscience, Sackler Faculty of Medicine, Tel-Aviv University, [5]Harvard Medical School

Background and Aim: The ability to successfully perform transitions (e.g., from sit to stand) reflects postural control, muscle strength, function, ageing, pathology and fall risk. While recent work has successfully detected and quantified transitions in laboratory settings using body-fixed sensors, less is known about transitions in real-life. The aim of this study is to evaluate the possibility of using a single, body-fixed sensor worn for 3 days to quantify sit-to-stand and stand-to-sit transitions as subjects carry out their routine daily life activities in the home environment. Methods: Patients with Parkinson's disease (PD), older adults (OA), idiopathic fallers (FL), and young adults (YNG) wore a 3D body-fixed sensor which measures linear acceleration and angular-velocity on their lower back for 3-days. Subjects were asked to continue in their normal activity and remove it only for showers and sleep. An algorithm was developed to identify sit-to-stand and stand-to-sit transitions. Various measures were extracted such as: duration, range and jerk of the anterior-posterior (AP) and pitch axes. We compared between the measures of patients with PD, OA, FL and YNG. Results: 176 subjects participated in this study: 27 OA (age: 78.5 /-4.4 yrs) 23 FL (age: 77.9 /-5.2) 96 PD (age: 64.85 /-9.57, disease duration: 5.45 /-3.5) and 30 young adults (age: 285 /-3.9). We successfully identified sit-to-stand and stand-to-sit transitions from the 3-day recordings. We found significant differences between the PD and the OA groups. Stand-to-sit: The AP jerk was significantly higher in the OA ($p<0.005$) and the duration was smaller ($p<0.001$). The OA had significantly lower pitch duration $p<0.0001$). Sit-to-stand: The AP range was higher in the OA ($p<0.002$) and the duration was smaller ($p=0.02$). The pitch range and jerk were also higher ($p<0.03$). Another important feature that we explored is the entropy on the slope of the signal. This feature represents the smoothness of the movement, and was correlated to the disease duration of the PD

patients (p=0.04). The YNG and OA groups differed only in lower stand-to-sit pitch range, duration, and jerk (p<0.001), and lower sit-to-stand pitch duration and higher jerk (p<0.001) in the OA compared to the YNG. Between the FL and CO groups, duration of the Sit-to-Stand in the AP axes was longer in the FL (p=0.04). Conclusion: We successfully identified transitions in the real world using a single body-fixed sensor. This is a very diverse dataset and challenging task since, for example, the transition from a kitchen chair is not like the transition from a sofa. These results suggest that this automated approach is a sensitive feature that can leverage the assessment of disease progression, aging and fall risk using body-fixed sensors. Acknowledgements: This work was supported in part by the European Commission (FP7-ICT-2011-7-ICT-2011.5.4-Contract no. 288878).

P2-A-5 The frequency analysis of acceleration for the detection of falling

Isu Shin[1], Soonjae Ahn[1], Jungyoon Kim[1], Youngho Kim[1]

[1]Yonsei University

BACKGROUND AND AIM: A hip fracture caused by fall result in serious effect to older people. The important problem in preventing or reducing the severity of injury in the elderly is to detect falling. Many previous studies reported that accelerations and angular velocities are one of the main parameters to detect falling. In this study, we distinguished falls from various activities of daily living (ADLs) using the short-time Fourier transform (STFT) of acceleration. Methods: Forty male volunteers participated in the experiment. The inertia sensor unit was positioned at the middle of the two anterior superior iliac spines (ASIS). The acceleration was measured at 100Hz. Every subject fell by simply relaxing to the side, back, and front. All falls were conducted on a soft foam mattress for five times. Accelerations were also measured at the same location during seven different ADLs (sitting, sit-stand transitions, walking, stand-sit transitions, lying, jumping and running). Each activity was conducted for three times. Signal vector magnitude (SVM) was calculated from the measured acceleration. Frequency analysis of the SVM value was conducted using STFT. Results: Frequency components in forward, backward and side falls showed the same characteristics. In three different fallings, the frequency of the SVM was approximately 5Hz. On the other hand, the frequency during ADLs was 1Hz-2Hz, which is much smaller than during falling. Significantly increased power was observed during impact period in all three fallings. Only the jumping movement revealed the similarly increased power during the landing period. However, frequency analysis of the acceleration provided no significant advantage in the early detection of the pre-impact for falling. Conclusions: In this study, frequency analysis of acceleration at waist was conducted using STFT. The results showed that falls and ADLs could be distinguished in the frequency domain. Nevertheless computational load for frequency analysis using SVM provided no advantage in comparison with threshold analysis using accelerations and angular velocities for the early detection of the pre-impact for falling.

P2-A-6 COMPARISON OF 7 PHYSICAL ACTIVITY MONITORS: A VALIDATION STUDY

Claudia Mazzà[1], Fabio Storm[1], Ben Heller[2]

[1]The University of Sheffield, [2]Sheffield Hallam University

BACKGROUND AND AIM: The number of steps walked per day, typically measured with activity monitors, can be considered as the most reliable daily living measurable input for non-exercise physical activity models. Accelerometry is the most commonly exploited technology in physical activity

monitoring. A number of physical activity monitors are available on the market, for both clinical and generic purposes. The aim of this work was to compare 7 physical activity monitors, belonging to one of the two above categories, and assess their accuracy in step detection during three walking protocols at different speeds. Data were collected both in an indoor laboratory setting and outdoor daily life conditions. METHODS: Sixteen healthy adults (10 males, 6 females; age: 28.9 ± 2.7 years; height: 1.75 ± 0.09 m, mass: 72.0 ± 9.2 kg; BMI: 23.46 ± 2.34 kg/m2) were recruited to the study after having given informed consent. They were fitted with seven activity monitors comprising the DynaPort Movemonitor (McRoberts), UP (Jawbone), One (Fitbit), ActivPAL (PAL Technologies Ltd.), Tractivity (Kineteks Corp.), Nike+ Fuelband (Nike Inc.), Sensewear Armband Mini (Bodymedia), each of those was located following the manufacturers indications. Data was collected during three 11-minutes trials, in which the participants walked at their self-selected natural, slow, and fast speeds. Each trial entailed walking on a 20-m long indoor straight walkway, walking along a self-selected path in an indoor setting, and walking along an outdoor path. Two additional magneto-inertial sensors (OPAL, ADPM Inc) were located on each of the participants' ankles and provided a definitive reference for the step count, with heelstrikes detected from the angular velocity around the mediolateral axis using a previously validated algorithm [1]. Total count of left and right steps (N) was then computed. Differences in group estimates between sensor outcomes were tested. Bland-Altman plots were used to test agreement between variables and to evaluate bias between scores. RESULTS: In all the speed conditions, N was underestimated by the DynaPort, Fitbit, ActivPAL, Fuelband and Armband ($p<0.05$) and overestimated by the Tractivity. All sensors performed best at the fastest walking speed. The lowest absolute percentage error was found for the DynaPort (<2.0%, Bland-Altman plot shown in figure 1), followed by ActivPAL and Fitbit One (errors <2.6% and 3.2%, respectively). CONCLUSIONS: This study provides a robust comparison of activity monitors to support the choice of a device for step recognition in a healthy, young adult population. DynaPort and ActivPAL were the best performing devices among those for clinical applications examined in this study. Fitbit One is a lower-cost alternative with only slightly inferior performance. ACKNOWLEDGMENTS: This study was funded by the EC contract FP7-ICT-2011-9, No.600803 (MISSION-T2D), and by the Sheffield National Centre for Sport and Exercise Medicine.

P2-B-7 Effects of non-slip socks on the gait patterns of older people when walking on a slippery surface

Anna Hatton[1], Daina Sturnieks[2], Stephen Lord[2], Joanne Lo[2], Hylton Menz[3], Jasmine Menant[2]

[1]The University of Queensland, [2]Neuroscience Research Australia, [3]La Trobe University

BACKGROUND AND AIM: Slip-related falls are reported to contribute to 25% of fall-related hip fractures in older people, with 66% occurring on wet or slippery surfaces. Non-slip socks have been marketed to prevent slips in older people; yet, few studies have investigated their biomechanical and clinical effects during walking. This study examined gait parameters of older people walking on a slippery surface, wearing non-slip socks, compared with standard socks and barefoot conditions. METHODS: Fifteen older people (5 female, mean [SD]: age 76.1 [5.0] years) completed five trials of the Timed up and Go (TUG) test, as fast as possible, while randomised to: barefoot (control), non-slip socks, and standard cotton socks conditions. A 4m-long wooden walkway, treated with water-based Estapol clear gloss polyurethane and beeswax polish, was constructed to simulate slippery interior wooden floorboards. Clinical performance data (total TUG time, total number of steps, number of steps in turn, observed slips, trips or falls) were collected. Kinematic (step length, heel horizontal velocity at heel strike, foot-

floor angle at heel strike) data were also collected, during the first TUG trial only, using two CODA scanner units, with active markers attached bilaterally to the feet and lower limbs. Participants rated the degree of perceived slipperiness of the floor surface using a 5-point Likert scale. Data were analysed using repeated measures ANOVAs with alpha set at 0.05. RESULTS: Performance on the TUG did not differ between barefoot and non-slip sock conditions. Older people took longer to complete the TUG when walking in standard socks compared with barefoot and non-slip socks, during the first and five averaged trials ($P<0.05$). Participants also took more steps when wearing standard socks compared to when barefoot during the first and five averaged trials ($P<0.001$). Non-slip socks did not significantly alter kinematic measures, relative to barefoot and standard sock conditions. However, older people took significantly shorter steps when walking in standard socks compared to barefoot ($P<0.001$). Participants rated the non-slip socks to feel less slippery than barefoot and standard socks ($P<0.001$). CONCLUSIONS: Compared with standard socks, wearing non-slip socks enhances gait performance during the TUG, and may have the capacity to reduce slip propensity in older people. When walking in non-slip socks, older people appear to adopt walking patterns similar to the barefooted condition. Conversely, when wearing standard socks, older people walk slower and take shorter steps. Therefore, barefoot or non-slip socks may be a safer footwear option than standard cotton socks for older people walking around indoors on potentially slippery surfaces.

P2-B-8 Differences between older adult "slippers" and "trippers" in measures of dynamic balance during walking

Mark Hollands[1], Derek Peters[2], Paul Robinson[2], Rachel Wright[3]

[1]Liverpool John Moores University, [2]University of Worcester, [3]University of Birmingham

Background and Aims: A recent study of falls in care homes (Robinovitch et al, 2013) reported that 24% of falls occurred during walking. Slipping accounted for just 3% and trips or stumbles accounted for 21% of falls. The most frequent cause of falling (41%) was incorrect weight shifting, whereby the faller shifted their body weight causing their centre of mass to (COM) move beyond their base of support. Studying the relationships between centre of mass and centre of pressure under the foot (COM-COP) in walking older adults has been shown to be a useful tool in determining dynamic stability. The aim of the current study was to compare COM-COP separation measures during walking between older adults with no falls history, falls history due to tripping or falls history due to slipping. Any differences between slippers and trippers in measures of dynamic balance would suggest differences in the mechanisms responsible for falls. Methods: 40 community-dwelling older adults were split into three groups based on their self-reported previous fall history during walking. The non-faller group (n=16, age 72±5 years) had not experienced a fall in at least the year prior to testing. Participants who had experienced at least one fall were split into two groups based on whether a trip (n=14, age 71±6 years) or slip (n=10, age 68±5 years) resulted in the fall. A Vicon system was used to collect full body kinematic trajectories, which were used to calculate COM and temporo-spatial gait characteristics. Two AMTI force plates were used to measure ground reaction forces. The horizontal distance between COM and COP was calculated for in the antero-posterior (AP) direction for 5 points across the gait cycle: heel strike, foot flat, toe off, mid-swing and late swing. Results: There were no significant differences between groups for either; walking velocity, stride time or stride length. COM was significantly further ahead of COP at heel strike for the tripper (14.3cm ± 2.7 $p=0.023$) and slipper (15.3cm ±1.1, $p=0.009$) groups compared to the non-fallers (12.0cm ± 2.7). COM was significantly further behind COP at toe off for the slippers (-17.0cm±2.7, $p=0.031$)

compared to both the non-faller (-14.1cm±3.0) and trippers (-14.4cm±1.7). At mid-swing, the COM of the trip group was ahead of the COP (0.9cm±1.6), whereas for the slip group the COM was behind the COP (-1.2cm±2.2, p=0.045). Conclusions: These results show that there are identifiable differences in dynamic balance control of walking between older adults with a history of tripping and those with a history of slipping. This finding has important implications for diagnosing falls risk and for falls prevention and treatment. References: Robinovitch et al (2013) The Lancet, Volume 381, Issue 9860 p 47 - 54

P2-B-9 POSTURAL STABILITY IN COMPLEX, WHOLE-BODY MOVEMENTS: EXPLORING AGE RELATED CHANGES

Andrew Huntley[1], Lori Ann Vallis[1], John Zettel[1]

[1]University of Guelph

BACKGROUND AND AIM: Postural instability leading to falls is one of the most serious problems facing our aging population. A typical characteristic of a fall is that it occurs during ongoing movement (e.g. reaching) [1]. Previous studies have been limited to relatively simple tasks [2], however, daily activities are much more complex. Therefore, the purpose of this current study was to characterize age-related changes in postural stability during complex whole-body movements. METHODS: Nine young adults (YA, 23.89±2.09 years) and eleven older adults (OA, 78.73±7.14 years) performed several complex movements: 180° step in both directions, transferring an object (0.5 kg) forwards or to the sides beyond reach (e.g. lean-to-reach) at counter height (91 cm), transferring an object at counter height with a side step in both directions, transferring an object at twice counter height, or half-counter height, to counter height. Movements were completed under two speed conditions: self-selected and "as quickly as possible". Reaching was done with the dominant right hand. Ground reaction forces (AMTI, USA) and whole body motion (OptiTrack, USA) was collected. Postural stability was characterized by Time-To-Contact (TTC): the minimum time for the current Center of Mass velocity (COMv) to leave the base of support (BOS). The current abstract will focus on results from the lean to reach tasks during "as quickly as possible" conditions only. RESULTS: Five YA and five OA have been analyzed to date. TTC in the Lean-to-Reach forwards task was smaller for OA (1.196±0.737 s) than YA (1.460±0.376 s). Similarly, TTC in the Lean-to-Reach right task was also smaller for OA (0.989±0.590 s) compared to YA (1.129±0.349 s). Conversely, TTC for the Lean-to-Reach left task was relatively equal for OA (0.724±0.226 s) and YA (0.732±0.158 s); however maximum COMv was smaller in OA (0.229±0.026 m/s) than YA (0.251±0.036 m/s). Since TTC is a measure of distance over velocity, a smaller COMv with similar TTC values is indicative of the COM being closer to the BOS boundary. Therefore, transporting an object to the ipsilateral side yielded greatest levels of instability for both age groups, however the OA completed the task at a slower velocity. This suggests that OA reduced COMv to compensate for reduced COM to BOS boundary distances, presumably to avoid further destabilization that may result in the COM broaching the BOS and potentially triggering a fall. CONCLUSIONS: Preliminary results show greater instability in OA during Lean-to-Reach tasks, with instability being the greatest when moving an object to the ipsilateral side. Continued analysis will identify which aspects of more complex movement present particular challenge to postural stability in older adults. REFERENCES: [1] Berg, W. et al.(1997) Age Ageing 26:261-268 [2] Melzer, I. et al.(2004) Age Ageing 33:602-607

P2-B-10 Comparison of muscle power and functionality among adults and the elderly with knee osteoarthritis

Carina Junqueira[1], Roberta Brunelli[1], Elisa Libardi[1], Daniela de Abreu[1]

[1]University of São Paulo

During the aging process, musculoskeletal disorders may contribute to the development of osteoarthritis (LOESER, 2009) that may result in decreased muscle function (Hinman et al., 2002). The loss of strength and muscle power can lead to a decreased ability to promote the faster joint torque necessary to, for example, rise from a chair, climb stairs and maintain the balance needed to avoid obstacles, which can increase the chance of falls (FEDER, 2000) and decrease independence. The relation between age, degree of osteoarthritis, decreased functional capacity and muscle performance is not fully understood in the literature. Therefore, this study aimed to evaluate the quadriceps muscle power and functionality of individuals with knee osteoarthritis, aged above and below 60 years. METHODS: The study included 14 subjects, seven aged 60 and above (60-74) and seven aged under 60 (41-54). There were two males and 12 females. All participants had previously been diagnosed with knee osteoarthritis radiographically by examining an x-ray following the criteria set out by Kellgren and Lawrence and degrees of identified involvement. For the isokinetic assessment of muscle power an isokinetic dynamometer Biodex Pro 4 (Shirley, New York) was used, with an angular velocity of 180 ° / s. An evaluation of the participant's functional capacity was carried out using the sit to stand (STS) test, which involved completing five consecutive sessions of STS as quickly as possible. To record the spent time a chronometer was started at the same time as a verbal command and stopped when the volunteer finished the fifth session. The procedure was performed twice.(Ribeiro et al., 2012). RESULTS: There was no significant difference comparing power (p> 0,11) and functionality (p> 0,9) in individuals aged above and below 60 years through the T test for quadriceps power and the sit-to-stand test. CONCLUSION: The lack of differences between groups is possibly linked to the fact that approximately 80% of the participants had early grades (grade I and II) of osteoarthritis. This finding may therefore be indicative of the importance of physiological age, including changes to the myoarticular system associated with environmental interference, which entails greater interference in functionality compared to chronological age.

P2-B-11 The effects of ambient lighting and macular degeneration on the ability to integrate motion for accurate foot placement

Daniel Marigold[1], Kim Lajoie[1], M. Scott Alexander[1], David Neima[2], Robert Strath[1], Stephen Robinovitch[1]

[1]Simon Fraser University, [2]N/A

BACKGROUND AND AIMS: Age-related macular degeneration (AMD) is one of the leading causes of severe visual impairment in older adults. It is mainly characterized by a loss or severe degradation of the central visual field as well as decreased visual acuity. These deficits greatly affect an individual's quality of life. A critical aspect of navigating in complex environments is our ability to detect and process motion cues. Motion perception is required to regulate gait speed, control foot placement and safely negotiate and avoid obstacles. Although studies in AMD have reported issues with motion perception in tasks using moving dots displayed on a computer screen, very few have examined this aspect in real-life mobility tasks. In addition, older adults with AMD often report having difficulty performing activities of daily living or seeing in dim light or at night. Thus, it is likely that any motion perception deficits are

further exacerbated in poor lighting situations. The purpose of this study was to determine the effects of AMD and changes in ambient light on the control of foot placement to stationary and moving targets. METHODS: Ten older adults with AMD and 12 healthy-eyed controls stepped to a single floor target under the following conditions: (1) no motion, (2) self-motion, (3) object-motion, and (4) self- and object-motion. In the no motion condition, subject had to perform a single step to a stationary target. In the self-motion condition, subjects were required to walk and step to the middle of the stationary target positioned at a distance 4-5 m in front. In the object-motion condition, subjects stood still as a target moved towards them before stepping on it. In the self- and object-motion condition, subjects were required to walk and step to the middle of a target moving towards them. Target speed varied randomly between 0.15, 0.21, or 0.30 m/s in the target motion conditions. Subjects performed three trials of each condition under the following lighting situations: bright light (~600 lux), dim light (~0.7 lux), and a sudden reduction from bright to dim (~600 lux to 0.7 lux). A motion capture system was used to determine foot placement accuracy. RESULTS: Independent of motion condition, older adults with AMD showed greater foot placement error under reduced lighting, particularly in the sudden reduction of light condition. Foot placement variability in the anterior-posterior direction was increased in the sudden reduction of light condition when motion was present compared with the no motion condition and healthy controls. CONCLUSIONS: The ability of older adults with AMD to process motion cues appears sufficient to guide the foot to a stationary and moving target in bright, and for the most part, dim lighting situations. However, sudden changes in ambient light greatly impact stepping accuracy in this population, which may increase the risk of a fall. A reduction in parafoveal rods associated with AMD may explain these results.

P2-B-12 Obstacle influence on gait variability of individuals with Parkinson disease, Alzheimer dementia and healthy individuals

Lucas Simieli[1], Fabio A. Barbieri[2], Diego Orcioli-Silva[2], Claudia Arroyo-Teixeira[2], Ellen Lirani-Silva[2], Lilian Gobbi[2]

[1]São Paulo State University at Rio Claro, [2]UNESP - São Paulo State University at Rio Claro - Brazil

Background and Aim: The obstacle avoidance, which is indicated as a dual-task, has been considered one of the major causes for falls in Alzheimer's dementia (AD) and Parkinson's disease (PD) individuals (Orcioli-Silva et al., 2012; Vitório et al., 2010). Variability of spatial-temporal parameters on unobstructed ground level walking is higher for individuals with neurodegenerative disease than healthy individuals (Maquet et al., 2010, Vitório et al., 2010, Camicioli et al., 2003). However, the effects of different neurodegenerative disease in variability of approach phase to an obstacle during walking are comparatively uncharted. The aim of this study was to investigate and compare the variability of the spatial-temporal parameters on approach phase to an obstacle during walking of DP, DA and healthy individuals. Methods: Fifteen PD individuals (H&Y: 1-3; 71.2±6.42 years), 15 AD individuals (CDR: 1-2; 78.33±5.23 years) and 15 matched-healthy (77.40±6.19 years) individuals were instructed to walk over an 8m pathway, at his self-selected speeds. The participants performed 5 trials of unobstructed ground level walking (UGL) and obstacle crossing during walking (OBST). For obstacle crossing during walking, the participants were instructed to avoid the obstacle. The order of task was randomized. An optical system (100 samples/s) was used to record spatial-temporal parameters (stride length, step width, double support duration, single support duration, stride duration and stride velocity) of the central stride for unobstructed ground level walking, and the stride before the obstacle for the obstacle crossing

during walking. The variability of the gait parameters was analyzed by coefficient of variation (Camicioli et al., 2003). Manova (group x condition), with repeated measure for condition, was used to evaluate the variability during approach to the obstacle groups. Results: The MANOVA indicated group*condition interaction for stride length ($p<0.01$) and double support duration ($p<0.001$). In a general way, healthy individuals decreased the variability of stride length of OBST in comparison to UGL ($p<0.04$) while PD individuals increased the variability in the obstacle presence ($p<0.03$). For UGL, the PD individuals showed higher variability of double support duration than DA individuals ($p<0.001$) and healthy individuals ($p<0.001$). For OBST, both neurodegenerative disease groups ($p<0.03$) increased the variability of stride length in comparison of healthy individuals, and PD individuals showed higher variability of double support duration than healthy individuals ($p<0.009$). Conclusion: The obstacle avoidance increased the variability of neurodegenerative disease groups while the healthy individuals appear to maintain the variability in the obstacle presence. Moreover, the PD group showed higher variability than the AD group, probably due to motor impairments caused by disease, which leads a fall or stumble during crossing an obstacle.

P2-C-13 Real-time and carry-over effects of multi-modal biofeedback during gait and balance tasks in the elderly

Shannon Lim[1], Brian Horslen[1], Justin Davis[1], John Allum[2], Mark Carpenter[1]

[1]The University of British Columbia, [2]University Hospital Basel

BACKGROUND AND AIM: Previous research suggests that real-time biofeedback (BF) can reduce trunk sway during stance and gait tasks. Attenuation of trunk angular displacement has been observed in several trained tasks during and immediately after training sessions with multi-modal BF. BF yielded improvements for both young and older healthy adults [1-3] and those with vestibular loss [4-6]. However, it is not known whether the immediate effects of balance training are dependent on BF, or if these effects result in long-term carryover benefits related to training with BF. The purpose of this study was to determine: 1) if training with BF led to greater improvements in performance, compared to training without BF; and 2) if any improvements in performance after training persisted over time. METHOD: 34 healthy older adults (age 60-88) participated in two weeks of training (three 30-min sessions a week) on 7 stance and gait tasks. Participants were tested prior to, immediately after, 1 week after, and 1 month after training. One group trained with real-time BF (n=18) of trunk angular displacements in the pitch and roll planes while the other group (CONTROL; n=16) received no BF. BF involved graded vibrotactile, auditory, and visual cues from a visor worn on the head and was activated according to individualized ranges set from initial assessment. RESULTS: Following training with and without BF, significant reductions of trunk angle were observed in the pitch and roll directions for the walking 8 tandem steps eyes closed (EC), and standing 30s on foam with EC tasks. Of these tasks, significant carryover effects up to 1 week post training were only observed for roll angle during the standing on foam EC task in the BF group. A significant decrease following training in trunk pitch angle was observed in the walking with head rotating task in the BF group, compared to an increased trunk pitch angle in the CONTROL group. The significant improvements observed with BF persisted immediately after BF was removed, however no further carry-over effects were found after 1 week or 1 month post-training. In contrast, the significant increase in pitch angle displacement seen in the CONTROL group persisted up to 1 month post-training. CONCLUSIONS: Training with or without real-time BF was effective in improving control of the trunk during the most difficult eyes closed tasks

(standing on foam, tandem walking). However, persistent improvements after training were restricted to tasks that had BF, with improvements lasting up to 1 week post-training. Based on this observation, BF could be used periodically for the elderly to improve balance rather than be used permanently. References: [1]Davis JR et al. Gait Posture. 2010; 31:465-72.[2]Huffman JL et al. Gait Posture. 2010; 32:62-6.[3]Verhoeff LL et al. Gait Posture. 2009; 30:76-81.[4]Horak FB et al. Ann N Y Acad Sci. 2009; 1164:279-81.[5]Dozza M et al. 2005; 86:1401-3.[6]Hegeman J et al. J Vestib Res. 2005; 15:109-17.

P2-C-14 Effect of lightly touching to a cane on postural sway during single-leg standing

Kazushige OSHITA[1], Kyotaro FUNATSU[1], Sumio YANO[2]

[1]Kyushu Kyoritsu University, [2]Kobe University

BACKGROUND AND AIM: Lightly touching the fingertips to a stable external object or the upper part of one's own legs (level of force is insufficient to mechanically support one's own body; < 1 N) results in decreased postural sway during standing. However, it is unusual for an individual to stand and lightly touch the upper leg or a stable surface while performing daily activities. If the postural sway also decreases the light touch of a cane during and after touching, this finding would be helpful in the development of a useful application for light touch. Therefore, the purpose of the present study was to investigate the immediate effect of lightly touching a cane on postural sway. METHODS: Data were obtained from 22 healthy men (age, 20 ± 1 years) who were randomly assigned to the light-touch group (LT-group, n = 12) or the heavy-touch group (HT-group, n = 10). The participants initially performed a single-leg stance (right leg) with their eyes closed for 30 s (no-touch standing). After a 3-min rest period, participants in the LT-group were asked to perform single-leg stance tasks with their eyes closed while lightly touching a cane with their left fingers and palm for 30 s (cane-touch standing). The participants in the HT-group were asked to perform a single-leg stance with their eyes closed and support their own body with a cane in their left hand for 30 s (cane-support standing). After a 3-min rest period, all the participants performed no-touch standing again (after-touch standing). To assess the postural sway during each task, the mean velocity of the center of foot pressure (total path length of the center of pressure divided by the calculated time; V-COP) and maximal ranges in the anteroposterior and mediolateral directions were measured. RESULTS: In the LT-group, the V-COP and maximal range of each direction were significantly decreased during cane-touch standing compared with no-touch standing. Furthermore, V-COP also decreased during after-touch standing compared with no-touch standing (Figure). Although postural sway was also significantly decreased during cane-support standing compared with no-touch standing in the HT-group, it did not change during after-touch standing compared with no-touch standing. CONCLUSIONS: Lightly touching a cane provides a haptic sensory cue during single-leg standing that can be used to assist postural control mechanisms due to enhanced perception of self-motion through sensory interaction with the environment through the cane. Furthermore, the association between postural control and haptic input through the cane might have an immediate effect on perceptual motor learning. Therefore, our results suggest a potential new use for a cane.

P2-D-15 Effects of instruction on turning in Parkinson's disease

Allan Adkin[1], Jacob Pfeiffer[1], Jae Patterson[1], Craig Tokuno[1]

[1]Brock University

BACKGROUND AND AIM: Parkinson's disease (PD) is characterized by postural instability, gait impairment, and falls. Research has shown that modifying an individual's focus of attention through the use of verbal instructions can reduce postural instability and improve gait performance in PD [1-3]. For gait, this evidence is limited to unobstructed straight-path walking tasks with or without dual tasking [2, 3]. However, turning difficulties (e.g., longer turn durations and reduced trunk yaw angular velocities compared to healthy age matched controls, [4]) and falls while turning are common problems in PD. Thus, it is important to determine if instructions can provide similar benefit to individuals with PD when performing more challenging gait tasks such as turning. The purpose of this study was to assess the influence of different instructional sets on turning performance in PD. METHODS: Twelve individuals with mild to moderate idiopathic PD (5F / 7M, mean (SD) age 68.8 (8.9) years) performed three trials of two different walking tasks (straight-path walking, walking with a 180 degree turn) under four instruction conditions (no instruction, take big steps, make large trunk movements, focus on the end of the pathway and/or the turn point). Task duration and peak-to-peak range excursions in yaw and roll directions for both trunk angular displacement and trunk angular velocity were calculated for specific intervals during the walking and turning tasks. This approach was similar to past research [4]. RESULTS: The results showed that providing verbal instructions related to step amplitude (i.e., take big steps) improved performance for both the normal walking and 180 degree turn tasks compared to providing no specific instruction at all or externally based instructions (i.e., focus on end of the pathway and/or the turn point). This improvement was inferred through shorter durations and greater trunk yaw and roll angular displacement and velocity values. For example, when performing the 180 degree turn, greater trunk yaw velocity and shorter turn durations were observed when using the instruction to take big steps. CONCLUSIONS: This study extends the observed benefits of instruction for normal walking to a turning task. Individuals with mild to moderate PD were able to use simple step amplitude based verbal instructions to improve turning performance. Future research will determine the long term effects of verbal instructions on turning in PD and whether these effects can transfer to daily life situations. REFERENCES: [1] Landers et al (2005) Physiotherapy [2] Morris (2006) Physical Therapy [3] Canning (2005) Parkinsonism and Related Disorders [4] Visser et al (2007) Clinical Neurophysiology

P2-D-16 Association between personality traits and dual task performance among the community dwelling older adults- work in progress

Maayan Agmon[1], Galit Armon[1]

[1]University of Haifa

Background: Although personality has been linked to physical health outcomes including mobility limitations, disability and executive function, its relationship to dual-task performance is yet to be explored. The ability to conduct two tasks simultaneously (i.e. dual-task or DT) relates to increased risk of falling among the elderly and is highly associated with executive function that was found to be associated with personality traits. The Big Five Model of Personality, which conceptualizes five distinctive domains of personality (Extraversion, Neuroticism, Openness/ Intellect, Agreeableness and Conscientiousness) represents the intersection of the social environment, biology and health outcomes of the individual. Illuminating the link between personality traits and DT performance may lead to the development of effective, individually-tailored interventions and provide a means of early detection of DT deterioration. Aims: To explore the relationship between personality traits and dual task performance among the elderly. Method: We are at the final stage of collecting data from 100

community dwelling older adults. All participants fill the Big-Five questioner and undergo measurements of dual-task performance: walking while conducting cognitive tasks (verbal fluency and subtraction). Dual-task cost will calculate for each task separately. Linear regression model will determine the relationships between each of the Big-Five personality traits and dual-task performance. Results: Data collection will be completed by the end of December, at which time analyses will be conducted and present. Conclusions: The findings of this study will be discussed from two perspectives of potential contributions: (1) addressing which of the personality traits associated with greater risk to develop deterioration in dual-task performance, (2) to promote individual based interventions for dual-task performance in which the specific personality traits is taken into account.

P2-D-17 Action strategies used to navigate cluttered environments and the effect of postconcussion syndrome

Carmen Baker[1], Michael Cinelli[1]

[1]Wilfrid Laurier University

BACKGROUND: Individuals who previously suffered from a concussion have been identified as having perception-action integration dysfunction up to 30 days post-concussion during a static balance task (1). Further analysis conducted by the current authors identified perception-action integration dysfunction up to 70 days post-concussion using a navigational task (under review). The current study attempts to identify perception-action integration dysfunction in individuals with post-concussion syndrome (PCS). PCS differs from long-term recovery from concussion as individuals with PCS have persistent physical symptoms of concussion (headache, dizziness, fatigue) for far longer than two weeks typical of physical recovery from concussion (2) and may therefore also display persistent cognitive deficits. METHODS: Participants (athletes (n=3), individuals with PCS (n=3)) performed a perceptual and a navigational task within a 10m by 6m space with two vertical poles placed along the travel path. The two poles created an aperture ranging between 0.9-1.7x participants' shoulder widths at increments of 0.2. Perceptual task: participants walked toward the goal and were asked to indicate whether they believed they could safely pass through without rotating their shoulders. Navigation task: participants walked toward the goal and were instructed to avoid contacting the obstacles (walk through aperture or around obstacles) located at 3, 5, or 7m from the start location. RESULTS: Preliminary data suggests individuals with PCS are more variable than athletes in path selection (i.e., through or around) especially for the aperture width that was 1.3 times their shoulder width ($u=1.5$, $p=.11$). Also, athletes perceived themselves safely passing through smaller apertures and their actions were consistent when required to navigate toward the goal and avoid the obstacles, and likewise, individuals with PCS perceived themselves safely passing through larger apertures and tended to navigate through larger apertures ($r=.88$, $p<.05$). Taken together, individuals with PCS tend to act more cautiously, but with higher variability in their action strategies than athletes. CONCLUSION: Results suggests that even with a small sample, the paradigm has elicited evidence that individuals with PCS demonstrate perception-action integration dysfunction as observed in their variable navigational strategies. Even though individuals with PCS appear to act more cautiously, their variable actions put them at risk of being unsuccessful when navigating through cluttered environments. Further analysis of kinematics and gaze behaviours will further identify cognitive deficits, specifically perception-action integration dysfunction in PCS. (1) Slobounov, S., Slobounov, E., & Newell, K. (2006). Application of virtual reality graphics in assessment of concussion. CyberPsychology and

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P2-D-18 Cognitive Compensation in the Context of an Unpredictable Platform Perturbation and Simulated Age-Related Hearing Loss

Halina Bruce[1], Gifty Asare[2], Ioannis Makris[3], Daniel Aponte[3], Nancy St-Onge[4], Karen Z. H. Li[2]

[1]Concordia University, [2]PERFORM Centre, Centre for Research in Human Development, Department of Psychology, [3]PERFORM Centre, Department of Exercise Science, [4]PERFORM Centre, Department of Exercise Science, Constance-Lethbridge Rehabilitation Center, Cente

BACKGROUND AND AIM: Epidemiological research indicates a link between hearing loss and mobility (Viljanen, & al., 2009). A potential explanation is that cognitive compensation occurs in both speech perception and postural tasks in older adults (Li, & Lindenberger, 2002). Therefore, simultaneous listening and balancing might be more challenging for older adults with hearing loss. The aim of the current study was to investigate this hypothesis experimentally by presenting auditory stimuli in a dual-task balancing paradigm. METHODS: Eighteen younger adults (M = 22.50 yrs; SD = 3.52 yrs) were administered baseline measures of neuropsychological, psychosocial and sensory/sensorimotor functioning. Participants then completed cognitive (modified n-back) and balance (balancing on a moving platform) tasks singly (A) and concurrently (B) in an ABA order. This design was repeated under both noisy and quiet conditions where the addition of background noise (multi-talker babble) was used to simulate age-related hearing loss. RESULTS: We found a main effect of auditory challenge, $F(1, 56) = 51.90$, $p < 0.001$, $\eta 2 = 0.74$, such that participants made more cognitive errors in noisy (M = 4.26; SD = 2.29) compared to quiet (M = 0.33; SD = 0.42) conditions. We analyzed muscle activation for the right tibialis anterior,and motion of whole-body center of mass (COM) for a subset of six participants (M = 23 yrs; SD = 2.90 yrs) in trials involving motion of the platform (single task or with cognitive load). Noise was shown to have the effect of delaying the time to the peak COM displacement (seconds) but to decrease the amplitude of the peak (mm). However, onset of COM displacement (seconds) is not affected by either noise or cognitive load. Furthermore, the addition of a concurrent cognitive task has a greater effect on TA EMG onset than on the COM parameters. CONCLUSIONS: Together, the results support the prediction that background noise (simulating age-related hearing loss) has a negative effect on listening task performance and changes the postural response to a mild perturbation. Young adult data will be contrasted with that of healthy and hearing-impaired older adults.

P2-D-19 Critical role of right inferior frontoparietal network in kinaesthetic illusory movement

Fabien Cignetti[1], Marianne Vaugoyeau[1], Bruno Nazarian[1], Muriel Roth[1], Jean-Luc Anton[1], Christine Assaiante[1]

[1]CNRS - Aix-Marseille Université

Background and aim: Under optimal frequency characteristic, vibratory stimulation of muscle tendon commonly evokes illusory limb movements, conveying kinaesthetic information to the cerebral cortex. Although the neural network underlying kinaesthetic processing is well-known, the neural basis responsible for the illusory feeling of movement, labelled kinaesthetic conscious perception, remains to be understood. Interestingly, certain subjects are insensitive to illusory movements despite optimal

tendon stimulation. In the present fMRI study, we sought to uncover the neural basis of kinaesthetic conscious perception by examining differences in central processing of kinaesthetic information between subjects who did experience illusory movements and those who did not. Methods: Fifteen subjects 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 so selected as 30 Hz stimulation drives weak discharges of the primary endings without kinaesthetic illusions and 100 Hz frequency optimally activates primary endings and usually provides consistent illusory movements. fMRI time series were analyzed using leave-one-subject-out general linear models and region of interest analyses. Results: Among the fifteen subjects, nine felt systematic illusory movement in the high-frequency condition, reporting ankle plantar-flexion movement, whereas the six other subjects did not experience illusions in any of the conditions. A non-limb-specific associative network, including the opercular part of the right inferior frontal gyrus and the right inferior parietal lobule, was more active in subjects with kinaesthetic illusions. Inversely, levels of activation in the other brain areas involved in kinaesthetic processing were rather similar between the two subsamples of subjects. Conclusions: The results suggest that activation of the right inferior frontoparietal areas, once passed a certain threshold, forms the basis of illusory movements, likely recruiting circuitries usually responsible for movement monitoring through forward computations.

P2-D-20 The effect of visual tracking on stabilization of posture in a dynamic virtual environment

Orit Elion[1], Sara Snell[1], Emily Keshner[1]

[1]Temple University

Background and aim: Balance maintenance is regulated by multisensory inputs including vision. Attention processes also use visual information to identify visual cues that support concurrent tasks. Therefore, decreased attention to visual field motion during a competing cognitive task may influence postural stability. The aim of this study was to determine the presence of a trade-off between postural stabilization and attention to visual field information when performing a visual tracking task. Methods: 11 young adults (YA), (26±4.8 yrs) and 5 older adults (OA), (66±4.03 yrs) with no history of central or peripheral neurological disorders or musculoskeletal problems system stood on a dynamic platform within a 3 wall, stereo virtual environment. Instability was provoked by simultaneous sway referenced motion of the dynamic force plates and anterior-posterior sinusoidal motion of the visual scene. A computational task requiring visual tracking (VT) was performed as a single task (no base of support or visual scene motion), or concurrent with motion of the platform, the visual scene or both. Root mean squares (RMS), Approximate Entropy (ApEn), and mean range and standard deviation (SD) of center of pressure (COP) were calculated. For the VT trials, time to correct answer was calculated from appearance of the numbers on the screen to the mouse-click denoting a correct answer. Numbers not attended to were calculated as the number of times they failed to click the mouse. Paired sample t-tests were used to compare within group performance and two sample unequal variance t-tests were used to compare between both groups. A significance criterion of $p<0.05$ was used for all tests. Results: Coupled motion of the force plates and the visual scene produced significant increases in range and SD of the anterior-posterior CoP ($p<0.1$) and side-to-side CoP ($p<0.02$) in YA and $p<0.04$ in OA) for both groups. Response RMS and ApEn increased significantly in the YA group in the anterior-posterior ($p<0.01$) and

side-to-side (p<0.01) directions, while in the OA only the anterior-posterior ApEn increased. There was no change in the RMS and side-to-side ApEn. The number of missed numbers also increased with coupled motion of the force plates and the visual scene in the YA (p=0.04). Conclusions: A trade-off between postural stabilization and attention to visual field information when performing a visual tracking task was shown. Performance of the visual tracking task during combined force-plates and visual scene motion did not affect the postural behavior; visual tracking, however, was affected by the combined destabilizing stimulus. YA showed both increased motion and complexity in their CoP response as the stimuli became more complex whereas OA did not change the magnitude or complexity of their responses. YA also made more calculation errors suggesting that they were more focused on responding to visual environmental motion than to the cognitive demands.

P2-D-21 Center of mass movement during sit-to-walk in healthy individuals while feeling emotions

Gu Eon Kang[1], Melissa Gross[1]

[1]University of Michigan

BACKGROUND AND AIM: Sit-to-walk (STW) is a functional day-to-day movement that demands a high level of postural control. Changes in STW such as movement duration and center of mass (COM) velocity have been observed in elderly adults and patients with neurological diseases. Recently, several studies have quantified changes in movement speed during gait and gait initiation associated with emotions. Since movement speed is a key characteristic of STW, it is likely that STW is altered with emotions. We aimed to investigate differences in movement speed and COM velocity during emotional STW. METHODS: Nine healthy participants (4 males and 5 females; 18-21 years) performed STW from a chair while feeling anger, sadness, joy and neutral emotion. An autobiographical memories task was used to elicit emotions. Participants rated the intensity of felt emotions with a 5-item Likert scale immediately after each STW trial. Trials in which participants reported feeling at least moderate intensity of emotion were included in angry, sad or joyful trials. Trials in which participants felt little or no anger, sadness or joy were considered neutral. Participants repeated STW three times for each emotion. A 3D motion capture system (Motion Analysis) acquired motion data from 41 markers on bony landmarks. Whole body COM was calculated from a 15-segment model using Visual 3D (C-Motion). We measured STW duration, peak forward and vertical COM velocity, and percent drop in forward COM velocity. We used a mixed model with random effects of participants and fixed effects of emotion and gender to evaluate effects on measurements. Post hoc tests with Bonferroni correction were used to compare significant differences between emotions and gender (p<0.05). RESULTS: STW duration and COM velocities changed when participants felt joy, anger, or sadness compared to neutral. When feeling joyful, mean STW duration was 28% less (p<0.001), mean peak forward and vertical COM velocities were 19 (p<0.001) and 8% (p<0.05) greater, respectively, and mean percent drop in forward COM velocity was 9% less (p<0.001) compared to neutral. When feeling anger, mean STW duration was 6% less and the mean percent drop in forward COM velocity was 5% less (p<0.05) compared to neutral. When feeling sad, mean STW duration was 5% greater (p<0.05), and mean peak forward and vertical COM velocities were 13 and 22% less, respectively (p<0.001) compared to neutral. There were no significant gender differences for any measurement between emotions. CONCLUSIONS: This study demonstrated that feeling an emotion affects COM movement during STW. As might be expected, sadness was associated with increased movement duration and decreased COM velocities compared to neutral; the converse

was found for the high arousal emotions of anger and joy. The results suggest clinical potential for investigating sit-to-walk movement in individuals with mood disorders.

P2-D-22 Gait dynamics during a dual task as marker for cognitive function in patients with dementia

Claudine Lamoth[1], Maartje de Groot[2], Bregje Appels[2], Jos van Campen[2]

[1]University of Groningen, University Medical Centre Groningen, [2]Slotervaart Hospital Amsterdam

BACKGROUND AND AIM: Apart from a decline in cognition, gait changes and increasing fall risk are common in the clinical phase of dementia. In persons with dementia performance of a cognitive task during walking is associated with impaired gait stability and increased fall risk.1,2 While gait with and without dual tasking has often been studied, few studies have investigated the relationship between separate cognitive domains and gait dynamics. The aim of the present study was to examine in cognitive impaired elderly the relationship between separate cognitive domains and dual task cost (DTC) with gait dynamics. METHODS: 17 cognitive impaired elderly, who underwent extensive neuropsychological examination, participated (77±6.7 years). 14 cognitive variables in 4 domains were assessed: 1) attention and psychomotor speed; 2) executive functioning; 3) memory; 4) visuospatial and constructive abilities. To assess gait, participants walked for 3-min at self-selected pace, under single (ST) and under dual task (DT) condition (letter-fluency). While walking, mediolateral (ML) and anterioposterior (AP) trunk accelerations were registered from which parameters were calculated that quantify gait variability and stability.2,3 To examine differences in gait between ST and DT conditions, t-tests were applied. DTC was calculated for gait parameters as: (DT-ST)/ST. Partial least squares (PLS) analysis was applied to step related variables and variables that quantify AP and ML trunk accelerations separately (3 models), to examine the relation of neuropsychological scores, representing the separate cognitive domains, and DTC of gait variables. PLS analysis finds latent variables that maximize the amount of variance explained in X (cognitive variables) that are relevant for predicting Y (DTC of gait variables). The variable importance on projection (VIP) scores quantifies the importance of cognitive variables to the prediction of gait variables. RESULTS: Dual tasking had a significant effect on all gait variables: walking speed decreased, stride time variability increased, and more variability in trunk accelerations was observed. PLS analyses revealed a combination of 4 latent variables to explaining 67%-87% of the variance in the DTC of gait variables. VIP scores revealed an association of executive function with DTC of gait variables, but also attention, memory and visuospatial and visuoconstructive abilities were associated with gait deficits. CONCLUSION: More insight in the relation between different cognitive domains with motor function might be of importance for early detection of mild cognitive impairment, since a decline in gait control and dual tasking even occurs in preclinical stages before the diagnosis dementia is established.
REFERENCES: 1. Scherder et al. Neurosci Biobehav Rev 2007;31:485-97. 2. IJmker & Lamoth. Gait Posture 2012;35:126-30. 3. Lamoth et al. JNER 2011;8:2

P2-D-24 Exploiting the environmental demands of locomotor mobility to detect mTBI: A preliminary study

Bradford McFadyen[1], Isabelle Cossette[1], Marie-Christine Ouellet[1]

[1]Laval University

Background and aim: Although mild traumatic brain injuries (mTBI) represent the majority of all TBI's, they are often underdiagnosed. Isolated clinical cognitive and motor tests are often not sensitive enough to detect deficits following mTBI. Multi-task paradigms involving ecological daily tasks, such as adapting one's gait while performing other simultaneous tasks, offers natural challenges to executive functioning that are proving to be more sensitive to detect persisting problems following mTBI. The aim of the present work was to begin to explore the level of sensitivity for different combinations of physical and cognitive demands during locomotor navigation in order to differentiate persons with mild traumatic brain injury from those without. Methods: Seven subjects with a mild traumatic brain injury and 7 control subjects have been recruited. Subjects walked in different conditions related to executive function demands related to environmental contexts of level physical adaptation (unobstructed walking, stepping over a 15 cm high obstacle and stepping down from 15 cm) and simultaneous information processing (no dual task, Stroop task (St), verbal fluency task (VFt) and arithmetic task (At)) factors. Three dimensional motion data were collected with a Vicon system (100 Hz). Dependent variables included, gait speed, stride length and cadence as well as response time and error. A generalized linear ANOVA was used to compare groups and conditions, with post-hoc analyses using T-tests. Results: There were no main effects for group. However significant interactions were found for both group by cognitive tasks and group by cognitive by physical tasks for gait speed ($p=0.013$ and $p<0.001$ respectively) and cadence ($p=0.034$ and $p<0.001$ respectively). The mTBI group generally showed slower walking speeds and cadences during the multi-task conditions. From post-hoc analyses, significant differences between groups were found for gait speed when stepping over the obstacle and responding to the simultaneous cognitive tasks, regardless of the cognitive task (St, $p=0.037$; VFt, 0.011; At, 0.014). Conclusion: From these preliminary findings, from the targeted locomotor tasks, the combination of stepping over an obstacle with a simultaneous cognitive task appears to better detect changes following an mTBI, probably due to its greater demands in executive functioning (planning and attention). Gait speed appears to be a potential clinical measure and could provide important information to diagnose and make decisions about the ability of one to return to play or function following an mTBI. The most sensitive simultaneous cognitive task to use is still unclear.

P2-D-25 The effect of attentional focus on postural control during quiet standing

Nadia Polskaia[1], Eliane Dionne[1], Natalie Richer[1], Yves Lajoie[1]

[1]University of Ottawa

BACKGROUND: Utilizing an external focus of attention (i.e. directing attention to the movement effects) promotes greater postural control by enabling the motor control processes to naturally self-organize; whereas, an internal focus of attention (i.e. directing attention to the movement itself) disrupts the automatic control processes that would normally regulate the movement resulting in poorer postural stability [1]. AIM: The present experiment examines if completely shifting attention away from postural control during quiet standing using an attention-demanding cognitive task, unrelated to postural control could be a better alternative for postural performance than an internal or external focus of attention. METHODS: Twenty participants between the ages of 18-26 were required to stand as still as possible on a force platform while attending to three different attentional focus conditions. Each condition consisted of 10 trials, each 60 seconds in duration. The internal focus of attention condition required participants to focus on minimizing the movement of their hips as much as possible. The external focus of attention condition required participants to focus on minimizing the movement of the markers placed

on their hips as much as possible. The final condition consisted of an attention-demanding cognitive task that required participants to silently count the number of times a selected number was verbalized in a sequence of 3-digit numbers. Manipulation checks were performed for the internal and external focus conditions to ensure participants were allocating their attention to the instructed task. A one-way ANOVA with repeated measures on condition (internal, external and cognitive) was performed and LSD post hoc tests were performed to determine the location of significant difference. RESULTS: The cognitive task produced a significantly smaller 95% Area Ellipse compared to the internal and external focus conditions (ps <0.001). The center of pressure (CoP) displacement in the anterior-posterior (AP) direction was significantly lower in the cognitive task condition (ps <0.005). The standard deviation of CoP in the AP and medial-lateral (ML) direction was significantly lower in the cognitive task condition compared to the internal and external focus conditions (ps <0.005). Mean velocity for the cognitive task was significantly lower only in the ML direction (p <0.05). CONCLUSION: These findings suggest that shifting attention to an unrelated task is more beneficial for postural stability in the AP direction than an internal or external focus of attention. The external focus did not present the same benefits to postural stability as the cognitive task. REFERENCE: [1]Wulf, McNevin & Shea. (2001). Q J Exp Psychol, 4, 11.

P2-D-26 Impaired cognitive performance is associated with gait speed decline in oldest old people

Marjon Stijntjes[1], D.G. Taekema[2], J. Gussekloo[1], R.G.J. Westendorp[1], C.G.M. Meskers[1], A.J.M. de Craen[1], A.B. Maier[3]

[1]Leiden University Medical Center, [2]Rijnstate Hospital, [3]VU University Medical Center

BACKGROUN AND AIM: Cognitive impairment and slow gait speed frequently co-occur in elderly and are strongly associated with functional decline. However, the temporal relationship between cognitive and physical performance in elderly is largely unknown impeding proper clinical decision making with regard to prognosis and planning of interventions. The aim of this study is to assess whether low cognitive performance is associated with a higher decline in gait speed or whether slow gait speed is associated with a higher decline in cognitive performance in oldest old people. METHODS: Cognitive performance and gait speed were measured among 526 participants of the Leiden 85-plus Study, a prospective population-based follow-up study of participants all aged 85 years at baseline. A neuropsychological test battery was used to assess global cognitive performance, attention, processing speed and memory function. Z-scores were calculated for all cognitive tests and averaged to compose a composite score of cognitive performance. Gait speed was assessed by a six meter walking test and expressed as Z-score. The cross-sectional and longitudinal associations between cognitive performance and gait speed were analysed by linear regression adjusted for potential confounders including socio-economic status, comorbidities and physical activity. RESULTS: Both at age 85 and 89 years, cognitive performance was cross-sectionally negatively associated with gait speed (p=.028 and p=.015, respectively). Between age 85 and 89 years, 1 SD lower cognitive performance at age 85 years was associated with a 0.27 SD higher decline in gait speed during follow-up (p=.005). A 1 SD lower gait speed at age 85 years was associated with a 0.094 SD higher decline in cognitive performance during follow-up (p=.025). CONCLUSIONS: The association of low baseline cognitive performance with a higher decline in gait speed suggests that cognitive performance is important in the generation of gait speed in oldest old people. Further assessment of the merits of preventive measures directed at either cognition, physical performance or a combination is warranted.

P2-E-27 Interference between posture and movement underlies difficulty standing up smoothly in healthy adults

Brian Day[1], Timothy Cacciatore[1], Omar Mian[1], Amy Peters[1]

[1]University College London

BACKGROUND AND AIM: Difficulty performing whole-body movements could result from various factors: i) executing the movement plan, ii) balancing the body's mass above the base of support, and iii) preventing postural collapse against gravity. It is also possible that action difficulties arise from either the orchestration of or interference between these subcomponent tasks. In theory, anti-gravity postural support has considerable potential to interfere with movement because it requires muscle activity that is spatially complex, dynamic and ever-present. Previous studies found that experts in the Alexander technique have altered postural tone and might also have an enhanced ability to rise smoothly from a chair, compared to untrained control subjects. While differences in the smoothness of sit-to-stand coordination might result from AT's more adaptive muscle tone and reduced postural stiffness, these differences could merely reflect trained vs. untrained habits. Here, we aim to determine if untrained adults do indeed have difficulty standing up smoothly and to understand whether difficulties may relate to postural tone. METHODS: We compared chair-rise coordination between Alexander technique (AT) teachers and healthy untrained (HU) adults under the instruction to rise smoothly at a uniform rate. A range of movement durations (1-8s) were performed. Very slow movements minimised any possible misunderstanding of the task instruction to stand up smoothly. To achieve accurate movement times, actual vs. instructed movement durations were fed back to subjects post-trial. Three anterior-posterior initial feet positions were used to modulate task difficulty. Coordination was evaluated by vertical feet loading rate, CoM velocity, CoM-CoP distance at seat-off (SO) and maximal leg joint moments. Statistical comparisons were made using ANOVA. RESULTS: Clear and profound performance differences occurred between groups, particularly for slower movements, that could not be explained by strength differences. Across conditions, HU used approximately twice the peak forward CoM velocity ($p<0.001$) and feet loading rate ($p=0.002$) as AT. For slow movements, HU violated task instruction by abruptly speeding up and rapidly shifting weight just before SO. In contrast, AT shifted weight gradually while smoothly moving the CoM forward, achieving a more anterior CoM position at SO ($p=0.002$). CONCLUSION: A mechanical model was constructed to elucidate HU's difficulty rising smoothly. This revealed that the antigravity hip and knee extensor moments underling weight-shift act to hinder the CoM's forward progression to balance over the feet. Moreover for high leg-joint stiffness, forward momentum is necessary to overcome this resistance, resulting in a jerky movement. Thus, HU's inability to stand up smoothly can be explained by a limited ability to resolve conflicting postural and balance constraints due to their higher posture-related leg-joint stiffness.

P2-E-28 Postural adaptation to contracting vs expanding optic flows

Guillaume Giraudet[1], Clementine Faron[1], Jocelyn Faubert[1]

[1]Universite de Montreal

BACKGROUND AND AIM: The aim of the study was to determine the effect of visual adaptation for contracting and expanding optic flows on postural response. METHODS: Twelve subjects participated in the experiment. They stood in a fully immersive virtual reality environment. The stimulus was a 3D

textured tunnel, either static or moving forward (expansion) or backward (contraction) at 3 different speeds: 0.275, 1.1 and 4.4 m/s. Each trial was composed of 3 stages. The first one was called "Baseline", during which the tunnel was static. It lasted 2 seconds. Then the stimulus started to move forward or backward for 10, 20 or 40 seconds; "Adaptation" stage. For the third, "post-adaptation" stage the stimulus suddenly halted and remained static for 15s. Optical motion sensors, located on the stereoscopic goggles, were used to track and register body movements. Behavioral reactions to the various visual conditions were described by comparing postural stability between the 3 different stages described above. RESULTS: Results showed that subjects get adapted to the expansion optic flows. The longer the adaptation stage lasted, the higher the postural response was. A similar effect was observed when movement speed increased. However, we did not measure any adaptation for the contraction optic flow. In this direction, postural behavior remained constant during the whole sequence, that is, during all 3 different stages of presentation and for all moving scene speeds. CONCLUSIONS: The current study confirms that expansion and contraction optic flows are processed differently and have different impacts on visuomotor systems. Several neurophysiological and imaging studies reported an expanding motion bias represented as greater activation in motion sensitive cortical areas than for contraction optic flow (Ptito, Kupers, Faubert, Gjedde, 2001). Our results highlight that, in the context of visually guided actions the control of body posture changes when the properties of the expanding optic flow are modified but it does not respond to properties of moving scenes in contraction.

P2-E-29 The influence of height-induced anxiety on human gait characteristics during aperture crossing

Amy Hackney[1], Luke Denomme[1], Michael Cinelli[2], Jim Frank[3]

[1]University of Waterloo, [2]Wilfrid Laurier University, [3]St. Jeromes University

AIM: When passing through apertures, individuals rotate their shoulders for spaces less than 1.3 times their shoulder width and pass straight through spaces larger than this ratio (safety margin)[1]. Research to date has examined the safety margin under normal walking conditions along level terrain however, research has not yet examined how robust this safety margin is during more challenging situations such as walking on elevated or narrow surfaces. Since previous research has demonstrated that standing[2] and walking[3] on raised surfaces increases anxiety and alters postural control and gait characteristics, the current study aimed to determine if height-induced anxiety during gait may also lead to changes in the size of the safety margin. It was hypothesized that walking on an elevated surface would lead to more cautious behaviours in young adults as demonstrated through reductions in walking speed and a larger safety margin. METHODS: Young adults (N=8) walked along a 7m path and were required to pass through two vertically oriented obstacles which were positioned 5m from the start. The obstacles ranged in widths of 1.1-1.7 times each participant' shoulder width in increments of 0.2. Participants completed three walking conditions which increased in task difficulty: 1) normal ground walking; 2) constrained-path ground walking (20cm wide) and; 3) raised-platform path walking (20cm wide x 40cm high). Each walking condition consisted of three trials of each aperture width (36 trials total). RESULTS: Analysis revealed that participants maintained an average safety margin of 1.3 for all walking conditions. However, individuals produced significantly smaller shoulder rotations at apertures requiring a rotation in the heightened path (avg=40.9deg) compared to normal walking (avg=58deg) ($p<0.05$). Additionally, a main effect of walking condition was identified for both walking speed ($p<0.05$) and medial-lateral trunk variability ($p<0.001$). Pairwise comparisons identified that both variables decreased in the heightened

path compared to normal walking. Lastly, perceived anxiety increased and confidence decreased as the task difficulty increased. Normal and constrained-path ground walking were not significantly different from one another in any of the variables examined. CONCLUSIONS: Consistent with previous research[2,3], gait characteristics, perceived anxiety and confidence were influenced by walking at elevated heights. Additionally, the current study showed that individuals will rotate their shoulders less when passing through apertures smaller than the safety margin even though the average safety margin (1.3) was not affected. The results demonstrate that walking at elevated surfaces induces cautious behaviours that aim to minimize the disruption of balance without altering the affordance of aperture crossing. REFERENCES: [1]Warren & Whang, JExp Psych: Hum Percep Perform, 1987 [2]Adkin et.al, Gait Posture, 2000 [3]Brown & Gage EBR, 2002.

P2-E-30 Energy adaptations of the trunk during transitions from level to inclined surfaces

Glynnis Pardo[1], Stephen Prentice[1]

[1]University of Waterloo

BACKGROUND & AIM: The purpose of the proposed research is to quantify the energy adaptations of the trunk during the transition from level to inclined walking. The transition from a level to an inclined surface presents a number of challenges to the locomotor control system.[1] Healthy young adults adopt more cautious gait patterns when transitioning between level and inclined surfaces.[2] Adaptations include increased base of support, decreased velocity,[2] and elevated toe clearance.[1] Examination of the transition from level to inclined walking have shown the gait pattern adapted for transition is distinct from steady state and graded to the incline.[1,2] Small but significant changes in trunk orientation occur in response to increased postural and propulsion demands associated with the change in orientation of the support surface.[1] These changes during transition have been hypothesized for the maintenance of the orientation of the head.[3] It was hypothesized that adaptations would directly grade to changes in inclination. METHODS: Four healthy young adults. (21.9 yrs, 170.1 cm,71.7 kg) Motion was measured using 6 bank OPTOTRAK Certus Motion Capture System sampling, 128Hz. 25 Smart Markers arranged on 5 rigid bodies, tracked unilateral limb motion of the foot, shank, thigh, pelvis, and trunk. A digitizing probe was used to create imaginary markers for the tracking of boney landmarks and characterization of limb motion. Participants ascended a 3m walkway inclined at 3, 6, 9, & 12°from level. First contact with the ramp occurred in mid-stance. Data was filtered using a second order Butterworth filter with frequency cutoff 6Hz. Data was interpolated using a cubic spline, with maximum gap 10. An average stride for each inclination was computed by averaging of five strides. Each stride was time normalized from heel contact of step immediately preceding contact with ramp to the next consecutive heel contact of the same foot. Peak kinetic and potential energy and rate of increase were measured during the transition from level to four different inclined surfaces. RESULTS: No differences in potential energy were measured during changes in inclination. Timing of kinetic energy peak was consistent for each inclination. Kinetic energy peak and rate increased with increases in grade; largest peaks occurring at 12° inclination. CONCLUSIONS: The consistency of potential energy regardless of inclination confirms the role of the trunk for maintaining the orientation of the head. There would appear to be increased energy demands as ramp inclination increases, especially at the higher grades. Specific differences with slope demands will aid in the identification of slope transitions requiring substantive changes. [1] Prentice et al. (2004) Gait Posture.20(3):255-65. [2] Gottshall et al. (2011) J

Appl Biomech 27(4):355-61. [3] Cooper et al. (1989). Canadian Journal of Occupational Therapy 56 (3) 120-127.

P2-G-31 Examining the sensory integration deficit hypothesis in adolescent idiopathic scoliosis: the case of proprioceptive information

Christine Assaiante[1], Fabien Cignetti[1], Jean-Luc Jouve[2], Gérard Bollini[2], Marianne Vaugoyeau[1]

[1]CNRS - Aix-Marseille Université, [2]Hopital de la Timone

Background and aim: Although the aetiology and pathophysiology of adolescent idiopathic scoliosis (IS) is still not well understood, an increasing number of studies suggest that deficits in sensory integration could contribute to the cause of IS. In particular, proprioceptive processing may be atypical in adolescent IS, leading to inappropriate motor commands and balance control problems. Accordingly, the aim of the present study was to examine whether deficits in proprioceptive integration are present in adolescent IS. Methods: 17 adolescents with IS (age = 11-18 years), 17 age-matched control adolescents, and 12 healthy adults (age = 20-40 years) took part into the study. Vibratory stimulations (90 Hz) were applied either to the Achilles tendons while the subjects were standing with the eyes open or closed or to the tibialis anterior tendons while the subjects were sitting with the eyes closed. Proprioceptive integration was evaluated from vibration-induced backward postural adjustment in the former condition and illusory movements (i.e., ankle plantarflexion illusion) in the latter condition. Results: We found two important findings: 1) the vibration-induced postural reaction was more important in control adolescents than in adults, with visual information enabling them to reduce this exaggerated reaction; and 2) the control adolescents perceived larger illusory plantarflexion movement at the ankle as compared to the adults. On the other hand, we did not observe any difference between adolescents with IS and age-matched controls regarding vibration-induced postural reaction and ankle illusory movement. The only difference between the two groups was a tendency in adolescents with IS to rely more heavily on vision during the postural task. Conclusions: The ability to integrate proprioceptive information is maturing the same way in adolescents with IS and age-matched controls. Accordingly, a specific dysfunction of proprioceptive processing seems not to underlie IS, which may rather be related to alterations of the reweighting mechanisms involved in multisensory integration.

P2-G-32 Vestibular assessments in children with global developmental delay: An exploration of test-retest reliability of three evaluation tools.

Elizabeth Dannenbaum[1], Lora Salvo[2], Victoria Horne[3], Farwa Malik[3], Anouk Lamontagne[2]

[1]Jewish Rehabilitation Hospital, [2]Feil and Oberfeld Research Centre of the Jewish Rehabilitation Hospital, [3]School of Physical and Occupational Therapy, McGill University

BACKGROUND AND AIM:Children with Global Developmental Delay (GDD) are not routinely evaluated for vestibular disorders, yet cumulative evidence suggests that vestibular integration may be affected in this population. In order to assess the impact of vestibular rehabilitation in children with GDD, it is important to have reliable tests of postural control and gaze stability. The aim of this research was to evaluate the test-retest reliability of the Clinical Test for Sensory Organization and Balance (CTSIB), the manual Dynamic Visual Acuity test (DVA), and the Manual Rotary Chair test (MRC), in children with GDD. A secondary objective was to compare the MRC and CTSIB scores of children with GDD to those of healthy children. METHODS:Twenty children diagnosed with GDD (aged 4.1-12.1 yrs, mean of 7.9 yrs)

were recruited from the Jewish Rehabilitation Hospital (JRH). A convenience sample of eleven staff children (aged 4.7 -12.2yrs, mean of 7.2 years) were used as healthy age-matched controls. GDD participants underwent two sessions of testing over a one-to-four week period. Each session consisted of administering the CTSIB, DVA, and MRC. The MRC was tested twice, each with a different method of preventing post-rotation visual fixation: once with infrared goggles and once with a visor which blocked frontal vision. Control participants were evaluated over one session with the CTSIB and MRC. RESULTS:The CTSIB, which comprises of 6 conditions during which the time a position can be maintained is recorded, showed a range of interclass correlation coefficients (ICCs) that varied from 0.32 to 0.79. The ICCs obtained for the durations of post-rotatory nystagmus on the MRC ranged from 0.76 to 0.78 with the goggles and from 0.56 to 0.65 with the visor. For the DVA, a Kappa coefficient of 0.4 was obtained. Children with GDD had significantly lower scores in all conditions with the exception of condition one (floor standing, eyes open) on the CTSIB ($p<0.05$,t-test) yet showed similar durations of post-rotatory nystagmus on the MRC compared to healthy controls ($p>0.05$, t-test). CONCLUSIONS:The CTSIB, MRC and DVA demonstrated fair to strong test-retest reliability, suggesting that these clinical tests can be used to monitor changes in postural control and gaze stability in children with GDD. The altered CTSIB results in the GDD group indicate that this population display abnormal postural control, possibly due to altered sensory integration.

P2-J-33 Postural control in individuals with spinal cord injury: Training, functional performance, and mechanisms

Anna Bjerkefors [1], Jordan Squair[2], Zhen Chen[3], Tania Lam [3], Mark Carpenter [3]

[1]The Swedish School of Sport Sciences, [2]University of British Columbia, School of Kinesiology, [3]University of British Columbia, School of Kinesiology

BACKGROUND AND AIM: Postural control in sitting is essential for people with spinal cord injury (SCI). Studies indicate that impaired postural control is related to decreased propulsion efficiency, respiratory dysfunction and development of pressure sores. Despite this, there is limited knowledge on the best methods to rehabilitate postural control in people with SCI and if and by what mechanism persons with high-thoracic SCI may improve their postural control. Thus, our aims were to 1) determine the efficacy of targeted rehabilitation towards postural control in people with SCI, and 2) investigate the neural mechanisms behind any observed improvements. METHODS: Persons with SCI completed 30 sessions over 10 weeks of a) seated double poling ergometer (SDP) training (n=13) or b) kayak ergometer (KE) training (n=10). Before and after functional tests were performed and included: sit-and-reach tests, propelling 15m on a level surface and propelling 50m up a 3º incline. Additionally, subjects sat in their wheelchair while support-surface translations were presented (KE) or performed isometric maximal voluntary contractions in a dynamometer during trunk flexion and extension (SDP). To investigate neural mechanisms of postural control improvement, electromyographic (EMG) responses in the ventral postural muscles to maximal voluntary contractions and transcranial magnetic stimulation (TMS) were assessed in 5 individuals with motor complete SCI above T6. RESULTS: Postural stability was improved after KE and SDP training demonstrated by smaller rotational and linear displacements of the trunk during support surface translations (KE) and improved postural muscle strength (SDP). There were also significant improvements in propelling tasks and in the sit-and-reach tasks, both in the sagittal plane (SDP) as well as in lateral directions (KE). All persons with motor complete SCI above T6 (n=5) were able to elicit task specific EMG activity in the ventral postural muscles during maximal voluntary contractions

despite their clinical classification. Motor evoked potentials were also recorded in each individual´s ventral postural muscles in response to TMS, confirming corticospinal pathway preservation. CONCLUSIONS: Postural control, upright sitting, and functional performance in daily life activities can be improved in people with high-thoracic SCI during regular exercising, such as kayaking and seated double poling ergometer training. The neural mechanism behind the improvement is in part due to partial preservation of the corticospinal pathways to the postural muscles as confirmed by the use EMG and TMS.

P2-J-34 Baseline White Matter Lesions do not Minimize the Benefit of Resistance Training on Mobility and Balance: Results from a 12-Month Randomized Controlled Trial

Elizabeth Dao[1], Niousha Bolandzadeh[1], Roger Tam[1], Lindsay Nagamatsu[1], Liang Hsu[1], David Li[1], Teresa Liu-Ambrose[1]

[1]University of British Columbia

BACKGROUND AND AIM: Maintaining mobility is essential for healthy aging and to function autonomously within society. Evidence from randomized controlled trials (RCT) suggests that targeted exercise training, such as resistance training (RT), can promote mobility in older adults. The origins of impaired mobility are multiple, including structural changes to the brain. Specifically, white matter lesions (WMLs) are associated with impaired mobility. These lesions are due to damage to the brain parenchyma, ranging from demyelination to complete axonal disruptions, and are prevalent among functionally independent community-dwelling older adults. The presence of WMLs may minimize the benefits of targeted exercise training on mobility among older adults. Thus, we aimed to assess whether or not WMLs may moderate the benefit of progressive RT on mobility and balance in community-dwelling older women. METHODS: Participants were a subset of 155 cognitively intact community-dwelling older women, aged 65 to 75 years old. All women were participants of a 12-month RCT designed to primarily assess the effect of RT on executive functions. Participants were randomly assigned to either: 1) twice-weekly resistance training (2xRT); 2) once-weekly resistance training (1xRT); or 3) twice-weekly balance and tone exercises (BAT; control group). Assessments of cognitive function and falls risk were conducted at baseline, 6 months, and trial completion (i.e., 12 months). Structural MRI was acquired at baseline. A battery of neuropsychological tests was administered to assess executive functions. The Short Physical Performance Battery (SPPB) was used to assess general mobility and balance. To identify WMLs, seed points were manually placed on co-registered pairs of T2-weighted/PD-weighted MR images and a semi-automatic region-growing method was used to generate lesion masks to quantify WML volumes. Statistical analyses included a linear regression model in which SPPB score at trial completion was entered as the dependent variable and baseline SPPB score, experimental group, and baseline WML volume were entered as independent variables. Baseline WML volume was entered last to assess whether or not it would significantly change the model. RESULTS: Of those who completed baseline MRI, 47 had pre-existing WMLs. After 12 months of training, participants of the 2xRT significantly improved their SPPB score compared with those in the BAT group ($p=0.034$). Participants of the 1xRT also improved compared with those in the BAT group, but failed to reach statistical significance (0.069). Results of the linear regression indicated baseline WMLs did not significantly moderate the benefits of RT on SPPB performance ($p=0.618$). CONCLUSIONS: These novel RCT results suggest that targeted resistance training is beneficial for promoting mobility and balance among older adults - even those with existing WMLs.

P2-J-35 Development of a rating scale for perceived stability during balance training

Debbie Espy[1], Nathan Casey[1], Tony Wiland[1], Natalie Kuchta[1], M Reinthal[1]

[1]Cleveland State University

BACKGROUND AND AIM: Video gaming is used increasingly as a means of balance training in physical therapy settings and has been shown to be equally or more effective than traditional PT for balance re-training in a number of patient groups. Advantages to video gaming as a therapeutic tool or adjunct include generating more practice repetitions and greater task engagement, the wide array of games which present challenges to the gamer in multiple domains, and the ease with which the balance environments can be manipulated simultaneously with the tasks. There is little research available, however, regarding how to quantify the therapeutic aspects in order to appropriately scale and progress the balance tasks. Across exercise types, initial load (e.g., intensity, difficulty, excursion) and decisions to increase or decrease the load are determined by initial and ongoing measurements of the person's ability to manage the load (e.g., lift a weight a certain number of times, run at a given speed with a given heart rate response, move a joint through a certain range of motion). In the Rate of Perceived Exertion (RPE) and the (similar) Borg scale, people rate their own perception of their exertion; there is no objective measure or outside scorer. Both have been shown to be valid measures of aerobic exercise intensity and are commonly used to set initial and subsequent aerobic training levels. There is not currently a scale used to self-rate a person's perception of the challenge to their balance posed by a given activity. The aim of this study was to create a "self rating of balance difficulty scale" to allow clinicians to assess the response of clients to balance activities, facilitating more effective modulation and progression of the training program. METHODS Using the Borg Scale/RPE as a model, we created a scale for participants to rate their perceived stability or balance difficulty during gaming on balance surfaces. Iterations of the scale were used by subjects playing video games specifically chosen to challenge postural control in different ways and on different therapeutic balance training surfaces. Changes were made at each iteration to the number of levels in the scale, the appearance and presentation of the scale, and the descriptors of the levels. RESULTS: Feedback from the subjects at each iteration was used to refine the scale for the next group. The final version was successfully used by 11 subjects and is presented in this poster. CONCLUSIONS: As there is no objective measure of difficulty of balance for task/environment/person interactions, a self-rated scale of balance or postural control difficulty presents an intriguing option. The RPS developed here may prove useful in assessing a patient's ability to manage a balance task in much the same way that the RPE scale is used to assess ability to manage a physical exertion, allowing difficulty of the program to be set and advanced appropriately.

P2-J-37 Effects of proprioceptive Exercises for Patients with Chronic Low Back and Neck Pain: A Systematic Review

Michael McCaskey[1], Corina Schuster-Amft[2], Nicole Wenderoth[1], Eling de Bruin[1]

[1]ETH Zurich, [2]Reha Rheinfelden

Background: Arbitrary modification of proprioception through exercise is widely debated. Nonetheless, proprioceptive training (PrT) is popularly applied as preventive or rehabilitative exercise method in various sports and rehabilitation settings. Its effect on pain and function is only poorly evaluated. This

systematic literature review aimed at summarising and analysing the existing data on the effects of PrT in rehabilitation of chronic (>3 months) neck- or back pain patients on pain alleviation and functional restoration. Methods: Relevant electronic databases were searched from their respective inception to December 2012. Randomised controlled trials of intervention studies comparing PrT with conventional therapies or with no interventions in patients with neck- or low back pain (chronic or recurring) were included. Only studies reporting at least one pain and functional outcome were selected. Two review authors independently screened articles for inclusion criteria and assessed risk of bias (RoB). Reference lists of included articles were reviewed for further citations. Data extraction was performed by the first author and cross-checked by the second author on three randomly selected references. Results: In total, 15 studies involving 1304 subjects described interventions related to PrT (years 1994-2012). 5 studies focussed on neck- , 10 on low back pain. PrT was described as discriminatory perceptive exercises with somatosensory stimuli to the back, as postural control or balance exercises on labile surfaces, or as head relocation practice with head-eye coordination. Pain outcomes included numeric pain rating or visual analogue scales; functional outcomes included Oswestry Disability Index, the Neck Disability Index, the Roland-Morris-Questionnaire, or self-developed questionnaires. Other outcomes assessed range of motion, joint repositioning accuracy, and pressure plate posturography. In 7 studies, PrT was incorporated within a multimodal intervention. Comparators entailed usual care, home based training, educational therapy, or strengthening, stretching and endurance training. In one study, the intervention was placebo-controlled. Quality was fair to good (PEDro 4-10/11) and RoB was deemed moderate. From the 4 studies reporting significant group effects in favour of the proprioceptive intervention, 1 was compared to a control intervention group while the others were compared to non-exercise interventions. Conclusions: There are only few relevant good quality studies on proprioceptive exercises. Clinical and methodological heterogeneity as well as missing data hinder quantitative analysis of the studies. A descriptive summary of the evidence shows that there is no consistent benefit in adding proprioceptive therapy to conventional therapy when compared to other exercise interventions.

P2-J-38 The effects of walking on fall prevention in lower-risk community-dwelling older adults

Yoshiro Okubo[1], Yosuke Osuka[1], Songee Jung[1], Raphael Figueroa[1], Takehiko Tsujimoto[1], Tatsuya Aiba[1], Teho Kim[1], Kiyoji Tanaka[1]

[1]University of Tsukuba

Background and aim: We have previously reported that a 3-month walking exercise intervention in the lower-risk community-dwelling older adults show significant improvements on dynamic balance/strength, and walking speed, similarly with a balance and strength training. The purpose of this study was to examine the effects of walking on fall occurrence during 1 year follow-up in the lower-risk community-dwelling older adults. Methods: A total of 110 men and women aged 65-79 years, who had no or only one fall risk factor (fall history in 1 year, 4 or more medications, depressive symptom, assistive device, mobility limitation, poor balance) were included in the study. The participants were allocated to either the walking or balance group. The participants attended supervised (brisk walking or tai chi, balance, and strength training) and home-based exercise programs (self-paced walking or balance and strength training, 3 to 5 days per week) for 3 months (Month 1 to 3). After the exercise intervention, the participants of the both groups were asked to continue the home-based exercise programs for 12 months (Month 9 to 15). Falls and their circumstances during the follow-up were

monitored by monthly fall calendars mailed to and from the participants. Differences in the time to the first falls, number of falls and trips, circumstances of falls among the walking and balance group were tested using Log Rank test, Poisson regression analysis, and Chi-square test / Fisher's exact test, respectively. Results: During the follow-up, 27.4% in the walking and 27.1% in the balance group experienced at least one fall. The Log Rank test showed no group-difference in the time to the first falls (P = 0.872) (Figure 1). The Poisson regression analysis showed that the walking group tended to experience fewer falls (incidence rate ratio [IRR]: 0.72, 95% confidence interval [CI]: 0.40-1.30) and trips (IRR: 0.83, 95% CI: 0.65-1.06) than did the balance group. Fallers in the walking group were more likely to fall during walking (59.1% vs 31.6%, P = 0.059), less likely to fall during standing up (0.0% vs 18.8%, P = 0.066), sitting down (0.0% vs 18.8%, P = 0.066), and resulted in a scratch/cut (27.3% vs 0.0%, P = 0.030), compared to those in the balance group. Although, no other differences in the circumstances were observed between the both groups, majority of the falls were caused by trips (60.5%), fell in forward direction (71.1%), and resulted in no injury (47.4%) and bruise (31.6%). No fracture in the walking group and one fracture occurred in the balance group. Conclusions: Walking program can be as effective as balance and strength training to reduce the number of falls among lower-risk community-dwelling older adults. Strategies to prevent trips during walking and prevention of injury were warranted to maximize the effects of walking as a fall prevention program.

P2-J-39 Locomotor and respiratory adaptability and interactions post-stroke

Cynthia Otfinowski[1], Jadranka Spahija[1], Joyce Fung[1]

[1]McGill University

BACKGROUND AND AIM: Consequences of a stroke may include reduced depth of breathing and walking speed. Since hemi-paretic gait has higher oxygen cost, treating these impairments may improve the exercise capacity in individuals post-stroke. A dynamic interaction between walking and breathing cycles has been shown in healthy, young individuals but not in people post stroke. Here, we investigate how increased walking speed impacts the depth of breathing (i.e. tidal volume) in healthy and post-stroke individuals and the effect of deep breathing on walking speed. We hypothesized that increased gait speed would increase the depth of breathing and reciprocally, increased depth of breathing would increase gait speed, in both groups. METHODS: Participants with a unilateral, cortical stroke and healthy individuals (sex- and age-matched by group) performed one session of four walking trials on a self-paced treadmill. Participants walked for two minutes at a comfortable or fast walking speed, while either breathing quietly or deeply. For each group, we recorded the breathing and walking patterns using a pneumotachograph and a VICON motion analysis system, respectively. Primarily, we were interested in the interaction between tidal volume and gait speed. Furthermore, we measured respiratory rate and minute ventilation in breathing, as well as step velocity, step length, swing and stance time in walking. RESULTS: Increasing the walking speed from comfortable to fast resulted in a small but significant decrease (8%) in tidal volume (from 1.25 to 1.15L) in people post-stroke while deep breathing (p=0.01; n=13). In contrast, there was a 25% increase in tidal volume (from 1 to 1.25L) in control participants with quiet breathing during fast-paced walking (p=0.01; n=10). Conversely, increasing depth of breathing induced a 14.3% increase in gait speed in people post-stroke (from 0.42 to 0.48 m/s, p=0.003) during comfortable-paced walking, whereas the control group was only minimally affected (with 4.6% increase, from 1.51 to 1.58 m/s, p=0.04) even during fast-paced walking. CONCLUSIONS: Contrary to our expectations, increased gait speed decreased tidal volume while deep breathing for people post-stroke.

This suggests that respiratory muscles prioritize postural stability over deep breathing at fast walking speeds. However, deep breathing while walking at a comfortable pace, could lead to increased gait speed post stroke. Hemi-paretic gait has higher oxygen cost and increased supply of oxygen to the muscles may facilitate faster gait speeds.

P2-J-40 An Intensive Exercise Program Improves Motor Performances in Patients with Dementia: Translational Model of Geriatric Rehabilitation

Michael Schwenk[1], Ilona Dutzi[2], Bijan Najafi[1], Jane Mohler[1], Klaus Hauer[3]

[1]University of Arizona, [2]Bethanien-Hospital at the University of Heidelberg, [3]Bethanien Hospital at the University of Heidelberg

BACKGROUND AND AIM: More that 50% of geriatric patients undergoing rehabilitation are cognitively impaired, demonstrating the need for effective rehabilitation exercise programs for those experiencing cognitive decline. However, the translation of intensive exercise programs developed specifically for patients with dementia into clinical settings is lacking. The aim of the present study was to implement a progressive resistance and functional training program, previously evaluated in dementia outpatients, in a geriatric inpatient setting in order to improve motor performances in patients with dementia. METHODS: Patients with confirmed mild to moderate dementia in one ward of a German geriatric hospital were assigned to the intervention group (IG, n=74) and received intensive group-based strength and functional training daily for up to two hours. The training program was specifically designed for patients with dementia. Patients in a second ward in the same hospital were observed as a control group (CG, n=74). All patients received usual care treatment. Primary endpoints were maximal lower extremity strength measured by a leg-press device and duration of the 5-chair-stand test for functional performance. Secondary outcomes included a number of parameters for strength and function. RESULTS: The sample population (mean age: 84.1 years) comprised of multimorbid inpatients with impaired cognitive, psychological and functional status. The rehabilitation period averaged 18.1 days. Patients attended 64.1% of the resistance training sessions and 60.4% of the functional training sessions. The IG significantly improved in both primary endpoints (change: maximal strength, IG: +51.9% vs CG: +13.5%, $p<.001$; functional performance, IG: +19.2% vs CG: +3.8% sec, $p=.037$). Secondary outcomes confirmed effects for strength and some but not all functional parameters. Interestingly, low baseline functional status, but not cognitive status, predicted positive training response. CONCLUSIONS: An intensive exercise program can be implemented in a geriatric rehabilitation setting to improve motor performances in patients with dementia. Patients may benefit from the dementia-adjusted group-based exercise training irrespective of the level of cognitive impairment, and thus may not in principle be excluded because of presence of dementia. The intensive exercise program may be recommended to promote functional recovery in geriatric inpatients with dementia and acute functional impairment.

P2-K-42 Reactive Gait Transitions Improve after Induced Stepping Training

Woei-Nan Bair[1], Robert Creath[1], Masashiro Fujimoto[1], Andrea Gaeta[1], Janice Abarro[1], Sandy McCombe-Waller[1], Michelle Prettyman[1], Brock Beamer[1], Mark Rogers[1]

[1]University of Maryland, Baltimore

Background and aim: Perturbation-based balance training leads to improved reactive protective stepping in older adults. However, it is less studied whether medio-lateral (M-L) step training transfers to other activities such as gait transitions, and, if so, whether transferability varies with different types of interventions affecting M-L stability. The aim of this study was to compare the effects of training on reactive gait transitions among four types of fall prevention interventions: hip abductor-adductor muscle strengthening (HST), M-L induced step training (IST), combined HST & IST (COM), and a control group with stretching, flexibility and relaxation exercises (SFR). We hypothesized that individuals receiving IST or COM would show greater improvements in reactive gait transition performance. Methods. Thirty-five community-dwelling older adults were stratified according to their self-reported fall history in the preceding year and randomly assigned to 4 training intervention groups. Training involved 36 sessions over 12 weeks (HST:n= 9, mean age 72.5±8.1; IST: n= 7, 75.0±7.7; COM:n= 8, 74.7±6.0; SFR:n= 11, 70.9±4.7). Gait variables were collected on a GAITRite electronic walkway. Subjects first performed level over-ground walking at their self-selected speed. Mean level walking parameters were calculated and normalized to height and cycle times. Reactive gait transitions were tested by giving a "walk fast" instruction to subjects while they walked with self-selected speed. Gait transition performance was normalized to each participant's self-selected walking. Gait spatio-temporal parameters were analyzed for five consecutive steps for each gait transition event: two steps before, one transition step, and two steps after transition. For each variable at each step, a separate mixed ANOVA model was used to test group by time of testing (baseline & post-training tests) and interaction followed by post-hoc analyses. Results: For level walking, there were no significant group or time of testing effects, and baseline reactive gait transitions were not different between groups. IST showed a significant training effect for reactive gait transitions. For the transition step (the leg started loading when instruction was given) the IST group had a shorter double support unloading time ($p=0.008$) and longer swing time ($p=0.014$); for one step after transition, shorter step time ($p=0.035$), double support time ($p=0.07$) and double support loading time ($p=0.005$) with longer step length ($p=0.014$) and wider step width ($p=0.025$). These training effects are consistent with an improved reactive transition to faster walking. Conclusions: Our hypothesis is partially supported in that only IST showed transfer of training effects to gait transitions, but not the COM group. It is possible that the interaction of the two training interventions in the COM group may contribute to this lack of immediate training effects. [Supported by NIH AG033607, NIDRR H133P100014]

P2-K-43 Fall risk prediction in high-functioning community-dwelling older adults: Reconsideration of clinical balance measures

Chitra lakshmi K Balasubramanian[1], Dawn Saracino[1], Rob Robinson[1], Amber Boyette[2], Peter Wludyka[1]

[1]University of North Florida, [2]University of Central Florida

BACKGROUND AND AIM: Gait and balance deficits are common risk factors for falls and need to be examined accurately to identify persons at risk for falling and design targeted interventions. Recent reports suggest that majority of currently-used gait and balance assessments poorly discriminate fallers from non-fallers in high-functioning community-dwelling older adults. We hypothesized the addition of a harder more challenging assessment for this high-functioning population may improve discrimination between fallers and non-fallers. Additionally, we hypothesized that altering cut-off scores of currently-used gait and balance assessments might enhance sensitivity of discrimination for high-functioning older adults. Therefore, the purposes of this study were to determine the clinical assessments of gait and

balance that discriminate fallers from non-fallers and compare the discriminatory accuracy of data-driven cut-off scores to those proposed in the literature in high-functioning community-dwelling older adults. METHODS: 39 active and ambulatory older adults (73.4 ± 6.9 years) participated in the study. Number of falls in the past year quantified falls risk. Seven clinical assessments of gait and balance were used as predictors of fall risk. The recently validated and challenging assessment of Community, Balance & Mobility Scale (CB&M) was also included. Logistic regression models investigated those assessments that discriminated both 'recurrent fallers' (≥2F) from those with fewer or no falls and those who fell 'one time or more' (≥1F) from non-fallers. Area Under the Curve (AUC) evaluated the discriminatory power. Sensitivity, specificity and diagnostic odds ratios were computed for data driven cut-off scores and literature-based scores and evaluated the discriminatory accuracy. RESULTS: The CB&M was the only significant predictor ($p = 0.0498$) of 'one or more falls' in the past year (≥1 F). Four predictors significantly ($p < .05$) predicted 'two or more falls' in the past year (≥2 F) and included CB&M. Discriminatory powers of these four predictors of ≥2 F were not significantly different (AUC = 0.77 - 0.80, $p>0.05$), but CB&M had the highest AUC index (0.80). Data-driven cut-off scores enhanced sensitivity of discrimination (with varying effects on specificity) when compared to the literature-based cut-off scores (figure 1). CONCLUSION: CB&M scale may be considered as an assessment for fall risk prediction in high-functioning community-dwelling older adults since it was the only predictor of 'one or more falls' and 'two or more falls' in the past year, had the highest discriminatory power, and demonstrated high sensitivity in discrimination of fallers from non-fallers. While currently-used clinical assessments had the ability to discriminate fallers from non-fallers, previously reported cut-off scores have lower discriminatory accuracy suggesting a re-consideration of cut-off scores for the high-functioning community-dwelling older adults.

P2-K-44 The role of proprioception during postural control in elderly and Parkinson's Disease patients with a history of falls

Esther Bekkers[1], Kimberly Dockx[1], Sabine Verschueren[1], Elke Heremans[1], Sarah Vercruysse[1], Alice Nieuwboer[1]

[1]KULeuven

BACKGROUND AND AIM: Age- and disease related proprioceptive deficits have been associated with loss of postural stability. The role of proprioception in balance control and how impaired proprioception is related to falls is still a relatively unexplored area. The aim of this study was to investigate how proprioception relates to balance control during static and dynamic posturography tasks in fallers with and without Parkinson's disease (PD). METHODS: Nine PD patients and nine age-matched elderly with both a history of falls participated in the study. Balance parameters were measured by force plates under static and dynamic conditions. Perceived limits of stability (LoS) were derived from the differences between maximal center of pressure (CoP) displacement in anterior-posterior (AP) and medio-lateral (ML) direction during a maximal leaning task. Quiet standing conditions comprised standing with eyes open (EO) or eyes closed (EC), with (20s) and without (20s) Achilles tendon vibration (ON/OFF). CoP displacements were calculated for the various conditions and expressed as a ratio of their respective LoS. Statistical analysis comprised of mostly nonparametric tests. RESULTS: The perceived limits of stability were not significantly different between groups. However, groups differed for the ratios of postural sway in relation to their LoS in the AP direction in different conditions. Patients with PD had more relative sway during eyes open ($p = 0.0111$) and closed ($p = 0.0199$) than elderly fallers (EF) when

vibration was ON. Furthermore, when standing with eyes closed, PD fallers responded with significantly greater postural sway upon tendon vibration in AP direction ($p = 0.0141$). Comparing the various conditions across groups revealed that in ML direction, both elderly and PD fallers had larger CoP displacements with vibration ON, irrespective of whether the eyes were open ($p = 0.0382$ EF, $p = 0.0117$ PD) or closed ($p = 0.0077$ EF, $p = 0.0173$ PD). CONCLUSIONS: The comparison between PD and healthy fallers showed the largest postural instability deficits occurred in the PD group during proprioceptive disturbances. These results suggest that patients with PD appear to focus even more on ankle proprioceptive input than elderly fallers. In addition, the fallers with PD responded with greater AP sway upon Achilles tendon vibration, bringing them closer to their perceived limits of stability and possibly setting the scene for falling.

P2-K-45 Adaptations to large-scale treadmill-based perturbation training:Improvements in spatial and temporal parameters of the reactive response

Tanvi Bhatt[1], Prakruti Patel[1]

[1]University of Illinois at Chicago

Background and Aims: Unlike other fall-prevention protocols, perturbation-training, an emerging paradigm, is still in its infancy. Previous laboratory based studies have demonstrated the mechanisms of training-induced adaptive improvements to overground slips, i.e., improved slip outcomes, stability and compensatory stepping response. The exact mechanisms of treadmill-based perturbation training where, the perturbation intensity is experimenter controlled (unlike overground slips) and adaptation dependent predominantly on reactive mechanisms, however, remain to be determined. The purpose of this study was to examine the trial-to-trial changes in the neuromechanical response to large-magnitude, treadmill induced, slip perturbations in standing. We hypothesized that repeated perturbations would result in significant reactive improvements in both temporal and spatial components of the recovery response. Methods: 20 young subjects after being given two familiarization trials were exposed to a pre-test slip (forward) perturbation (displacement of 0.38m and acceleration of 21 m/s2). Subjects were then trained at a lower level intensity (displacement of 0.28m and acceleration 16.75 m/s2) by exposing them to a block of 10 slip perturbations. A post-test consisting of a single perturbation as the pre-test was performed. Kinematic data was recorded using a passive marker system and EMG from bilateral tibialis anterior muscles recorded via wireless sensors. The reaction time (EMG onset), compensatory step characteristics (step initiation time and backward step length) and trunk stability were computed and analyzed. Results: There was a significant training-induced trial-to-trial change in, reaction time compensatory step kinematics and trunk ankle ($p < 0.01$ between 1st and 10th trial). There was an inverse relationship between compensatory step length and trunk angle, with increasing backward step length resulting in decreased trunk extension ($p < 0.05$ for all variables). These changes were reflected on the post-test trial. Compared to the pre-test trial subjects demonstrated significantly faster step initiation (M = 0.225s, SD = 0.02 to M = 0.177s, SD = 0.02), a greater backward step length (M = 239.08 mm, SD = 141.81-to M = 288.28, SD = 79.59) and reduced trunk extension (M = 19.39 degrees, SD = 5.92 to M = 16. 61 degrees, SD = 6.62) ($p < 0.05$ for all variables). Conclusions: The results demonstrate the possibility of inducing reactive adaptation within the central nervous system upon exposure to threatening external perturbations. The significant change demonstrated on the post-test conducted at a different intensity that the training lends evidence towards training-induced implicit (trial-error) adaptive learning that could be generalized to a wide range of perturbation profiles. Further

studies should examine the possibility of enhancing such implicit adaptation via other explicit feedback, for longer-term retention.

P2-K-46 Temporal and kinematic parameters of real falls recorded from older adults using accelerometers attached to the lower back.

Alan Bourke[1], Lorenzo Chiari[2], Aminian Kamiar[3], Clemens Becker[4], Lars Schwickert[4], Jochen Klenk[4]

[1]EPFL, [2]University of Bologna, [3]Ecole Polytechnique Fédérale de Lausanne (EPFL), [4]Robert Bosch Hospital

BACKGROUND AND AIM: Body worn inertial sensor technology is capable of distinguishing falls from normal activities with high levels of accuracy [1], however there is a fundamental lack of substantial real-world fall data recorded from older adults to develop appropriate fall detection algorithms [2]. The FARSEEING project (farseeingresearch.eu) aims to compile a database of real-world falls harvested from elderly people using body worn inertial sensors [3]. We aim to extract temporal and kinematic parameters to inform the development of fall detection algorithms from a harvested data-set of 29 real-world falls. METHODS: The data was recorded using a tri-axial accelerometer attached at L5 harvested from older adult volunteers aged 50-81 years (67.1±7.92 years). Post fall interviews were performed to determine the cause, pre-fall activity and location of the fall. The following temporal and kinematic parameters were extracted [4]. The maximum upper and lower peak acceleration values (UPV and LPV), time taken to fall tfalling , the maximum angle during the fall θmax and the time when the maximum angle occurred tθmax relative to the UPV. These extracted parameters relate to the "falling phase" and the "impact phase" that occur during a fall as described by Becker et al [5]. RESULTS: The maximum and minimum fall UPV's were 8.41g and 1.59g respectively, Table 1. The 1.59g value occurred when the subject fell backwards when trying to sit down, the maximum LPV (0.82g) also occurred indicating a "soft" fall. The minimum LPV (0.044g), indicating a high vertical acceleration, occurred when the subject fell backwards from a standing position. The maximum and minimum times taken to fall were 2.15 seconds and 0.03 seconds. The time for tθmax ranged from -0.46 to 0.71seconds before and after the UPV occurred, indicating that the impact shock occurs before the trunk reaches it maximum posture angle. CONCLUSION: Post-fall interviews were used to gather information about the fall. The definition of a fall may have been interpreted differently by the faller thus some situations could also be described as stumbles. In conclusion we have extracted a number of temporal and kinematic parameters from a data set of real-world falls harvested from older adults which can inform the development of fall-detection algorithms using a tri-axial accelerometer. REFERENCES: [1] T. Shany, et al. Sensors Journal, IEEE, 12(3), 2012. [2] L. Schwickert, et al. Gerontologie und Geriatrie, 46(8). 2013. [3] J. Klenk, et al. Med Eng Phys, 33(3), 2010. [4] A. K. Bourke, et al. IEEE EMBC, pp. 4449-52, 2011. [5] C. Becker, et al. Gerontologie und Geriatrie, 45(8). 2012.

P2-K-47 Safety on stairs: influence of a tread edge highlighter and its position

Richard Foster[1], John Hotchkiss[1], David Elliott[1], John Buckley[1]

[1]University of Bradford

BACKGROUND AND AIM:Falls sustained when descending stairs are the leading cause of accidental death in older adults [1]. Highly visible edge highlighters/friction strips (often set back from the tread edge) are sometimes/often present on stairs, but the usefulness of either is unclear. The aims of this study were to determine whether the presence of an edge highlighter and its location relative to the

tread edge affected foot placement/clearance and accidental foot contacts when descending stairs. METHODS:Older adults with normal vision (N = 16, Experiment 1) and young adults with a simulated visual disability (N = 8, Experiment 2) completed step descent trials during which a high contrast tread edge highlighter was either not present (plain), placed flush with the tread edge (abutting), or set back from the edge by 10mm or 30mm. Foot placement prior to the step edge, foot clearance over the step edge, and the number of accidental foot contacts were compared across conditions. RESULTS: Experiment 1: There were no differences in stepping characteristics between the abutting highlighter condition and plain tread surface, whereas foot placement and clearance were significantly reduced when the edge highlighter was set back by 30 mm ($p < 0.001$) in comparison to plain or abutting. In addition, the number of low clearances (< 5mm) increased from 8% (plain) and 2% (abutting) to 17% when the edge highlighter was set back by 30 mm. Experiment 2: When comparing the abutting highlighter condition to a plain tread surface, within-subject variability in foot placement ($p = 0.038$) and horizontal foot clearance ($p = 0.022$) decreased, the number of low clearances (< 5mm) reduced from 8% (plain) to 0% (abutting), and the number of accidental foot contacts reduced from 15% (plain) to 3% (abutting). When the tread edge highlighter was set back by 30 mm foot clearance was significantly reduced in comparison to abutting ($p = 0.001$), and 10% of trials had foot clearances less than 5mm. CONCLUSIONS:The results indicate that the presence of a tread edge highlighter can significantly influence foot placement and clearance during stair descent, and that the location of the highlighter relative to the edge of the tread impacts upon the risk of tripping in visually normal adults and more so in adults with a simulated visual disability. These findings suggest that building regulation specifications should be updated to highlight the importance of having tread edge highlighters on step and stairs and to stress the importance of their relative positioning. In summary, findings indicate that to improve stair safety a tread edge highlighter should be present and positioned flush with the edge of the tread or as near to this as possible. Refs: [1] Startzell et al. J Am Geriatr Soc, 48:567-580, 2000.

P2-K-48 Associate factors to fear of falling in elderly with Parkinson's disease

Erika Franzén[1], Maria Hagströmer[1], David Conradsson[1], Maria Nilsson[2]

[1]Karolinska Institutet, [2]Lund University

Background and aim: Fear of falling (FoF) is common in the elderly and is increased in neurological disorders such as Parkinson's disease (PD). Many factors are suggested to be associated with FoF in individuals with PD such as falls and disease severity, yet many factors are unknown. Our aim was to determine whether FoF in elderly with mild to moderate PD differ between groups in terms of personal factors (age, gender, falls, walking aids and time since PD-diagnosis), physical performance factors (balance and gait performance) and physical activity (steps per day). Methods: Eighty-nine participants (39 females), mean age 73 years (range, 61-87) with mild to moderate PD (Hoehn & Yahr 2 to 3) were included (baseline data from a randomized controlled intervention study). Data collection contained two steps, firstly demographic data, questionnaires (FoF) and physical performance tests (Mini-BESTest, pull-test and gait), and secondly, measurement of physical activity during free living conditions (accelerometers for seven consecutive days). FoF was assessed with the Falls Efficacy Scale-international (FES-I), which consists of 16 activities (items) scored from 1 to 4. The total score ranges from 16-64, higher scores indicates more concern about falling. Based on prior cut-off values described for PD, data were dichotomized as follows: Personal factors: age (cut-off ≥72years), gender (male/female), time since diagnosis (≥5 years), walking aids (yes/no) and experience of at least one fall

the last year (yes/no), Physical performance factors: Mini-BESTest scores (≤19), pull test (normal/abnormal response), walking velocity (≥ 1m/s), and physical activity (≥5000 steps/day). Mann-Whitney U-test was used to describe FES-I in relation to these factors and groups. Results: Median FES-I scores were 28 (range 17-63). Participants who were physically active had significantly (p=0.033) lower scores on the FES-I compared to the inactive group. Moreover, those with poorer balance had significantly higher scores on the FES-I compared to those with better balance score (Mini-BESTest, p=0.017 and pull-test, p=0.015). A tendency was seen towards a higher score on the FES-I for those with a gait speed below 1 m/s (p=0.068). Participants with walking aids also reported significantly higher levels of concern on the FES-I (p<0.001). However, FES-I scores did not differ in relation to personal factors such as age, gender, time since PD-diagnosis and falls during the last year. Discussion: Results imply that FoF is higher in elderly with PD who are physically inactive, have poorer balance control and walk with a walking aid. Hence, this study suggests that FoF in elderly with mild to moderate PD is related to physical activity and physical performance factors rather than personal factors. Longitudinal studies using multivariate analysis are however warranted.

P2-K-49 Validity and Reliability of Psychological Measures Related to Fear of Falling in Older Community-Dwelling Individuals

Laura Hauck[1], Mark Carpenter[2], James Frank[3]

[1]University of Waterloo, [2]University of British Columbia, [3]St. Jerome's University

BACKGROUND AND AIM: Fear of falling (FOF) is common in elderly individuals. A prevalence of 54% has been reported in community-dwelling elderly and nearly forty percent of those individuals curtailed their activities of daily living as a result of their fear. Increasing attention has been devoted to psychological issues as they relate to falls with a handful of constructs emerging as the most studied and widely-recognized; fear of falling, falls efficacy and balance confidence. Despite increased devotion to measurement of psychological issues, consensus among researchers and/or clinicians has not been reached regarding a criterion measure to assess psychological factors as they relate to falls and fall-risk. This study was designed to explore the experimental and construct validity as well as test-retest reliability of task-specific balance confidence and fear of falling scales, state anxiety questionnaires, and the Activities-specific Balance Confidence Scale (ABC). METHODS: Thirty-two elderly participants aged 65-89 living independently in the community were recruited. Procedures were approved by the University of Waterloo Office of Research Ethics. Participants performed one-leg stance (OL) and functional reach (FR) under cognitive loading and/or postural threat conditions, and reported on psychological measures during rest periods. This procedure was repeated on a second occasion for each participant to assess test-retest reliability of the dependent measures. RESULTS: The reliability of OL times and FR distance was acceptable, with ICC values ranging from 0.50 to 0.73. Psychological measures also demonstrated acceptable reliability, with ICC values ranging from 0.48-0.78. General fear of falling demonstrated reliability comparable to condition-specific fear of falling ratings with an ICC of 0.64. Ratings on the ABC demonstrated excellent reliability, with an ICC of 0.89. Reliability of retrospective fall reports was only moderate with a kappa value of 0.60. Under both threatening and non-threatening conditions, higher levels of balance confidence were associated with better performance on the one-leg stance task. Under threatening conditions, lower levels of anxiety were related to better performance on one-leg stance tasks. The more generalized measures (ABC and general fear of falling) were unrelated to performance of either the OL or FR tasks. CONCLUSIONS: State-

specific psychological measures are distinct constructs and are not synonymous with more global measures of psychological state. The state anxiety questionnaire and the Activities-specific Balance Confidence Scale demonstrated strong internal consistency and factor analysis showed that both are multi-dimensional. When correlation and reliability analyses are considered together, it is recommended that relationships between and among psychological constructs and balance performance be evaluated in a situation-specific manner.

P2-K-51 Higher involvement of executive dysfunction in serious falls will fracture than in slight falls

Kristell Pothier[1], Christian Marcelli[1], Valérie Caridroit[1], Pablo Descatoire[1], Pascale Lescure[1], Antoine Langeard[1], Nicolas Bessot[1], Chantal Chavoix[1]

[1]Inserm, U[1]0[75], COMETE

? BACKGROUND AND AIM: Implication of cognitive impairment in falls is now well-acknowledged. The risk of falling is significantly higher in older adults with cognitive decline than in cognitively normal adults (Montero-Odasso et al., 2012 for a review). A few studies suggest preferential involvement of executive dysfunctions in fall risk (Hausdorff et al., 2006; Muir et al., 2012). Relationship between executive function and gait has also been reported (Yogev-Selimann et al., 2008 for a review). What about serious falls, especially falls with bone fracture? To our knowledge, the issue of specific gait and cognitive profiles in injured fallers with fracture has not yet been addressed. The main objective of this study is to determine whether executive dysfunctions could play a higher role in fractures post-fall than in falls without fracture. The issue of a different gait profile between both groups of fallers is also raised. ? METHODS: Fifty injured fallers with fracture (34 with an upper-limb fracture and 16 with a lower-limb fracture) and 32 slight fallers (fall that did not require medical consultation), aged 55 and more, took part in this study. The participants underwent gait and cognitive assessments. Gait evaluation, mainly based on the "Timed-Up and Go" (TUG) complex walking test, was performed in the slight fallers and in fallers with upper-limb fracture only. The Montreal Cognitive Assessment (MoCA) was used to evaluate global cognitive efficiency. Various cognitive domains (executive functions, attention, memory...) were also selectively explored using both specific tests (analyses in progress) and the MoCA subtests. ? RESULTS: A significant negative Pearson's correlation was found between the MoCA score and the TUG duration ($r=-0.53$; $p<0.001$); this relation was even stronger when considering only the executive subtest of the MoCA ($r=-0.55$; $p<10-5$). Intergroup comparisons, as assessed with analyses of covariance (ANCOVA) with age as a covariate, did not reveal significant intergroup difference for the TUG duration but showed significantly lower MoCA score in the injured fallers than in the slight fallers ($p<0.05$). When focusing on the subtests of the MoCA, the intergroup difference was even stronger with the executive subtest ($p<0.01$) whereas it was not significant for the memory subtest. ? CONCLUSIONS: These preliminary results confirm the role of executive dysfunction in complex walking. They also suggest major involvement of executive dysfunction in fracture post-fall. We hypothesize that a fracture post-fall would result from poor planning and lack of foresight both before and during the fall. Further investigations are, nonetheless, required to determine whether slight fallers and injured fallers with fracture also show distinct gait profile.

P2-K-52 Exploring the causes of falls and balance impairments in people with neuropathy

Gita Ramdharry[1], Magdalena Dudziec[1], David Tropman[2], Liz Dewar[3], Amanda Wallace[3], Matilde Laura[3], Robert Grant[1], Mary Reilly[3]

[1]Kingston University/St George's University of London, [2]St George's hospital NHS trust, [3]Centre for Neuromuscular Diseases, UCL/UCLH

Background and Aim: Falls are commonly reported by people with Charcot-Marie-Tooth disease (CMT). To successfully manage the problem of falls there needs to be greater understanding of the causes of balance and gait impairment. This study explores balance performance and falls frequency in people with CMT, to ascertain the relationship with their clinical presentation. Methods: People with CMT and matched healthy controls were recruited. Quantitative lower limb muscle testing, sensory measures, disease severity (CMT examination Score -CMTES), functional balance scales (Tinetti Balance Scale, Berg Balance score, Bruininks Osteretsky Test -BOT) and self-reported balance and walking questionnaires (Modified Falls Self Efficacy scale -mFSE, Walk-12) were administered. Falls events were recorded over 6 months using weekly postcards for participants with CMT to record falls or near falls. Kinematic and kinetic analysis of walking and balance was performed in all subjects. Group comparisons were performed using unpaired t-tests and Mann-Whitney U tests, depending on data type. Correlations were investigated using Pearson's and Spearman's tests. Significance was set at $p<0.01$ to account for multiple comparisons. Results: (1) Group comparison: To date, 12 of the target 30 people with neuropathy have been recruited and 16 of 30 control subjects. Kinematic and kinetic analysis of balance and gait are yet to be analysed. Early results demonstrate significant worse functional balance performance for people with CMT (BOT: $z = -3.67$, $p<0.01$; Berg: $z = -3.73$, $p<0.01$; Tinetti: $z = -3.73$, $p<0.01$). Self-reported balance confidence and walking performance were also worse in people with CMT (mFSE: $z = -4.18$, $p<0.01$; Walk-12: $z = -4.04$, $p<0.01$). People with CMT were significantly weaker in the distal muscles, had higher vibration thresholds and reduced light touch sensation. (2) Balance performance: People with CMT demonstrated strong negative correlations between balance performance measured by the BOT and Berg Balance Scale versus CMTES (BOT: $p<0.01$; Berg: -$p<0.01$), vibration threshold at the malleoli (Berg: $p<0.01$), tibia (BOT: $p<0.01$; Berg: $p<0.01$) and dorsiflexor strength (BOT: $p<0.01$; Berg: $p<0.01$). (3) Falls frequency: People with CMT fell an average of 5±6 times in 6 months and reported 7±12 near falls. Falls frequency was most closely, though not significantly, related to the BOT score ($r = -0.68$, $p<0.05$) for functional balance. Vibration disappearance threshold at the malleolus and tibia were the only impairment measures related to falls frequency ($p<0.01$). Conclusions: This early analysis indicates that people with CMT have greater distal weakness and sensory impairment than healthy controls that relate to worse functional balance performance. The rate of actual falls, however, relates to sensory impairment only. This may be because of poorer perception of balance threat leads to a delay in a corrective motor response.

P2-K-53 Margin of dynamic stability (mds) during walking combined with grasping in fallers older adults

Natalia Rinaldi[1], Renato Moraes[2]

[1]School of Medicine of Ribeirao Preto, University of São Paulo, [2]School of Physical Education and Sport of Ribeirao Preto, University of São Paulo

BACKGROUND AND AIM: The incidence of falls is high during locomotion tasks. Furthermore, the risk of falling increases when two motor tasks are combined. However, it is not known the effect of an

additional task, such as grasping an object, on walking dynamic stability control of older adults with history of falls. This analysis can help understanding how a history of falls could influence the dynamic stability control when walking is combined with grasping. The aim of this study was to investigate MDS in both AP and ML directions when walking was combined with grasping in older adults with history of falls. Moreover, it was investigated how this control was modified due to increased grasping task difficulty. METHODS: Ten right-handed older adults with history of falls (73.8 ±5.7 years old) in the last year participated in this study and were invited to perform two tasks: free walking and walking combined with grasping an object. This object was positioned on the right side over a support adjusted to the participants' greater trochanter height. In all conditions, the object was placed on a wood cylindrical support. This support was stable (wide base) or unstable (narrow base). For each type of support, there were three obstacle conditions: none, short and long distances. For the short and long distances, the object was placed between two wood obstacles. The short distance corresponded to three times the right hand thickness, whereas the long distance corresponded to five times the right hand thickness. The level of difficulty of these conditions was the distance between the obstacles and type of support. For each condition, 3 trials were collected. These trials were completely randomized. Data collection was performed using a 8-camera motion analyses system (VICON) at a sampling frequency of 100 Hz. Passive reflective markers were placed on the skin at defined landmarks according to the Plug-in-Gait Full Body model. Center of mass position was calculated based on this model by the NEXUS software. The extrapolated center of mass was computed for calculation of the MDS. MDS was calculated at heel contact for the step corresponding to object contact (N) and two heel contacts before grasping (N-2, N-1). Metatarsal and heel markers on both feet were used to define the extremities of the foot and to compute MDS in the AP and ML directions, respectively. RESULTS: ANOVA revealed condition effect ($F_{6,54}=4.78$, $p=0.008$) for MDS just in AP direction. MDS AP was greater for walking and grasping combined for all manual task conditions (0.08 m ±0.03) than free walking task (0.04 m ±0.01). CONCLUSIONS: These results show that fallers older adults increased their MDS for grasping an object during walking, regardless of the manual task difficulty. This finding suggests that walking combined with grasping is a challenging task for fallers older adults. These finding contradicts young adults results, since they modulated MDS according to manual task difficulty.

P2-K-54 The influence of the content of speech production and perception on gait variability

Katie Sheehan[1], Rose Kenny[2], Isabelle Killane[3], John Gormley[4], Tim Foran[5]

[1]Vancouver Coastal Health Authority, [2]Technology Research for Independent Living, [3]Trinity Centre for Bioengineering, Trinity College Dublin, [4]Discipline of Physiotherapy, Trininty College Dublin, [5]St James? Hospital

BACKGROUND: Recently movement related language (when compared to non movement related language) was found to refine overt motor behaviour of the upper limb (1). Furthermore increased corticospinal excitability of bilateral leg muscle representations was shown to be enhanced by speech production and perception (2). The effect of language content on gross motor function of the lower limbs is not well understood. Should the content of language influence characteristics of gait this should be accounted for clinically by rehabilitation programs. The current study sought to determine the effect of movement related (e.g. step, lunge) and non movement related (e.g. cat, house) speech production and perception on gait variability. METHODS: Twelve healthy subjects were matched by height (mean±standard deviation: age: 26.0±4.0years; height: 164.6± 1.8cm). Participants were required to

listen to movement and non movement related pros, and to read movement and non movement related words projected onto a screen while ambulating at 3.5 m/s on a treadmill. Increased variability of minimum ground clearance and temporal-spatial parameters have previously been associated with an increased falls risk. These parameters were extracted from a CODAmotion system (Charnwood Dynamics, England). Coefficients of variation were calculated and paired t-tests generated to assess for significance between test conditions. Alpha was set at ≤ 0.05. RESULTS: Battery failure resulted in complete data being collected for eight participants. As compared to non movement speech perception, minimum ground clearance ($p \leq 0.001$) and stride width ($p = 0.01$) variability were significantly reduced when speech perception was movement related. The content of speech perception had no influence of stride time variability for the current cohort ($p = 0.2$). Similarly the content of speech production had no effect of the variability of minimum ground clearance ($p = 0.5$), stride width ($p = 0.2$) or stride time ($p = 0.9$). When comparing movement related speech perception and production the variability of minimum ground clearance was significantly lower for speech perception ($p = 0.03$). CONCLUSION: Movement related speech perception reduced the variability of minimum ground clearance and stride width when compared to non movement related speech perception. These parameters have been previously been associated with an increased falls risk. This was found for a group of young healthy adults. Should this translate to the older adult population the content of language could represent a progression in dual task rehabilitation for falls risk and neurological rehabilitation. REFERENCES: 1.Fargier R, Menoret M, Boulenger V et al. Grasp it loudly! Supporting actions with semantically congruent spoken action words. PLOS One 2012;7(1). 2. Liuzzi G, Ellger T, Floel A et al. Walking the talk-speech activated the leg motor cortex. Neuropsychologia 2008;(46).

P2-K-55 Exergaming for fall risk reduction: Investigating older players' movement characteristics

Nina Skjæret[1], Ather Nawaz[1], Kristine Ystmark[1], Jorunn Helbostad[1], Beatrix Vereijken[1]

[1]Norwegian University of Science and Technology

Background: Exergames are increasingly used as an intervention to reduce fall risk in elderly. However, few exergames were designed specifically for elderly and most empirical studies used (modifications of) off-the-shelf exergames originally intended for younger players, which can have important limitations when used in older persons. For example, we lack knowledge about the characteristics of the movements elicited by different exergames and thereby about their potential to train functions important for fall risk reduction, such as the ability to shift body weight and flexibility in size, direction, and speed of stepping movements. Aim: To compare the movement characteristics elicited by three off-the-shelf stepping exergames in senior citizens. Methods: Fourteen senior citizens (mean age 73 years ± 5.7, range 65 - 85) played three stepping exergames in a laboratory: a modified version of DanceDanceRevolution (originally developed as a children's game), LightRace from X-box (developed for general training purposes), and The Mole from SilverFit (developed as a training tool for elderly). Five movement characteristics (weight shift; variation in step length, speed, and movement direction; visual attention) were scored by three movement scientists on a 5-point Likert scale based on video-observations of each player and each game. Disagreement was resolved by consensus. Scores on individual characteristics and sum score were analyzed with 1-way ANOVAs on the three exergames. Results: The Mole received the highest sum score and the best individual score on each of the five movement characteristics (all p's < .0005). LightRace scored lowest on weight shift and variation in

movement direction (both p's<.0005). DDR scored lowest on step length variation and visual attention (p<.03 and p<.0005, respectively), and lower than The Mole on speed variation (p<.05). Discussion: The Mole scored best in terms of eliciting movement characteristics shown to be important to reduce fall risk. The differences in movement characteristics were closely related to the exergame characteristics. For example, LightRace and DDR are played in confined space which constrains movement possibilities and, hence, these exergames were less successful in eliciting variations in step length and movement direction. Furthermore, only the Mole required a full weight shift; the other games allowed the player to make partial weight shifts or just tap the foot. If exergames are to be used successfully as a training tool to reduce fall risk, they must entice the player to make a variety of movements. In addition, they must gear visual attention to an overall task objective, not the details of the movements. Encouraged by the results of the current qualitative study of movement characteristics, a second study is ongoing where 3D motion capture is used to quantify movement characteristics objectively and in more detail. The results of the second study will be included in the presentation.

P2-K-56 Biomechanical and Physiological Determinants for Hip Impact during Falls in Older Adults

Yijian Yang[1], Dawn Mackey[1], Teresa Liu-Ambrose[2], Stephen Robinovitch[1]

[1]Simon Fraser University, [2]University of British Columbia

BACKGROUND: Over 90% of hip fractures in older adults are caused by falls [1], and the risk for hip fracture increases 30-fold by landing on the hip [2]. An improved understanding of factors that separate falls that result in hip impact, from those that do not, may generate new opportunities for hip fracture prevention. In this study, we analyzed real-life falls captured on video in long-term care (LTC) to determine the biomechanical and physiological factors that contribute to hip impact. METHODS: Over a 5-year period (2008-2013), we captured 960 falls experienced by 306 residents (mean (SD) age = 81±10; 57% female). Each video was analyzed by a 3-member team using a validated questionnaire [3] to determine whether impact occurred to the hip or hand, the initial fall direction and landing configuration, and attempts to recover balance by stepping or grasping. For individuals who provided written consent, we also collected information related to physical and cognitive function, disease diagnoses, and use of medications from the computerized Minimum Data Set system. We used generalized linear statistical models to calculate the odds ratio (OR) for hip impact associated with the various factors. RESULTS: Hip impact occurred in 42% (n=397) of falls, in which 6 cases resulted in hip fracture. There was no difference in risk for hip impact between falls initially directed forward versus sideways (OR=0.9 [95% CI 0.6-1.3]). Falling forward or sideways was associated with higher odds of hip impact, compared to falling backward (4.2 [2.8-6.2] and 5.0 [3.7-6.9], respectively) and straight down (5.5 [3.1-9.5] and 6.5 [4.0-10.6], respectively). Sideways landing created higher odds of hip impact than landing forwards (4.3 [8.2-25.1]) or backwards (48 [31.7-71.6]). In 32% of sideways falls, individuals rotated to land backward, which substantially reduced the odds for hip impact (0.023 [0.011-0.047]). Probability for hip impact also associated with dependency in daily activities (2.5 [1.2-5.2]) and impaired cognition (2.9 [1.3-6.5]). This followed from a decreased tendency for body rotation for individuals with impaired physical function (0.44 [0.17-1.16]) or cognitive function (0.11 [0.03-0.46]). CONCLUSIONS: Impact to the hip occurred in over 40% of falls in older adults residing in LTC. Hip impact was equally likely in falls initially directed forward as sideways. This was due to the tendency for axial rotation of the body in the backward direction during descent. Risk for hip impact was lowest in falls that were initially

directed backward or straight down. In nearly one third of sideways falls, individuals rotated to land backward, and this decreased the odds of hip impact 44-fold. Individuals with impaired physical and cognitive function were at higher risk of hip impact, due to the decreased tendency to rotate. These results may contribute to improvements in risk assessment and exercise-based strategies to reduce risk for hip fracture in older adults.

P2-L-57 Wearable Auditory Biofeedback of gait for persons with Parkinson's Disease

Alberto Ferrari[1], Filippo Casamassima[2], Pieter Ginis[3], Eran Gazit[4], Laura Rocchi[2], Moran Dorfman[4], Alice Nieuwboer[3], Lorenzo Chiari[2]

[1]University of Bologna, [2]Universita' di Bologna, [3]KU Leuven, [4]Tel-Aviv Sourasky Medical Center

BACKGROUND and AIM: Gait difficulties are disabling signs of Parkinson's disease (PD) with a strong impact on everyday activities and QoL. Auxiliary auditory cueing techniques have recently shown the potential for improving gait performance [1]. Inertial measurement units (IMUs) associated with a smartphone as processing unit allow for unobtrusive and ecologically valid data collection, enabling the possibility to continuously monitor patients and at the same time provide audio-feedback (AF) in a closed-loop modality. Our aim was to test the feasibility and user-satisfaction of an easy-to-use, wearable and stand-alone system based on IMUs as sensing units and a smartphone as processing unit and feedback provider. METHODS: The system was designed in order to provide instructions usually reported to patients by clinicians during ambulatory gait rehabilitation. The system was designed in order to be able to compute step length, cadence, gait speed asymmetry and foot clearance in real-time and to provide vocal feedback or support every time patients walk respectively out of- or close to- their best performance. The system was tested at home on 8 patients along multiple sessions and days. RESULTS: To make the system usable in everyday life by PD patients directly, the IMUs were limited to 2 units fastened on the shoes. A stand-alone Android app was developed with a single button interface for patients to start and stop the training. The software architecture comprises three main threads: i) an online automatic algorithm able to estimate initial contact and foot-off events, similarly to [2]; ii) a pedestrian dead-reckoning algorithm able to estimate step length, similarly to [3] and iii) a package of objects able to realize a closed loop AF by comparing online gait parameters with reference values (Fig.1). The reference values are set once with patients walking at their best. During training the system compares gait parameters with references providing periodically vocal support or tutoring messages. Noteworthy, the application automatically increases or decreases the difficulty of the task in case the patient is able or unable to remain regularly within the target zone. Using a questionnaire, the average scores obtained for system sensitivity, independent usability and comfort weree, respectively: 4.2, 3.8 and 4.1 (1 = low satisfaction 5 = high satisfaction). In addition, the feedback was found appropriate and meeting patients' needs. CONCLUSION: An Android application was developed based on the use of two inertial sensors aimed at providing tutoring vocal messages to Parkinson's patients from online gait analysis. The system resulted easily usable and highly sensitive to patients' gait pattern. ACKNOWLEDGEMENTS: EU-FP7/2007-2013 grant agreement n°288516 (CuPiD project). REFERENCES: [1] Nieuwboer A et al, J Neurol Neurosurg Psychiatry 2007; 78(2): 134-40. [2] Ferrari A et al, Gait & Posture 2013, 37(S1): S27. [3] Nilsson JO et al. (2012) PLANS,

P2-L-58 Is perception of vertical impaired in individuals with chronic stroke with a history of 'pushing'?

Avril Mansfield[1], Roshanth Rajachandrakumar[2], Lindsey Fraser[3], Cynthia Danells[4], Svetlana Knorr[1], Jennifer Campos[1]

[1]Toronto Rehabilitation Institute, [2]University of Waterloo, [3]York University, [4]Sunnybrook Health Sciences Centre

BACKGROUND AND AIM: Up to 65% of individuals with stroke demonstrate a behaviour known as 'pushing' [1], characterized by a shift in body weight towards the paretic side and a resistance to correction to a symmetrical posture. Previously, researchers have demonstrated that individuals with pushing have a contralesional tilt of subjective visual vertical (SVV) and subjective postural vertical (SPV) [2]. Pushing behaviour typically resolves with rehabilitation and recovery from stroke; however, it is not known if the misperception of vertical persists. The purpose of this study is to determine if SVV and SPV are impaired among chronic stroke survivors with a documented history of pushing behaviour. METHODS: Preliminary data are presented for one individual with chronic right-hemisphere stroke (80 years old, >6 months post-stroke) and 10 healthy controls (55-79 years old) with no history of stroke or other neurological condition; data for a larger sample of stroke survivors with and without history of pushing will be presented at the conference. The stroke participants' Scale for Contraversive Pushing [3] score was 3 (out of 6) early post-stroke, and 0 at the time of assessment. For assessment of SPV and SVV, participants sat upright on a chair in a virtual reality laboratory surrounded by a completely immersive curved projection screen. The laboratory was placed on a 6-degree of freedom motion base. The SVV was assessed using a forced-choice protocol. Participants viewed a line projected on the screen and were asked to indicate if they felt the line was tilted to the right or the left for 30 trials. For the SPV, participants wore a blindfold and the motion base was randomly tilted to the left or right by between 10°, 15°, or 20° (6 trials total, 1 trial per direction and initial angle). Participants were then asked to direct the angular movements of the motion base until they felt upright. 95% confidence intervals (CI) were calculated for the SPV and SVV for controls, and the stroke participants' data were compared to these ranges; negative values indicate a leftward bias. RESULTS: The SVV for controls was -0.7°, 95% CI [-1.6°, 0.3°] and the SPV was -0.3°, 95% CI [-1.3°, 0.7°]. The stroke participant had a negative bias for both the SVV (-2.5°) and SPV (-0.7°); the SPV was within the controls' 95% CI but the SVV was below the lower limit of the 95% CI. CONCLUSION: Individuals with a history of pushing behaviour post-stroke may have continued misperception of vertical, even when pushing behaviour resolves. The impact of continued misperception of vertical on postural control and mobility is currently not known. FUNDING: This study is supported by the Canadian Partnership for Stroke Recovery. REFERENCES: [1] Danells CJ et al, Stroke 2004;35:2873-2878; [2] Pérennou DA et al, Brain 2008;131:2401-2413; [3] Karnath HO et al, Neurology 2000;55:1298-1304

P2-L-59 Adapted tango alters center of mass displacement and muscular activity during reactive balance in individuals with Parkinson?s disease

Johnathan McKay[1], Lena Ting[1], Madeleine Hackney[2]

[1]Emory University and Georgia Tech, [2]Emory University School of Medicine

BACKGROUND AND AIM: Adapted tango dance (AT) has improved clinical balance and gait measures in individuals with Parkinson's disease (PD) via unknown neural mechanisms. Compared to age-matched individuals, during automatic postural responses to perturbations individuals with PD exhibit atypical electromyographic (EMG) responses with increased co-contraction between agonist and antagonist

muscles and increased displacement of the center of body mass (CoM). The aim of this study was to assess the efficacy of AT in reducing co-contraction and CoM displacement during postural responses in individuals with PD. METHODS: While ON medications, 22 participants (7 female) with mild-moderate PD (Hoehn and Yahr stages 2-3) underwent clinical assessments of PD symptoms, balance, and gait before and after high volume AT. Twenty individuals completed 15, 1.5 h lessons within 3 weeks. Of these 20 individuals, nine (2 female) participants were also assessed before and after treatment with forward and backward support-surface translation perturbations (displacement: 7.5 cm; velocity: 15 cm/s; acceleration: 0.1 g). Surface EMG from tibialis anterior (TA) and medial gastrocnemius (MG) was recorded and synchronized with kinematics and ground reaction force data. EMG onset and offset times were identified and mean EMG levels were calculated over a time window 100 - 600 ms after perturbation onset. Repeated measures ANOVAs were used to identify changes in clinical measures and reactive balance measures after AT. Spearman correlations were used to determine the association of change in clinical measures with change in reactive balance measures. RESULTS: At post-testing, participants (n=20) improved on the Berg Balance Scale ($p<0.001$; effect size $d=0.66$), Fullerton Advanced Balance Scale ($p<0.001$; $d=0.55$), Dynamic Gait Index ($p<0.01$; $d=0.53$), preferred ($p<0.01$; $d=0.54$) and fast cadence ($p=0.03$; $d=0.44$), and Unified Parkinson's Disease Rating Scale Motor Subscale-III ($p<0.01$; $d=-0.42$). Participants in the reactive balance group (n=9) also exhibited significant reductions in peak CoM displacement ($p=0.03$; $d=-0.26$), increases in antagonist onset time ($p<0.03$; $d=0.60$) and decreased agonist EMG mean level ($p=0.03$; $d=-0.52$) during support surface perturbations. Significant correlations were identified between changes in reactive balance measures and changes in clinical measures, including between BBS and CoM displacement (rho=-0.68; $p=0.04$) and antagonist offset time (rho=0.84; $p=0.04$). CONCLUSIONS: Adapted tango beneficially altered clinical measures of balance ability, reduced CoM displacement and may have potentiated reduced co-contraction during postural responses to perturbations. Studying neuromuscular activity before and after balance rehabilitation may provide insight into potential neural mechanisms underlying the recovery of balance in individuals with PD through rehabilitative means.

P2-L-60 Dynamic balance while walking on a treadmill with a load on the ankle in hemiparetic individuals

Carole Miéville[1], Séléna Lauzière[2], Martina Betschart[2], Sylvie Nadeau[2], Cyril Duclos[2]

[1]École de réadaptation, Université de Montréal; CRIR (IRGLM), [2]École de réadaptation, Université de Montréal; CRIR, site IRGLM

BACKGROUND AND AIM: Gait pattern and balance ability of hemiparetic individuals are altered following a stroke. In neurorehabilitation, adding a load to a body segment is an approach that could improve the gait pattern. However, its effects on balance during gait are unknown. The aim of this study was to determine the effects of a load on the ankle on dynamic balance during walking in hemiparetic individuals. METHODS: Eighteen hemiparetic individuals (6/18 women, 48.9 (SD: 12.7) years and 6/18 left stroke) with moderate to severe motor and balance impairments (overground self-selected speed: 0.51-1.40m/s; Chedoke McMaster Stroke Assessment foot/leg (/7): 1-7/3-7; Berg Balance Scale (/56): 49-56) were recruited. Participants were evaluated under three walking conditions at a self-selected speed: 1) without a load; 2) with a load on the non-paretic ankle; and 3) with a load on the paretic ankle. The load was equivalent to 3% of the participant's body weight. Difficulty in maintaining postural and dynamic balance during walking was quantified from kinematic and kinetic data extracted from a 3D

whole-body motion analysis system and an instrumented treadmill and by using the concepts of destabilizing (postural component) and stabilizing (dynamic component) forces. Analyses of variance (repeated measures ANOVA) and paired t-tests were used to compare participants and walking conditions. RESULTS: Difficulty in maintaining postural balance during walking decreased by 5.8% with the addition of a load on the ankle, regardless of the side to which the load was applied but dynamic balance difficulty remained unchanged. This was associated with an increase in vertical ground reaction forces, with no change in position and velocity of the centre of mass or position of the centre of pressure. Moreover, the percentage of support on the paretic side increased and the single support time became less asymmetrical with the load on the non-paretic ankle ($p<0.001$). CONCLUSIONS: The addition of a load on the non-paretic ankle seems to improve postural balance and symmetry during gait in hemiparetic individuals, without affecting dynamic balance difficulty. Balance results need to be confirmed by analyzing trunk kinematics and other gait parameters. Analyzing ankle loading during overground locomotion and in healthy age-matched individuals will help clinicians understand the rehabilitation potential of this intervention for hemiparetic individuals. This project is being funded by the OPPQ/REPAR partnership. Séléna Lauzière, Carole Miéville and Martina Betschart are supported by Ph.D. scholarship from CIHR-Vanier, FRQ-S and SMRRT (CIHR), respectively.

P2-L-61 Timing of providing ankle-foot orthoses in (sub)acute stroke patients: first results on balance-related measures of mobility

Corien Nikamp[1], Jaap Buurke[1], Marc Nederhand[1], Johan Rietman[1], Hermie Hermens[1]

[1]Roessingh Research & Development

BACKGROUND AND AIM: Falls are highly prevalent after stroke, potentially resulting in fractures. This might substantially impair health and participation. Ankle-foot orthoses (AFOs) are often used to improve balance and safety after stroke. However, scientific evidence about long-term effects of AFO-use after stroke is lacking and no generally accepted guidelines for timing of AFO-provision after stroke are available. The aim of this study is to determine the longitudinal effects of timing of providing AFOs in the rehabilitation process after stroke, including the effects on balance related measures of mobility. METHODS: (Sub)acute stroke patients with AFO-indication admitted to the rehabilitation center were included and measured bi-weekly for 17 weeks, with a follow-up measurement at week 26. Two groups with different randomized moments of AFO-provision were compared: "early" (AFO-provision at inclusion) and "late" (AFO-provision 8 weeks later). The study protocol included clinical outcome measures related to balance and mobility: Berg Balance Scale (BBS), Functional Ambulation Categories (FAC), and Rivermead Mobility Index (RMI). Results over time (week 1, 9, 17 and 26) of both groups were compared using a mixed model analysis. Furthermore, survival analysis (Kaplan Meier) was used to compare the time until independent walking (FAC ¡Ý 4) was reached, and the time to reach a score above the threshold for increased fall-risk (threshold is BBS < 45) between both groups. RESULTS: Analysis included 25 subjects (early N=15, late N=10), of which 3 subjects (all early) are still enrolled in the study (measurements completed up to week 17). Both groups have shown progress over time on BBS, FAC and RMI, with higher scores in the early AFO-group. Only the BBS showed statistically significant differences between the early and late group over time ($p=0.030$). Time until independent walking ($p=0.219$) and time to reach a score above the threshold for increased fall-risk ($p=0.063$) were decreased in the early AFO-group, but no significant differences between the early and late group were found. CONCLUSIONS: Early AFO-provision shows a positive trend on all outcome measures, with

statistically significant differences between the early and late AFO-group over time for the BBS. The results indicate positive effects of early AFO-provision on balance related measures of mobility, but need further study as these first analyses were performed with a limited number of subjects. Future analysis will include more subjects. This should elucidate whether or not early AFO-provision is beneficial.

P2-L-62 The effect of local muscle vibration on the sit-to-walk performance

Marcelo Pereira[1], Paulo Henrique Pelicioni[1], Lilian Gobbi[1]

[1]UNESP - Rio Claro

Background and aim: Past studies showed that the use of local muscle vibration improves gait and balance-based tasks performance in both healthy and movement-impaired people. However, it remains unknown the effects of local muscle vibration on the performance of more complex motor tasks as sit-to-walk. And also, before suggesting the use of this technique by people with movement disorders, it is important to well-establish its effect on healthy subjects. Therefore, the aim of this study is to investigate the effect of local muscle vibration on the motor behavior and performance of sit-to-walk task in healthy young adults. Methods: Nine participants (mean aged: 22.73±2.25 years) performed the sit-to-walk task after a 30-seconds period of vibration (Vib) and without vibration (NonVib). Three pairs of cylindrical devices (vibration parameters: 120Hz, 0.8mm of amplitude) were positioned bilaterally on the belly of tibialis anterior, rectus femoris and superior trapezious using elastic straps. Subjects were instructed to rise from an armless chair and start walking with a fluid and continuous movement. The trajectory of twenty-four reflective markers was captured by four cameras and processed offline. To investigate the motor behavior and the effect of vibration on the sit-to-walk performance we assessed the duration of each movement phase, the center-of-mass (CoM) velocity and range in each phase and also the first step spatiotemporal parameters. Results: A longer step length was observed during Vib (66.92±7.16cm) in comparison to NonVib (63.61±6.26cm - $p<0.001$). As consequence a faster step velocity was also observed with the use of vibration (Vib: 119.51±17.44cm.s-1; NonVib: 110.77±14.39cm.s-1 - $p=0.039$). Vibration also reduced the CoM horizontal range during the standing phase (Vib: 34.22±4.50cm; NonVib: 36.50±3.00cm - $p=0.02$). Likewise, a tendency for CoM horizontal range reduction was found during the flexion phase (Vib:15.46±5.43cm; NonVib: 18.31±5.85cm - $p=0.07$). Conclusions: The vibration effects during this complex motor task seem to be restrained to phases where a transition between balance and movement is required. It is believed that in healthy young subjects the voluntary motor action necessary to rise from a chair reduces the external vibratory effects. Vibration could be responsible to recreate a self-body image on the brain allowing subjects to be more efficient on movement (reducing CoM movement ranges).

P2-L-63 The effect of a unilateral ankle foot orthosis on the kinematics in normal walking

Jacqueline Romkes[1], Reinald Brunner[1]

[1]University Children's Hospital Basle

BACKGROUND AND AIM: Unilateral ankle foot orthoses (AFOs) are utilized for walking by patients with excessive plantarflexion such as a drop foot or hemiplegic cerebral palsy. AFOs block plantarflexion during swing phase of gait enabling certain groups of patients to restore the initial pathological toe-contact into a heel-contact. Literature is available on walking with and without AFOs in patient

populations but data on kinematic changes in healthy subjects are lacking. This exploratory study investigated the influence of a unilateral AFO on lower body gait kinematics in asymptomatic normative adult subjects. METHODS: Fifteen asymptomatic normative subjects (age 24.7±5.0 years) volunteered for the study. Three sizes of AFOs (small, medium, large) with fixed neutral ankle position were manufactured by an orthotist. The subjects walked barefoot with and without an AFO on the right leg along a 10 m walkway at a self-selected speed. Conditions were randomized among the subjects. Kinematic data were recorded using a motion capture system (Vicon, Oxford, UK) with the PlugInGait model for the lower body. All reflective markers, except for the heel marker in the AFO condition, were placed directly on the skin. The average of five walking trials was used for each subject and each test condition. Excel and MATLAB software were used to create movement curves normalized to 100% gait cycle and to calculate specific parameters (e.g. peak values) of clinical relevance. Statistical testing was done by a paired t-test with significance level set at $p<0.05$. RESULTS: With blocked plantarflexion, the subjects compensated mainly at the hip and knee in the sagittal plane on the side wearing the AFO (figure 1). Peak hip flexion in terminal swing increased significantly by 5.8±2.9° ($p<0.000$) and peak hip extension in mid-stance reduced significantly by 2.8±1.9° ($p<0.000$) with AFO compared to without AFO. At the knee, peak knee flexion in mid-swing increased significantly by 9.2±4.9° ($p<0.000$) whereas peak knee extension in mid-stance was unaffected by the AFO ($p=0.320$). CONCLUSIONS: In contrary to studies investigating the effects of AFOs in patients, this study explored the kinematic adaptations to unilateral blocked plantarflexion in healthy subjects. Blocked plantarflexion by an AFO resulted in compensatory movements, namely increased peak knee and hip flexion and decreased peak hip extension. The results provide a more complete understanding of the effect of AFOs and the secondary gait adaptations.

P2-L-64 Using action-sounds to cue gait in Parkinson's disease patients with freezing of gait

William Young[1], Lauren Shreve[2], Emma Quinn[2], Cathy Craig[3], Helen Bronte-Stewart[2]

[1]Brunel University, [2]Stanford University, [3]Queen's University Belfast

BACKGROUND AND AIM: Despite optimal pharmacological treatment, gait disturbances are a common feature of Parkinson's disease (PD), the most severe being freezing of gait (FOG). Various strategies have been devised to facilitate the initiation and maintenance of gait in PD with FOG, the most prevalent being the provision of auditory, visual and even haptic sensory cues. Recent work demonstrated that, compared to when walking to a metronome, PD patients without FOG showed reduced gait variability when walking to recorded sounds of footsteps made on a gravel path. However, no study has examined whether PD patients with FOG derive any benefits from using footstep sounds as a sensory cue. METHODS: The current study compared the effects of four different auditory cues on stepping characteristics of 6 PD patients with FOG. Whilst our primary objective was to compare stepping behaviours between conditions when patients walked to a metronome (discrete invalid) or footstep sounds on gravel (continuous valid), two further cueing conditions were added: the sound of footsteps in a corridor (discrete valid) and white noise (continuous invalid). The inclusion of the latter conditions allowed us to assess whether any benefits shown when walking to the continuous valid sounds relate to: a) the continuity of the sound, and/or b) the ecological validity (i.e., whether the sounds are perceived as actions). The efficacy of each cue was assessed using a 'stepping-in-place' protocol where patients stepped on two force plates for 80 seconds whilst listening to cues through headphones. After completing an initial baseline trial (no sound) participants completed one 80 second trial for each of the

four cues plus an additional baseline trial, the order of which was randomised. The stepping-in-place protocol provides a validated quantitative assessment of FOG that would be necessary to reliably evaluate the extent to which the cues affected stepping parameters. Two outcome measures were calculated: a) the time to the first freeze, and b) stepping rhythmicity. Each variable was expressed as a percentage change relative to baseline. RESULTS: Results showed that the time to the first freeze was increased in all conditions compared to a mean baseline of 22 seconds: discrete valid = 45%, continuous invalid = 59%, discrete invalid = 27%, and continuous valid = 136%. For rhythmicity, all conditions showed an increased percentage change (indicating increased variability), with the exception of continuous valid cues where patients showed a mean reduction of 10%. CONCLUSIONS: Despite the small cohort included in the current analysis, the results clearly show the potential of using action-sounds as sensory cues for PD with FOG. We suggest that the improvements shown might be considered a form of audio-motor priming (i.e., listening to the sounds of footstep will engage sensorimotor circuitry relevant to the production of that same action, thus bypassing the defective basal ganglia).

P2-M-65 Visually Guided Interlimb Adaptation During Walking In Children And Adults: 'Virtual' Split-Belt Treadmill Adaptation

Julia Choi[1], Peter Jensen[1], Jens Bo Nielsen[1]

[1]University of Copenhagen

BACKGROUND AND AIM: Voluntary visually guided movements must be constantly adapted to maintain accuracy (e.g., foot placement). Here we applied principles of visuomotor adaptation to drive inter-limb adaptation of joint kinematics in a walking task that demands voluntary control of endpoint (i.e., foot) position. Our results showed that step length symmetry could be adapted and stored after training with mismatched visual feedback on two legs (i.e., 'virtual' split-belt adaptation). Moreover, we investigated how visuomotor adaptation in walking develops from childhood to adulthood. METHODS: 17 healthy children (9M/8F, 6-15 yrs) and 8 healthy adults (7M/1F, 26±6 yrs) were tested. We created a computer task where subjects modified step length trial-by-trial to hit virtual targets while walking on a treadmill (Fig. 1A). The relationship between screen-space and treadmill-space was defined by a visuomotor gain for each leg. Each test consisted of a 1-minute baseline period (same gain on both legs), a 3-minute adaptation period (one high gain, one low gain) and a 1-minute post-adaptation period (same gain on both legs). The 'fast leg' and 'slow leg' refers to the leg adapted with the higher and lower gain, respectively. During the adaptation period, the leg adapted with the higher gain appeared to move fast, and the other leg appeared to move slowly on display. RESULTS: All healthy children and adults tested could rescale step length to maintain endpoint accuracy during visually guided walking. The results showed that step length gradually became more asymmetric during adaptation (Fig. 1B). The fast leg shortened step length (to correct overshoot), and the slow leg lengthened step length (to correct undershoot). In the post-adaptation period, step length asymmetry persisted (after-effect) despite the fact that the gains have returned to normal. The presence of an after-effect indicates storage of a new inter-limb visuomotor calibration. The after-effect was partially washed out after one minute of post-adaptation walking. Step length adaptation was achieved by changing the range of limb excursion on both the leading leg and trailing leg. Longer step lengths were associated with more hip flexion and knee extension on the leading leg, and more hip extension on the trailing leg. The opposite was true for shorter step lengths. CONCLUSIONS: This study suggests that visually guided inter-limb adaptation can alter step length, a major determinant of gait stability and energetic costs. Healthy adults and children

as young as 6 years old are capable of modifying limb kinematics in response to visually perceived movement errors. This may open up new opportunities to correct abnormal, asymmetric walking patterns in children and adults with neurological damage (e.g., stroke, cerebral palsy).

P2-M-66 Adaptation of multi-joint balance coordination to whole body force fields

Denise Engelhart[1], Alfred Schouten[2], Ronald Aarts[1], J Pasma[3], Carel Meskers[4], Andrea Maier[4], Herman van der Kooij[1]

[1]University of Twente, [2]Delft University of Technology, [3]Leiden University Medical Centre, [4]VU University Medical Centre

Background and aim: The ankles and the hips play an important role in standing balance. Multi-joint coordination adapts with task, the magnitude and type of disturbance [1]. Arm studies show that postural responses are highly dependent on externally applied force fields [2]. Our aim is to study how multi-joint postural responses in standing depend on such force fields, using closed loop system identification techniques (CLSIT) where two disturbances are applied [3]. This offers knowledge about the plasticity of the neuromuscular controller; e.g. the adaptive capacity to maintain standing balance. We hypothesize that application of a stabilizing force field will lead to downscaling of postural responses. Methods: Ten healthy subjects maintained standing balance while whole-body force fields were applied in three conditions 1) no force field 2) stiffness at the hip and 3) stiffness at the shoulder. In addition, unpredictable continuous pushing and pulling forces (0.05-5Hz) were applied at hip and shoulder level (Figure 1). Leg and trunk segment angles were recorded and the ankle and hip torques were obtained from ground reaction forces and torques by inverse dynamics. With CLSIT, the Frequency Response Function (FRF) of the neuromuscular controller was estimated. The FRF describes for each frequency in the disturbance signal the magnitude and relative timing (gain and phase) of corrective joint torques evoked by motions of the leg and trunk segment. Results: Figure 2 shows that the ankle provides relatively more torque at low frequencies and the hip is dominant at higher frequencies. Hip torque compensates for both trunk and leg movement, whereas ankle torque only compensates for movement in the legs. The phases of all neuromuscular controller FRFs decreased with frequency, indicating a delayed response. Addition of force fields decreased FRF magnitude mainly at the low frequencies, where stiffness dominates. Stiffness at the hip or shoulder both reduce the corrective ankle torque to maintain standing balance. Hip torque is only slightly reduced by additional shoulder stiffness. Conclusion: By adding force fields (i.e. stiffness) in standing balance, subjects adapt by lowering their control action mainly in the ankle torque. The gain of the neuromuscular controller is reduced, as subjects are externally stabilized and balance maintenance becomes easier. Downscaling of postural responses indeed occurs. In future studies, our methods allow to study pathological changes in multi-joint coordination as well as its adaptive capacity. References: [1] Kim et al, J Biomech, 2012 [2] Franklin et al, Exp Brain Res, 2003 [3] Boonstra et al, JNER, 2013

P2-M-67 The Effects of Transcranial Transcutaneous Electrical Nerve Stimulation on Primary Motor Cortex Enhance Implicit Motor Learning Process and Cortical Excitability

Jer-Junn Luh[1], Cheng-Kai Shih[1]

[1]National Taiwan University

Background and aim: Non-invasive brain stimulation includes transcranial electrical stimulation and transcranial magnetic stimulation (TMS) have been gradually be emphasized because of feasible in clinical use for neurological patient. TMS is prove the effect of modulating the cortical excitability. Currently, cranioelectral therapy (CES) was a treatment tool for sleeping disorder and psychological disorder by applying sponge electrode on human scalp. Transcranial transcutaneous electrical nerve stimulation (tTENS) was one form of CES. Previous study showed tTENS can enhance cognitive function in dementia population, but the effect of tTENS applied on motor cortex was unclear. Our previous study reveal that after the tTENS intervention, the cortical excitability was increase and also found in intracortical facilitation (ICF) but no significant change of motor performance. However, the long-term potentiation after motor learning process may affect cortical excitability measurement, so we divided the motor leaning task and tTENS stimulation into separate conditions. Methods: 24 subjects was recruited from Chang Gung University in Taiwan without any neurological deficit or contraindication of TMS. Subjects were randomize into two group. First group only measure the cortical excitability in initial condition and follow up in 0, 30, 60 mins after tTENS stimulation. Second group measure cortical excitability and motor learning process contemporary and also follow up until 60 mins. Subject need to complete two trails of experiment include sham stimulation condition and tTENS condition. The intertribal interval should be longer than 1 week to prevent any retention effect. We measured single and pair pulse TMS included motor evoked potential (MEP), intracortical inhibition (ICI) and intracortical facilitation (ICF). Serial reaction time task was commonly used in motor learning experiments. We also performed block sequence and random sequence to make sure any transfer effect of learning process. Results: Both first group and second group in in the condition of truly received tTENS immediately got significant higher normalized MEP value (p: 0.031) compared with sham stimulation condition. The excitatory response of tTENS kept up to 30 mins(p:0.38) but not in 60 mins. The motor performance significant improved in both tTENS and sham stimulation after blocks of practice. In true stimulation condition he subjects got more reaction time change from baseline throughout follow up. Conclusion: tTENS had short-term effect of increasing cortical excitability. No difference was found in ICI or ICF, that's means modulation effect cannot influence cortical-cortical network. We also found that tTENS have learning stabilization effect compared with no stimulation condition. We suggest further research to reveal that whether tTENS applied on primary motor cortex can improve or stabilize training effect in population with neurological deficit.

P2-N-68 Modelling of optimal locomotor avoidance strategies with the differential games approach

Anuja Darekar[1], Valery Goussev[2], Bradford McFadyen[3], Anouk Lamontagne[1], Joyce Fung[1]

[1]McGill University, [2]Feil & Oberfeld CRIR Research Center, Jewish Rehabilitation Hospital, [3]Laval University

BACKGROUND AND AIM: The differential games approach can be used to express the dynamic interaction between an individual walking towards a central target while avoiding collision with an intersecting obstacle. This obstacle avoidance task is mathematically solved using a set of differential equations to find an optimal strategy, attained by the minimization of 'risk energy' along the subject's pathway to the goal. Risk energy is obtained by the superposition of two fields representing different risks: colliding with the obstacle (obstacle risk) and not reaching the goal (goal risk). During the avoidance task, the obstacle risk field is larger and influences the avoidance strategy to a greater degree,

until the risk of a collision is negated. The objective of this study is to model this risk field and to explore its influence on avoidance strategies. METHODS: The experimental set-up that derived the model involved subjects walking towards a central target while avoiding obstacles (viewed in a virtual environment) that randomly approached at 0.5 m/s from either head-on, or 30° to the left or right, in a physical space of 6m x 6m. The obstacle risk field was modelled by a Gaussian 2D distribution with constant amplitude and elliptical horizontal cross-sections. The elliptical cross-section represents an asymmetric risk field with greater risk (and orientation of the major axis) along the direction of motion of the obstacle. The risk field could vary based on obstacle characteristics (size, shape, speed etc.). Therefore, the effect of changing the risk field by changing the diameter of the major axis on avoidance strategies was explored as a first step. RESULTS: The model assumed two rules : i) that the movement of the subject in 2D space was similar to the mechanical movement of a heavy ball in a gravitational field on an uneven surface, and ii) that the subject chose the path with the lowest risk energy to avoid the obstacle and reach the target. Using the above rules and by varying the major axis, it was observed that avoidance strategies changed when a given threshold in the diameter of the major axis (and consequently the risk field) was reached. With diameters smaller than or equal to 1.1m, the subject was able to avoid the obstacle by passing in front of it. However, when this diameter was increased to 1.2m or greater, a change in avoidance strategy was seen with the subject now passing behind the obstacle. Thus, diameters of 1.1-1.2m represented a transition zone for change in strategy. CONCLUSIONS: In a mathematical simulation of obstacle avoidance based on differential games, a change in the obstacle risk field forces a change in the avoidance strategies after a given threshold is reached. This approach will be used to further evaluate the effect of obstacle risk field on avoidance strategies and to validate the findings with experimental data.

P2-N-69 A Case Study on Gait Improvement after Clinical Program using Robot Suit HAL in a Stroke Patient

Hideki Kadone[1], Yukiko Ueno[1], Kiyoshi Eguchi[1], Ryohei Ariyasu[1], Shigeki Kubota[1], Shun Irie[1], Hiroaki Kawamoto[1], Yoshio Nakata[1], Akira Matsushita[1], Masataka Sakane[1], Yoshiyuki Sankai[1]

[1]University of Tsukuba

1. Background and Aim For the purpose of assisting repetitive lower limb motion to improve walking ability after neurological disorders, robots are being introduced. Among them, robot suit HAL (Hybrid Assistive Limbs, CYBERDYNE) is a wearable type device that assists lower limb joint movement in locomotion according to the user's intention indicated by BES (Bio-Electric Signal) including electrical neuro-muscular activation of relevant motor systems. Kubota et al. reported improvement in walking speed, number of steps and cadence in 10m walk test, after HAL clinical program with 32 patients suffering from spinal/cervical cord injury, traumatic brain injury, cerebral vascular disorder or(and) myopathy. Kawamoto et al. reported the higher effectiveness of the program for severer cases in cerebral vascular patients. In this presentation, for further analysis of the effects of the clinical program, we report a case study on gait improvement with a stroke patient in terms of spatiotemporal gait symmetry. 2. Methods A subject with right hemiparesis (female, 8 months after cerebral hemorrhage, Functional Ambulation Categories 5) participated in the HAL clinical program of 8 weeks with two sessions per week; 16 sessions in total. Each session lasted 90 minutes including preparation, walking wearing HAL and poses. Motion capture (VICON MX with 16 T40S cameras) was used to evaluate walking speed, step length, stance/swing/double support duration, and affected/contralateral ratio of

these parameters, in 10m walk at the assessments before and after the program without HAL and at the 11th session with HAL. 3. Results Walking speed, average affected/contralateral ratio of step length, swing duration, stance duration and double support durations of right foot in front and left in front were 0.32[m/s], 1.6, 2.0, 1.3, 0.39[s] and 0.56[s], respectively at the initial assessment; 0.44[m/s], 1.3, 1.1, 1.0, 0.35[s] and 0.44[s] respectively at the 11th session; and 0.39[m/s], 1.3, 1.4, 1.1, 0.24[s] and 0.43[s] respectively at the final assessment(Figure). 4. Conclusions Walking speed as well as the gait symmetry in terms of step length, swing duration and stance duration were improved after the HAL clinical sessions. Double support durations were shortened without symmetry improvement. Gait pattern while wearing HAL at one of the sessions showed better values, suggesting the effect of the interactive feedback provided by the robot for the above improvements. Actually, right/left ratio of weight bearing in standing posture recorded before and after the sessions using stabilometry for clinical assessment also showed improvement. These observations are coherent with reports in the literatures (Lewek et al. Hendrickson et al.). 5. References Kubota et al. (2013) Arch Phys Med Rehabil. Kawamoto et al. (2013) BMC Neurol. Lewek et al. (2012) Phys. Ther. Hendrickson et al. (2013) Gait Posture. 6. Acknowledgements This study was supported by FIRST program.

P2-N-70 Assessment of Postural Stability and Balance in Parkinson Disease Patients after Deep Brain Stimulation Surgery Using Full Body Motion Capture Suit

Kristina Ognjanovic[1], Mehdi Delrobaei [2], Mandar Jog[3], Greydon Gilmore[1]

[1]University of Western Ontario, [2]University of Western Ontario, London Health Sciences, [3]London Health Sciences, University of Western Ontario

Background and Aim: Deep Brain Stimulation (DBS) is a therapy that seeks to reduce the symptoms of advanced, L-dopa responsive Parkinson's Disease (PD) patients who are not sufficiently controlled by medication. DBS is a relatively new technique and as such its full potential remains elusive. Over the past decade DBS has been shown to be beneficial in reducing common PD motor fluctuations. However, the stimulation parameters including contact location, electrode polarity, voltage, pulse width and the frequency of stimulation that can be modified to achieve this result are vast. As such, successful DBS therapy relies on proficient electrode programming. DBS programming for optimal therapy benefit in patients remains a difficult task for clinicians due to the number of complex permutations available on the DBS device. Choosing the optimal DBS settings is still a subjective trial and error process for clinicians. Overall, this has a direct impact on patient progress and outcomes because programming is limited to modifying simple settings that relate to short term visually observable clinical symptoms and signs. In order to overcome this weakness the development of a computational platform for the optimization of DBS parameters is necessary and far overdue. In this study we employ a state of the art motion capture suit called Animazoo to objectively track DBS patient motor fluctuations. This suit will allow us to systematically and objectively track the impact of randomized programming parameters on DBS patient motor symptoms. Methods: The study aims to examine 24 PD patients who have undergone Sub-thalamic nucleus DBS Surgery and 24 healthy age matched controls. This study was approved by Western University Ethics (Human Subjects Research Ethics Board). Participants are invited to undergo a DBS programming session and subsequent kinematic assessments. The Animazoo motion capture suit will be used to measure mobility parameters. It is a light weight, multi-sensor and fully portable data collection system of full body motion, consisting of inertial measurement units (IMUs). Patients perform a series of tasks while wearing the suit. This allows tracking of their movement and provides enough

information for mobility analysis. The IMUs provide 3D orientation, acceleration, and rate of turn (gyro rate). This allows for the extraction of a large number of full body motions including: range of motion, and balance and postural stability. The entire session is videotaped and several well established clinical scales and assessments including the UPDRS are completed during the visit. Results: To date, 25 lab visits have been conducted. These visits consist of full-day programming which tests multiple DBS device parameters and their effect on mobility, balance, and gait using the Animazoo motion capture suit. Full body kinematic data has been collected to assess gait, range of motion, balance and postural stability.

P2-N-71 The applicability of the inverted pendulum model to stooping and crouching postures

Tyler Weaver[1], Michal Glinka[1], Andrew Laing[1]

[1]University of Waterloo

BACKGROUND AND AIM: In the inverted pendulum model, the body pivots about the ankle under the control of the plantar/dorsiflexors for the anterior-posterior (AP) direction, and the hip abductors/adductors for the medio-lateral (ML) direction [1]. Currently, it is unknown if this model applies to stooping, which pitches the centre of mass (COM) forward, or crouching, which reduces the size of the base-of-support (BOS). Nonetheless, many studies have used an inverted pendulum to model similar dynamic postures [2]. Therefore, the aim of this study was to determine the degree of applicability of the inverted pendulum model to stooping and crouching postures, by comparing correlations of the COM acceleration and centre of pressure (COP)-COM difference for standing, stooping and crouching postures. This relationship is a defining feature of the inverted pendulum model, where in quiet stance, the COM acceleration of the pendulum is proportional to the difference between the COP and COM [3]. METHODS: Ten young adults participated in the study (age: 22.8 (2.5) y; height: 1.7 (0.1) m; mass: 73.2 (16.6) kg). Kinematics were collected using clusters of infrared markers, with additional points digitized at the endpoints of each segment. Marker positions were recorded using four Optotrak Certus camera banks (NDI, Waterloo, ON) at 32 Hz, and used to calculate the whole body COM. The COP was determined using signals from a floor-mounted force platform, (AMTI, Watertown, MA); sampled at 512 Hz. Participants performed standing, stooping and crouching once each, for 20 seconds. For each posture and direction, the time-varying acceleration of the COM and the COP-COM were computed, with the relationship between these variables determined using Pearson's correlations. RESULTS: For the standing, stooping and crouching postures, average (SD) correlation coefficients were -0.852 (0.066), -0.785 (0.125) and -0.803 (0.115) in the AP direction and -0.818 (0.100), -0.935 (0.047) and -0.766 (0.211) in the ML direction, respectively. A 2 x 3 ANOVA revealed a posture x direction interaction effect ($F(2,18)=4.033$; $p=0.036$). Along with no main effects of posture in the post-hoc one-way ANOVAs (AP: $p=0.418$; ML: $p=0.053$), pairwise comparisons also revealed that in the ML direction, standing was not different from stooping ($p=0.121$) or crouching ($p=0.612$). CONCLUSIONS: This study provides evidence that the inverted pendulum model for AP and ML control is applicable for stooping and crouching postures. Based on their role in activities of daily living, future work should investigate if the control of these postures is similar to that proposed by Winter et al. [1] for quiet stance, namely through the plantar/dorsiflexors for AP sway, and the hip load/unload mechanism for ML sway. REFERENCES: [1] Winter, D.A., et al. (1993). Neur Res Com, 12: 141-148. [2] Papa, E. & Cappozzo, A. (1999). J Biomech, 32: 1205-12. [3] Winter, D.A., et al. (1998). J Neurophysiol, 80: 1211-21.

P2-O-72 Increased lateral position of the center of mass during turning is associated with freezing of gait in Parkinson's disease

Aniek Bengevoord[1], Griet Vervoort[1], Wim Vandenberghe[2], Alice Nieuwboer[1], Joke Spildooren[1]

[1]K.U.Leuven, [2]U.Z. Gasthuisberg

Background and aim: Freezing of gait (FOG) often occurs while turning in Parkinson's disease (PD). However, it is currently unclear whether there is a relationship between the position of the center of mass (CoM) in the turning trajectory and freezing of gait. Therefore, the goal of this study was to investigate the position of CoM in relation to the ankles in patients with Parkinson's disease (PD) with and without FOG and healthy controls. We also compared the turning sections just before a FOG---episode with similar turning sections of non-freezers. Methods: Six patients with PD and confirmed FOG, 14 patients without FOG and 13 age--matched healthy controls performed a series of standardized 180° turns while 'off' medication. Turns were recorded using the VICON 3D-motion analysis system. CoM and ankle movements were analyzed for 4 turning quadrants of 40° of pelvic rotation (the first and last 10° were not used for analyses) and compared between PD groups and healthy controls. Additionally, CoM position in relation to the ankles was analyzed during the 40° of pelvic rotation before a FOG--episode and subdivided into 10° intervals. For each pre--FOG trial, comparable 10° sections were analyzed and averaged from 3 non--freezer turns. Outcome variables were distance between CoM and the medial ankle (inner side of turn) and lateral ankle (outer side of turn) as well as the total distance between the ankles. Furthermore, relative medial and lateral distances (expressed as a percentage of the total distance) were compared between patients and controls and between the pre--FOG turning sections and comparable sections of non---freezers. Results: Comparison of turning quadrants showed no significant differences for the medial distance between subgroups. However, lateral distance and total distance were clearly reduced in both PD groups compared to controls in all quadrants (p=.000--.004). Furthermore, paired analyses showed reduced lateral distances in freezers during the 30°-40° (p=.010), the 20°-30° (p=.033), the 10°-20° (p=.004) and the 0°--10° (p=.033) pre--FOG turning sections compared to similar sections in non-- freezers. Investigation of the relative distance showed a more lateral position of the CoM in PD patients compared to controls in all quadrants (p=.000-.007), but not between freezers and non--freezers during pre-FOG. Conclusion: These results indicate that turning in PD is characterized by a more lateral position of the CoM and a smaller base of support during the entire turn. This may hinder fluent turning as leaning towards the inner side of the turning arc (medial position) is reduced. This phenomenon became even more pronounced in the turning sections preceding actual freezing episodes and may contribute to difficulties with step generation during a turn in freezers.

P2-O-73 Deficits in predictive scaling of postural responses in people with Multiple Sclerosis (MS)

GEETANJALI DUTTA[1], Fay Horak[2]

[1]Oregon Health Sciences University, [2]Oregon Health Sciences University, Veterans Adminstration Medical Center

BACKGROUND AND AIM: Aim of this study was to gain better understanding of imbalance related to the deficits in postural responses in people with MS. In non-neurologically impaired individuals, scaling of postural responses to displacement amplitude is observed when displacements of different amplitudes are presented in predictable blocked manner. The cerebellum is considered to be responsible for this

predictive scaling. Thus, we hypothesized that people with MS who have predominantly cerebellar involvement will show more deficits in predictive scaling than those with somatosensory impairments. METHODS: In this ongoing study, five subjects with MS (four relapsing-remitting and one primary progressive; age:56.4±5.3 yrs.;5F) and five control subjects (age:51.2±12.3 yrs.,4F;1M) participated so far. A clinical battery was administered for MS subjects, which included the measure of disease severity using the Expanded Disability System Score (EDSS), a test to determine severity of ataxia through International Co-operative Ataxia Rating Scale (ICARS) and balance assessment using mini Balance Evaluation Systems Test (miniBESTest). Average EDSS, ICARS and the miniBESTest scores for the MS subjects were 3.6±0.9 (maximum score:10), 16±10.9 (maximum score:100) and 18±6.9 (maximum score:28) respectively. We investigated amplitude scaling of automatic postural responses to changes in the amplitude of backward displacement of the support surface. The subjects stood on two computer-servocontrolled custom-made, hydraulic platforms that translated backward together causing forward body sway. Responses to four different displacement amplitudes (3.6, 6.0, 8.4, and 12 cm), all at a velocity of 15 cm/ second, were presented in blocks of 5 repetitions, with increasing amplitude, for a total of 20 trials. This block presentation was used to allow for predictive amplitude scaling based on experience from prior trials. Postural responses were estimated by computing the rate of change of center of pressure under each foot. Postural scaling of the automated responses, i.e. central set scaling, to gradually increased perturbation amplitudes was computed as the slope of the regression between the postural response and perturbation amplitudes. RESULTS: Control subjects demonstrated the ability to scale postural responses with the perturbation amplitude. The magnitude of central set scaling for control subjects approached 1.0 (0.9±0.06), whereas for MS subjects' this value was 0.62±0.14. Correlation coefficients of the linear regression between the central set scaling with the cerebellar component of EDSS as well as that of ICARS were strong and negative (EDSS: -0.98,ICARS: -0.76), whereas correlation between central set scaling and sensory score of EDSS was low, i.e. 0.37. CONCLUSIONS: These preliminary results support our hypothesis that the cerebellar feedforward control contributes more towards the deficits in postural response scaling than their somatosensory deficits.

P2-O-74 How does dopaminergic dysfunction in Parkinson's disease influence planning for stepping over multiple obstacles during gait? Insights from gaze behaviour.

Frederico Faria[1], Jeffery Jones[2], Quincy Almeida[3]

[1]Wilfrid Laurier University/MDRRC, [2]Wilfrid Laurier University, [3]Sun Life Financial Movement Disorders Research & Rehabilitation Centre/Wilfrid Laurier University

BACKGROUND AND AIM: Individuals with Parkinson's disease (PD) have planning deficits likely associated with cognitive or sensory processing dysfunction when approaching an obstacle to be stepped over. Yet, it is unknown how the dopaminergic system contributes to planning deficits especially when crossing multiple obstacles. Analysis of gaze behaviours provides an opportunity to evaluate how far ahead individuals with PD plan a sequence of actions during such complex locomotor tasks. The aims of current study were to investigate: (i) the gaze behaviour when individuals are approaching two obstacles in sequence; (ii) how a second obstacle influences the planning and clearance of the first obstacle; (iii) the influence of dopaminergic replacement on both gaze behaviour and obstacle clearances. METHODS: Individuals with PD (n=20) were tested during "ON" and "OFF" dopaminergic medications. A group of healthy controls (HC; n=19) matched by age and height were also included to verify the effects of PD. Gait and gaze behaviour were tracked using wireless motion and eye

tracker systems, respectively. Participants walked ~6.5 m and then stepped over a sequence of two obstacles (multiple obstacle condition) or one obstacle (single obstacle condition). The second obstacle was placed 1m beyond the first obstacle. Gaze was analysed for the last six steps prior to the first obstacle, as was the toe clearance over the first obstacle. RM ANCOVAs verified the effects of PD (PD OFF x HC), dopaminergic medication (PD ON x PD OFF) and number of obstacles (single x multiple) for both fixation duration and frequency on each obstacle. The effects of number of obstacles (single x multiple) on toe clearances were also evaluated. RESULTS: Interactions between group and number of obstacles for gaze variables ($F_{1,37}=5.48$; $p=0.02$/ $F_{1,37}=5.35$;$p=0.02$) showed that both groups had similar gaze patterns for the first obstacle; however, PD OFF fixated less frequently and for shorter durations on the second obstacle (compared to the first obstacle and also compared to HC for the second obstacle). A separate interaction between group, obstacle, and trial ($F_{2,72}=4.89$; $p=0.01$) revealed that toe clearance over the first obstacle was reduced when the second obstacle was present but only in PD OFF, and this was driven by first trial effects. Medication effects were not significant for either gaze behaviours or gait. CONCLUSIONS:This study reveals that PD negatively influences the ability to plan ahead for more than one obstacle. In addition, the disruptive influence of a second obstacle on toe clearance (reduced clearance) suggests that planning deficits may be attributed to cognitive overload, which is not alleviated by dopaminergic replacement. These findings shed important insight into causes of tripping and fall in PD.

P2-O-75 Reduced structural connectivity of proprioceptive neural pathways in MS

Brett Fling[1], Michelle Cameron[1], Fay Horak[1]

[1]Oregon Health and Science University

Background and Aim: Mobility and balance impairments are a hallmark of Multiple Sclerosis (MS), affecting nearly half of patients at presentation, resulting in decreased activity participation, falls, injury, and reduced quality of life. A growing body of work suggests that balance impairments in people with early stage MS are primarily the result of deficits in proprioception, the ability to determine body position in space in the absence of vision. Proprioceptive information from the ankles is the primary sensory feedback used to maintain balance and central processing of this feedback is critical as evidenced by recent work showing significant associations between balance performance and proprioceptive-related neural activity. We hypothesize that compromised white matter of proprioceptive pathways in MS disrupts the transmission of proprioceptive feedback leading to declines in balance control and increasing the likelihood of falls and injury. Methods: We are using diffusion tensor imaging to image the structural connectivity of the conscious and unconscious proprioceptive pathways in MS participants and healthy age-matched controls. Additionally, participants' proprioceptive acuity (conscious) and compensatory postural adjustments (unconscious) are being tested to determine the relationship between structural connectivity of the relevant neural networks and behavior. Data collection is currently in progress; here we present structural connectivity analyses of an initial sample of five patients with MS and five age-matched controls. This is the first study to identify the structural proprioceptive networks within the human brain. Results: Preliminary results demonstrate that patients with MS have reduced microstructural integrity of both the conscious and unconscious proprioceptive pathways as evidenced by greater radial diffusivity. Further, reductions in white matter integrity of the unconscious proprioceptive pathway are related to poorer balance on tasks requiring anticipatory postural adjustments in MS patients. Conclusions: Results from this work will form

the basis for neuroanatomically-driven balance rehabilitation studies. Successful rehabilitation in people with MS requires clinicians and researchers to identify specific deficits in their patients to optimize intervention effectiveness.

P2-O-76 Single and dual tasking in high risk individuals for Parkinson's disease

Markus Hobert[1], Sebastian Kleinhans[2], Sandra Hasmann[2], David Weiss[2], Eva Schaeffer[2], Johannes Streffer[3], Inga Liepelt-Scarfone[2], Daniela Berg[2], Walter Maetzler[2]

[1]University of Tuebingen, [2]Center for Neurology, University of Tuebingen, [3]Janssen-Pharmaceutical Companies of Johnson & Johnson

BACKGROUND AND AIM: Parkinson's disease (PD) has a long prodromal phase. Diagnosis with the ultimate aim of treatment of individuals in this prodromal phase is one of the main challenges of current PD research. There is preliminary evidence that subtle motor changes occur even years before clinical diagnosis is possible, and that challenging assessment strategies, e.g. dual tasking, are more useful than convenient tasks to detect these changes (Maetzler et al., 2012; Mirelman et al., 2011). METHODS: In this cross-sectional study we investigated convenient as well as challenging single- and dual tasking conditions in 14 patients with PD, 12 healthy controls and 37 individuals at high risk for PD. High risk for PD (HR) was defined by hyperechogenicity of the substantia nigra by transcranial sonography and either one motor sign (e.g. slight bradykinesia) or two of a set of well-established risk and prodromal markers of PD (positive family history, depression, hyposmia, one-sided reduced arm swing). All participants performed the following tasks: checking boxes with a pen on a sheet of paper with either white or white and grey boxes where only the white boxes had to be checked, as well as 20m straight walking with slow, convenient, and fast speed. Individuals had then to perform dual tasking under fast walking conditions. The box checking tasks require mainly fine motor (white boxes) and cognitive skills (white and grey boxes) (Bock, 2008). Gait parameters were assessed with an accelerometer (Dynaport®, McRoberts, The Hague, The Netherlands) worn at the lower back. Time for checking boxes was assessed with a stopwatch. Dual task costs (DTC) of walking parameters as well as of checking boxes speed were calculated. RESULTS: PD patients differed from controls in the fast walking and dual tasking conditions, but not when walking at convenient speed. Parameters which differed between groups were gait speed, double support time, and step number. DTC of the checking boxes speed were different between PD and controls only in the "white boxes" condition. These significantly different parameters between PD and controls were used to calculate a model to differentiate HR from controls. The area under the curve yielded 0.78, with a sensitivity of 89.2% and a specificity of 52.8%. CONCLUSIONS: Our results suggest that dual tasking during gait has the potential to differentiate HR from controls. Tasks that are challenging, here two simultaneously performed motor tasks, have a higher discriminatory effect than non-challenging tasks. To date we do not know if all HR individuals are in the prodromal stage and will develop PD. Therefore longitudinal studies are mandatory to delineate the association of dual tasking deficits and motor alterations in prodromal PD. REFERENCES: Bock O, J. Neuroeng. Rehabil. 2008; 5:27 Maetzler W, et al., PLoS One 2012; 7: e32240 Mirelmann A, et al. Ann Neurol 2011, 69: 193-7

P2-O-77 Adaptability of Gait in Stroke Survivors: relationships to clinical measures of balance, motor recovery and walking speed

Kristen Hollands[1], Trudy Pelton[2], Jonathan Mathias[2]

[1]University of Salford, [2]University of Birmingham

Background:Although, there is strong evidence to indicate that stroke survivors have reduced gait adaptability; indicated by reduced obstacle avoidance abilities [1], impaired turning [2] and an increased response time to changes in walking context [3] the underlying mechanisms for poor adaptability and the relationship to functional mobility are still largely unknown. This study sought to explore the relationship between adaptability of walking and known clinical measures of balance, motor recovery and functional walking ability in stroke survivors.Methods:Participants (n=44, 41.6% female, with 55% right and 8.3% bilateral lesions and mean±SD age 57.5±15.7yrs, 232±363days since stroke) 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 while walking as quickly and safely as possible. The depth of the targets corresponds to the variability in step length reported in stroke patients [4]. Thus, targets should only be missed if the error in footfall location exceeds 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 total number of targets missed as well as those missed on the paretic and non-paretic sides 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 were recorded. A target was missed if the participant was visually observed to be unable to place any part of the foot on the target. Fugl-Meyer lower limb assessment (FM), Berg Balance Scale (BBS), self-selected walking speed (SWWS) (using GaitRite) were also assessed. Total targets missed as well as number missed on the paretic and non-paretic sides and time to complete were regressed onto each of the clinical measures using multiple-linear regression.Results: Participants had (mean±SD) SSWS of 0.48±0.28m/s: BBS 43.8±8.5; FM 23.8±5.8. Only time to complete target stepping was significantly ($p<0.05$) related to BBS ($F(3,43)=4.3$, $p=0.01$, $r2= 0.245$) and FM ($F(3,43)=6.36$, $p=0.001$, $r2= 0.323$).Discussion: Impaired ability to adjust step locations as required according to environmental demands may be reflective of impoverished regulation of changes in the relationship between the base of support and centre of mass which is crucial for dynamic balance control. The relationship between time to complete target stepping and measures of balance and motor recovery may reflect these mechanisms of impairment. Impoverished adaptability of gait may underlie the high prevalence of falling in stroke survivors.[1]Den Otter AR et al, Exp Brain Res 2005;161(2):180-92. [2]Hollands KL et al, Neurorehabil Neural Repair. 2010 May;24(4):358-67. [3]Reisman DS et al, Brain. 2007;130(7):1861-72. [4]Balasubramanian CK et al,Arch Phys Med Rhabil 2007;88(1):43-9

P2-O-78 Cutaneous sensory function and plantar foot pressures during walking in people with Multiple Sclerosis

Stephanie Jones[1], Jebb Remelius[2], Karthik Sugumaran[1], Michael Busa[1], Richard Van Emmerik[1]

[1]University of Massachusetts Amherst, [2]University of Massachusetts

BACKGROUND AND AIM: Balance and mobility dysfunction have been reported by 90% of individuals with MS. Recent evidence supports the somatosensory system is a major contributor to balance impairment in MS. Higher sensation thresholds on the foot plantar surfaces have been associated with reduced standing balance function. Similar relationships between impaired cutaneous sensation and gait patterns have been examined although the findings are equivocal. Individuals with reduced plantar sensation due to cooling demonstrate reduced plantar pressures that correspond to areas of plantar sensory loss. However, individuals with reduced sensation due to neuropathy or local anaesthesia had

increased or unchanged plantar pressures, respectively. Given that individuals with MS demonstrate impaired plantar sensation and altered walking patterns they may demonstrate altered plantar pressure patterns during walking. Therefore the aim of this study was to characterize the relationship between impaired plantar cutaneous sensation and pressure distribution during gait in people with and without MS. METHODS: Nineteen individuals with MS (MS; 16 Females) and twenty individuals without (CON; 17 Females) performed overground walking trials at preferred and three matched speeds (0.6, 1.0 and 1.4 m/s). Kinematic (240 Hz; Qualisys AB) and plantar pressure data (60 Hz; RSscan International) were collected as participants walked barefoot along a 14 m instrumented walkway. Vibration detection thresholds of the plantar surfaces were tested using a biothesiometer (Bio-medical Instrument Co.) and peak plantar pressures at the toes, metatarsals, midfoot and heels were assessed during walking using repeated measures, mixed model ANOVAs. Each foot was classified as LOW vs. HIGH sensitivity based on the summed vibration threshold. Plantar pressure and biothesiometer data were reallocated accordingly before analysis. RESULTS: Compared to controls, the MS group demonstrated increased vibration thresholds at all locations on both feet (P-values: 0.004-0.04; trends only for HIGH sensitivity ball and arch, P=0.09 and 0.06, respectively). Individuals with MS demonstrated reduced peak pressures compared to controls at the 2nd and 3rd metatarsals, midfoot and lateral heel, across speeds (P-values: 0.01-0.05), particularly on the HIGH sensitivity foot. CONCLUSIONS: Individuals with MS who demonstrate impaired cutaneous sensation appear to reduce peak plantar pressures at preferred and imposed walking speeds, and this reduction was of greater magnitude under the more sensitive foot. Reduced peak plantar pressures in those with MS may reflect a cautious gait strategy.

P2-O-79 The integration of vision and proprioception on obstacle crossing strategies in people with motor-incomplete spinal cord injury.

Raza Malik[1], Tania Lam [1]

[1]University of British Columbia

Background and Aim: In people with motor-incomplete spinal cord injury (m-iSCI), functional ambulation is an important goal. The ability to perform skilled walking tasks (such as obstacle crossing) is an essential component of functional mobility. Important components of obstacle crossing include accurate foot placement, adequate toe-obstacle clearance and appropriate coordination across multiple segments. Sensorimotor integration of visual and proprioceptive inputs are important in mediating these strategies. In people with m-iSCI, proprioceptive information could be compromised because the axons carrying proprioceptive information pass through the spinal cord. Thus, the overall objective of this study is to understand how motor and sensory deficits in people with m-iSCI affect obstacle-crossing strategies. Methods: Individuals with m-iSCI and able-bodied controls performed an obstacle-crossing task. Obstacle height was scaled to 10% of each participant's leg length. Three conditions were presented: 1: Full vision, no instructions; 2: Full vision, instructed to look straight; 3: Lower visual field obstruction (using dribble goggles), instructed to look straight. An eye tracker device was used to determine gaze behavior (gaze duration and number of glances to the obstacle), and motion capture analysis was used to determine lead and trail limb horizontal distance from the obstacle and lead toe clearance height over the obstacle. In subjects with SCI, lower extremity motor score was used to measure strength, the Spinal Cord Injury- Functional Ambulation Profile (SCI-FAP) was used to assess ambulatory capacity, and lower limb proprioceptive sense was assessed using a hip and knee joint position-matching task using the Lokomat and customized software controls. Results: Lower limb

proprioceptive sense was varied across subjects with m-iSCI. In general, m-iSCI participants tended to glance at the obstacle more frequently with longer gaze durations compared to controls. As the lower visual field became more obstructed, able-bodied controls exhibited increasing lead and trail limb horizontal distance and toe-obstacle clearance (consistent with previous studies). In subjects with m-iSCI, lead and trail limb horizontal distance and toe-obstacle clearance height tended to be smaller and was modulated to a lesser extent with visual field occlusion compared to that measured in controls. Subjects with m-iSCI also showed more trial-to-trial variability in these gait parameters compared to controls. Conclusion: The results of this study indicate that people with SCI rely more heavily on vision to cross obstacles and show limited ability to modulate the key gait parameters required for successful obstacle crossing. Our data suggest that proprioceptive deficits also need to be considered in rehabilitation programs aimed at improving functional mobility in individuals with m-iSCI.

P2-O-80 Effects of Foot Support on Sitting Postural Stability among Individuals with Spinal Cord Injury

Matija Milosevic[1], Kei Masani[2], Meredith Kuipers[1], Hossein Rahouni[1], Mary Verrier[1], Kristiina Valter McConville[3], Milos Popovic[1]

[1]University of Toronto, [2]Toronto Rehabilitation Institute - University Health Network, [3]Ryerson University

BACKGROUND AND AIM: Individuals with cervical spinal cord injury (SCI) who sustain motor and/or sensory deficits or impairments of the lower limbs and trunk have difficulties maintaining upright sitting posture. Typically, people with cervical SCI cannot use their lower limbs due to the paralysis and the utility of their foot support during sitting is generally underestimated. To date, effects of foot support on postural stability during sitting are not fully understood in this patient population. The purpose of this study was to: 1) compare postural stability of individuals with cervical SCI and able-bodied participants and; 2) analyze effects of foot support on postural stability during sitting. METHODS: Ten able-bodied participants (control group - age: 31.0±5.9 years; height: 174.4±9.5 cm; weight: 68.5±13.2 kg) and six individuals with traumatic cervical SCI (SCI group - injury between C4 and C6 levels; age: 41.3±18.1 years; height: 175.3±5.1 cm; weight: 75.1±9.8 kg) participated in this study. Center of pressure (COP) for both the seating surface and foot rest surface was calculated separately and then a global COP, which included fluctuations of the upper body and foot support, was computed. Analysis of all COP measurements, and the vertical and shear forces were utilized to evaluate sitting postural stability. RESULTS: When we compared the SCI group with the control group, individuals with SCI had considerably larger postural sway compared to able-bodied subjects for the global and seat COPs. This result suggests that postural stability is lower in the SCI group than in the control group. When we compared the global and seat COPs in each group, we found that global COP showed higher velocity compared to the seat COP, suggesting that foot support caused an increase in postural regulatory activity among both groups. The amount of force fluctuations for the vertical and shear force components were not different between the two groups. Individuals with cervical SCI cannot use their lower limbs and their foot support appears to be passive. Our results also suggest that able-bodied individuals may use their lower limbs for sitting stability in the same way as individuals with cervical SCI. CONCLUSION: Since foot support appears to have a passive role in helping maintain stability during sitting in both cervical SCI and able-bodied individuals, trunk control seems to be the dominant mechanism of sitting postural stability/instability that contributes to the difference in sitting control between able-bodied individuals and individuals with cervical SCI. Our findings indicate that foot support

has to be measured and that the global COP has to be evaluated to adequately assess postural stability during sitting.

P2-O-81 Effects of aging and disease on frontal brain activation while walking and dual tasking

Anat Mirelman[1], Inbal Maidan[1], Hagar Bernad-Elazari[1], Freek Nieuwhof[2], Miriam Reelick[3], Nir Giladi[1], Jeffrey Hausdorff[1]

[1]Tel Aviv Sourasky Medical Center, [2]Radboud University Nijmegen Medical Center,, [3]Radboud University Nijmegen Medical Center

Background: Functional near-infrared spectroscopy (fNIRS) can be used to study cortical activation when walking. It has been shown that performing cognitive tasks while walking increases oxygenated hemoglobin (HbO2) levels within the prefrontal cortex, a brain region linked to both cognition and locomotor control. This response, however, is apparently reduced with aging. The aim of this study was to assess differences in aging and disease, specifically Parkinson's disease (PD), in hemodynamic activation during walking and dual tasking. Methods: Frontal brain activation was assessed using an fNIRS system. The fNIRS consisted of two probes placed on the forehead at a height of 15% of the distance from nasion to inition, and width of 7% of circumference to left and right. The subjects preformed two tasks: walking at a comfortable speed and walking while serially subtracting (DT) out loud. Each walking task consisted of five walks of 30 meters. Quiet standing of 20 seconds was performed before and after each walk and served as a baseline for hemodynamic measures. After subtracting the baseline value, the HbO2 level for each task was determined by averaging five repetitions of the task. This level defined the change in HbO2 during the specific task and was used for comparison between the different tasks. Repeated Measures ANOVA was used to determine differences between groups and between conditions. Results: Twenty-three healthy young adults (mean 30.9±3.7 yrs, 13 females), 16 older adults (mean 71.1±1.6 yrs, 13 females) and 24 patients with PD (mean 77.7±1.3 yrs, 9 females, mean disease duration 12.5±6.07 yrs , Hohen and Yahr 2.6±0.4) participated in this study. Differences in HBO2 levels between conditions were observed in all groups (p=0.02). Compared to quiet standing, patients with PD had the largest increase in HbO2 during usual walking (0.44±0.11ìMl) as compared to the older adults (0.09±0.12ìMl) and young adults (0.02±0.08 ìMl). Interestinglìy the increase in activation from usual walking to dual tasking walk was lowest in PD (0.05±0.12 ìMl) followed by the older adults (0.01±0.07 ìMl) with the largest difference in HbO2 level observed in the young adults (0.26±0.09 ìMl). A negative association trend was observed between disease duration and change in HbO2 levels between conditions (r=0.51, p=0.082). Age was not correlated to any of the above measures. Conclusion: The study provides a window into dual task gait and the role of the pre-frontal cortex in aging and disease. The findings suggest that hemodynamic activation is linked to increased oxygenated hemoglobin and decreased performance. In addition, decreased change in HbO2 levels during DT was inversely correlated with disease duration. This provides a possible explanation to the decreased performance during dual task observed in patients with PD and perhaps some compensatory activation during simple tasks. Further research is underway to explore these questions.

P2-O-82 Cerebellar gray matter volume and balance functions in Parkinson disease

Martijn Muller[1], Roger Albin[1], Nicolaas Bohnen[1]

[1]University of Michigan

BACKGROUND AND AIM: Postural control involves subcortical brain structures including the striatum, pedunculopontine nucleus (PPN), thalamus, and the cerebellum. Although Parkinson disease (PD) is characterized by nigrostriatal dopaminergic denervation, we recently showed that decreased postural sensory integration functions were associated with PPN-thalamic cholinergic denervation. The cerebellum likely plays an important role in control of postural sensory integration functions because of its input of peripheral sensory information and anatomic connections to the PPN and the thalamus. The aim of this study was to explore the relationship between cerebellar gray matter volume and sensory integration functions in PD subjects while taking into account the degree of striatal dopaminergic and PPN-thalamic cholinergic innervation. METHODS: 125 PD subjects (32 F; 65.6 ± 7.4 yrs old; 5.9 ± 4.2 yrs motor disease duration; modified H&Y mean 2.4 ± 0.5, MDS-UPDRS part III motor score 31.9 ± 13.7) underwent dopaminergic [11C]DTBZ vesicular monoaminergic transporter-2 (VMAT2) and [11C]PMP acetylcholinesterase positron emission tomography (PET), and anatomic brain magnetic resonance imaging (MR). Sensory integration function was assessed on an EquiTest (Neurocom) balance platform while performing the Sensory Organization Test (SOT) protocol. All assessments were performed in the dopaminergic 'off' state. Striatal [11C]DTBZ distribution volume ratio (DVR) and acetylcholinesterase hydrolysis rate (k3), respective measures of dopaminergic and cholinergic availability, were estimated. MR anatomic information was used to estimate gray matter volume of the cerebellum normalized by total intracranial volume using FreeSurfer software. Total sway excursion and sway variability were determined for individual SOT conditions. Principal component analysis, performed to reduce postural sensory organization functions to robust factors with an eigenvalue greater than 2, yielded a single factor mainly reflecting postural sway. Linear regression analysis was performed with the postural sway factor as dependent variable and rank-ordered normalized cerebellar gray matter volume, striatal [11C]DTBZ DVR, thalamic [11C]PMP k3, MDS-UPDRS part III motor score, and motor disease duration as independent variables. RESULTS: There was an overall significant model ($F=3.1$, $p=0.012$). Cerebellar gray matter volume ($\beta=-0.205$, $t=-2.2$, $p=0.027$) and thalamic [11C]PMP k3 ($\beta=-0.263$, $t=-2.9$, $p=0.005$) were both independent predictors of the SOT sway factor. CONCLUSIONS: Decreased cerebellar cortical gray matter volume was associated with abnormal sensory integration functions independent of motor disease duration, overall motor impairment, striatal dopaminergic denervation, or thalamic cholinergic denervation in PD. These results show that in addition to PPN-thalamic cholinergic denervation, cerebellar cortical pathology may also affect postural sensory organization functions in PD.

P2-O-83 Neuronal correlates of steering in the human brain - changes induced by stroke

Caroline Paquette[1], Jean-Paul Soucy[1]

[1]McGill University

Background and aim: Inability to measure full brain activations during whole-body movements has limited our understanding of the neuronal structures involved in complex tasks such as steering of gait. Brain injuries, such as a stroke, can induce changes in brain activations in regions surrounding the infarct. It is known that the risk of falling is higher in stroke survivors than among the general population and that these falls more frequently occur during transfers or during turning. Yet, because of limitations in quantifying brain activity during large scale movements, no data is currently available on mechanisms

of post-stroke neuroplasticity for steering of gait. Our aim was to determine whether changes in brain activations during steering of locomotion can be quantified using 18F- fluorodesoxy-glucose (18F-FDG) Positron Emission Tomography (PET) in-vivo in healthy subjects and whether stroke stroke-induced changes can also be captured. Methods: Brain imaging with 18F-FDG PET was used to quantify cerebral glucose metabolism (CMRGlc) during walking. Two tasks were quantified (straight walking and turning) on separate days, in subjects with chronic subcortical and healthy controls. Before participants began the walking task, a 5 mCi bolus of 18F-FDG was injected. The walking task was carried out without interruption 40 minutes (> duration of 18F-FDG uptake). Within 10 minutes of completing the walking task (well within reaching the 2h half-life of 18F), subjects were scanned with an ECAT HR PET camera (20min emission followed by 10min transmission). Images obtained during straight walking were subtracted from the ones acquired during steering. Results: Pattern of CMRGlc were asymmetrical in the superior parietal lobule and sensorimotor regions of subjects post-stroke. Modulation of CMRGlc were observed in the unaffected hemisphere only. Difference images showed large changes between the tasks in the cerebellum of healthy controls, more specifically in the vermis, an area predominant for the control of trunk and balance. Subjects with stroke showed instead modulation in the cerebellar hemisphere, a region associated with goal-directed leg movements. Conclusions: Changes in whole-brain activations can be quantified using 18F-FDG PET during steering of gait, a complex locomotor task. Changes observed in steering of gait in subjects with stroke results in modulation of several brain regions remote to the infarct. A better understanding of neuroplasticity-related changes post-stroke during steering of gait might help improve rehabilitative and preventive strategies to promote functional mobility in stroke survivors.

P2-O-84 Asymmetric pattern of lower extremity loading during post-stroke gait

Kara Patterson[1], Stephanie Marrocco[2], Stephen Parsons[2], Ian Jones[3], Trevor Birmingham[2]

[1]University of Toronto, [2]Western University, [3]Wolf Orthopaedics Biomechanics Laboratory

BACKROUND & AIMS: Temporal gait asymmetry post-stroke may lead to musculoskeletal injury of the unaffected lower extremity (LE) due to excessive, repetitive loading. However, very little is known about the pattern of LE loading during post-stroke gait. The knee adduction moment (KAM) reflects the load on the knee medial compartment[1] and increased KAM values are associated with the development of chronic knee pain[2]. Two gait compensations seen in individuals with knee osteoarthritis (OA) that alter the KAM (and may be observed post-stroke) are toe out and trunk lean over the stance LE[3, 4]. This work aims to determine the feasibility of measuring the KAM, and variables likely to influence it, bilaterally during unassisted level walking in individuals post-stroke. METHODS: Participants post-stroke were assessed for level of motor impairment in the affected leg and foot with the Chedoke-McMaster Stroke Assessment (CMSA; 0-7, 7= no impairment). Kinematic and kinetic gait variables, collected with an 8-camera motion capture system and a single force plate, were averaged over 3 walking trials for the affected and unaffected LE where the respective foot cleanly struck the force plate. The following values were calculated for each LE: 1) the external KAM (using inverse dynamics); 2) toe out; 3) trunk lean. KAM (Nm/kg) was plotted as a function of percentage of the gait cycle. KAM was also normalized to body weight (BW) and height (Ht) and the peak value (pKAM) was identified for each participant and compared to a 95% confidence interval (CI) for pKAM in healthy middle-aged adults (1.84-2.64 %BW*Ht)[5]. RESULTS: Participants (n=3) had mean (SD) CMSA leg and foot scores of 6(0) and 5.7 (0.7) respectively. Unaffected and affected LE range of values for toe out were 11.99-19.82°and 8.72-

22.11°respectively and for trunk lean were 0.15-2.42°and -0.20-2.67°respectively. Visual inspection of KAM curves revealed substantial variation between limbs and between subjects. One individual had a peak KAM value (3.35 %BW*Ht) > upper boundary of the CI for healthy adults also assessed in this lab (Fig 1). CONCLUSIONS: A protocol commonly used to assess knee joint loads during walking is feasible to administer post-stroke. Preliminary results indicate variation both in the compensations employed and peak KAM values. Some individuals with stroke may experience excessive loading of their unaffected LE during gait. Ongoing work will examine unaffected LE loading in post-stroke individuals with greater motor impairment. REFERENCES: [1]Zhao D et al. J Orthop Res 2007;25:789-797 [2]Amin S et al. Arthritis Care Res 2004;51:371-376 [3] Hunt MA et al. Osteoarthritis Cartil 2008;16:591-599. [44] Jenkyn TR et al. J Biomech 2008;41:276-283. (3) Leitch KM et al. J Biomech 2013;46:1408-1412.

P2-O-85 Dual-task interference is related to PPN structural connectivity in people with Parkinson disease who freeze

Daniel Peterson[1], Rajal Cohen[2], Brett Fling[1], Martina Mancini[1], John Nutt[1], Fay Horak[1]

[1]Oregon Health & Science University, [2]University of Idaho

BACKGROUND AND AIM: Freezing of gait is a devastating symptom of Parkinson's disease (PD). Recent evidence suggests freezing involves a complex interplay between alterations in cognitive and motor function. For example, freezing has been related to specific cognitive deficits (e.g. response inhibition, task-switching), and biomechanical factors (e.g. reduced and more variable stride length (SL)). Further, people with PD who freeze (FoG+) exhibit altered structural connectivity of the brain with respect to those who do not freeze (FoG-), such that connectivity between the frontal cortex and the pedunculopontine nucleus (PPN) is asymmetric in FoG+. Our objectives were to determine the effects of cognitive dual-tasking on stride length (i.e. dual task interference) in FoG+ and FoG-, and to correlate dual-task interference with structural connectivity. METHODS: Wearable inertial sensors were used to calculate SL during two-minutes of plain walking and two minutes of dual-task walking in 25 participants with PD (13 FoG+). In the dual task walk condition, participants wore headphones which produced a tone in the left or right ear. While walking, participants turned their head to the left or right depending on the side that the tone was produced. Diffusion Tensor Imaging (DTI) was used to assess the volume and quality of white matter tracks originating in the area of the PPN. Simple reaction time (RT) was also assessed. RESULTS: No freezing events were observed during walking, and gait velocity was similar across groups. After correcting for disease duration and Montreal Cognitive Assessment, SL was not significantly different between FoG+ and FoG-. However, dual-tasking had a more pronounced effect on SL in FoG+ than FoG- (1.9% decrease in SL in FoG-, 5.1% decrease in FoG+; task-by-group interaction: $p=0.005$). In FoG+, but not FoG-, asymmetry of PPN connectivity correlated with dual-task interference (changes from plain to dual-task walking) for SL amplitude ($p<0.001$), SL variability ($p=0.026$) and SL asymmetry ($p=0.017$). RT also correlated with both PPN connectivity ($p=0.006$) and dual task interference (SL amplitude: $p=0.002$, SL variability, $p<0.001$, SL asymmetry: $p=0.001$) in FoG+. CONCLUSIONS: Dual-task walking affected SL of FoG+ more than FoG-. This result suggests the ability to maintain SL when attention is divided may be associated with freezing and supports the "posture second" hypothesis for freezing. In FoG+, dual-task interference was related to asymmetry of PPN structural connectivity, providing further evidence that dysfunction within the PPN plays a role in freezing. Specifically, the PPN may play a role in cognitive, as well as motor, aspects of freezing of gait. Finally, the correlation between PPN asymmetry and RT supports previous work suggesting the PPN may

play a role in the initiation and control of gait. Supported by a pilot grant from Pacific Northwest Udall Center #P50 NS062684, NIA #R37 AG006457, and #UL1 RR024140.

P2-O-86 Effect of Gaze Fixation on Gait Parameters in Parkinson's Disease

Rebecca Reed-Jones[1], V.N. Pradeep Ambati[2], Nicholas Murray[2], Fabricio Saucedo[2], Caitlin Schneider[3], Douglas Powell[3]

[1]University of Prince Edward Island, [2]The University of Texas at El Paso, [3]Campbell University

BACKGROUND AND AIM: Oculomotor deficits are known to occur in addition to body motor deficits in Parkinson's disease. An increasing number of studies are investigating gaze behaviour in parkinsonian patients to further understand the link between eye and body motor symptoms. The purpose of this study was to examine the effects of gaze fixation on gait parameters in individuals with Parkinson's disease (PD). METHODS: Eight individuals with PD (aged 62.3 ± 8.1 years) volunteered for the study. Participants were mean 6.86 ± 6.62 years since diagnosis of PD and between stages 1 and 4 of the Hoehn and Yahr scale. Full body kinematic data were collected at 120 Hz during over ground walking using a Vicon motion capture system (Model 5.2.9, ViconPEAK, Oxford, UK). Two visual conditions were used to determine the effects of gaze fixation: Free Gaze and Fixed Gaze. During Fixed Gaze, participants were required to fixate on a fixed target 13 meters ahead. During Free Gaze, participants were free to visually scan the environment. Five walking trials were performed in each of the two visual conditions for a total of ten walking trials. Step width, step length, Centre of Mass (CoM) velocity and CoM medial-lateral deviation were calculated for two strides of each trial of over ground gait. Comparisons of mean values and variability were made using repeated measures MANOVA. RESULTS: Results revealed that Fixed Gaze had no significant effect on step length and step width. However, a significant increase in step width variability ($p = .003$) was observed as a result of Fixed Gaze. CoM velocity was also not significantly different between Free and Fixed Gaze conditions, means 1.17 ± 0.20 m/s and 1.16 ± 0.19 m/s respectively. CoM medial-lateral deviation was observed to be greater in the Fixed Gaze condition 47.14 ± 36.91 cm compared to Free Gaze 26.92 ± 15.05 cm, though not significantly so. CONCLUSIONS: These data suggest that gaze fixation does not significantly alter gait parameters in individuals with PD, however further analyses of lower limb joint kinematics and head-trunk coordination during gaze fixation will provide more insight into these findings.

P2-O-87 General motor-cognitive deficits in the postural instability and gait disorder (PIGD) subtype in Parkinson?s disease (PD)

Griet Vervoort[1], Aniek Bengevoord[1], Alenxandra Vanneste[1], Sarah Vercruysse[1], Wim Vandenberghe[1], Alice Nieuwboer[1]

[1]KU Leuven

Background and aim: The postural instability and gait disorder (PIGD) subtype in Parkinson's disease (PD) is typically characterized by increased gait, balance and cognitive deficits compared to the tremor dominant (TD) subtype. It is however unclear if the PIGD-specific problems are restricted to gait and postural control or extend to general spatiotemporal motor disturbances as assessed by motion analysis instruments. Methods: A group of 33 patients with early PD (disease duration: 4.8 ± 2.8 years) and 10 age-matched controls were included. Patients with PD were classified as PIGD (n=15), TD (n=12) or indeterminate (n=6) based on MDS-UPDRS subscores while 'off' medication. PIGD and TD subgroups

were matched for disease duration and MDS-UPDRS III score and the indeterminate group was excluded from the analysis. Gait was recorded using the VICON 3D Motion Analysis System and balance was evaluated using the mini-BESTest. Subjects also performed a bilateral antiphase repetitive movement task of the index fingers recorded with shaft-encoders. All tests were performed 'OFF' medication. Cognition was assessed using the Mini Mental State Examination (MMSE), Frontal Assessment Battery (FAB), Trail Making Test (TMT) part A/B and Alternating Intakes Test (AIT). Primary gait outcome measures were gait speed, gait asymmetry, step length, step time and their variability measures (COV). Similarly, for the upper limb (UL) task variability in amplitude and frequency in the disease dominant (DD) and non-dominant (ND) index finger were measured. All parameters were compared between PIGD, TD and controls using one-way ANOVAs or Kruskall-Wallis ANOVAs with Newman-Keuls posthoc tests. Results: A main effect of Group (PIGD, TD, control) was found for several parameters regarding gait (gait speed, step length and step length variability), balance, cognition (FAB score and TMT A time) and upper limb (UL) motor control (asymmetry and amplitude variability). Post-hoc testing showed a significantly decreased gait speed and step length in the PIGD compared to the TD group and increased frequency variability in the ND index finger. There was a trend for increased amplitude variability in the ND index finger. Additionally the PIGD group showed lower mini-BESTest scores and increased TMT A time, step length, step length variability and asymmetry during the UL task compared to controls. There was a trend for increased amplitude variability in both the DD and ND index finger. Conclusion: The results confirm increased gait and balance problems in patients with PD classified as PIGD and suggest that the mini-BESTest is a sensitive marker for PIGD in early disease stages. A novel finding is, however, that motor timing and scaling of a repetitive UL task is worse in PIGD compared to TD patients. Combined with greater cognitive impairment in this subpopulation, the results suggest the need to refine the PIGD subtype towards a more severe motor-cognitive profile.

P2-O-88 Postural responses to base of support and visual field in adults with cerebral palsy

Yawen Yu[1], Emily Keshner[1], Carole Tucker[1], Elizabeth Thompson[1], Richard Lauer[1]

[1]Temple University

BACKGROUND AND AIM: Deterioration of balance control has been found in adolescents and adults with Cerebral Palsy (CP) with aging. While musculoskeletal and sensory deficits may both affect balance, very little is known about how the sensory components play a role in balance control among individuals with CP. The current study is aimed at identifying postural responses to changes of the visual environment and the supporting surface in adults with CP in comparison to adults with typical development (TY). METHODS: Five adults with spastic CP and seven adults with TY participated in this study. They stood on a platform in a three-wall virtual environment. The platform was either tilted up into dorsiflexion by 3°, or kept stationary. During the tilting condition, the platform was held at tilted position for the first 30 s, and then gradually returned to a neutral position over 30 s. The visual scene was set to either pitch up or pitch down, at either 15°/s or 30°/s. Center of mass (COM) throughout the trials was measured for analysis. RESULTS: Greater speed of the visual scene movement induced greater positional variability of COM in both the anterior-posterior (AP; $p < .001$) and the medial-lateral (ML; $p = .002$) directions for both groups. The speed induced an even greater response in the ML axis in adults with CP in comparison to adults with TY, as depicted by an interaction effect between group and speed ($p = .018$). Furthermore, an exaggerated visual illusion that emerged from opposite movements of the visual scene and the

platform turned out to impose greater postural response of adults with CP in the ML direction (p = .023). There was no effect of platform movement in either group. CONCLUSIONS: Overall, the results from the current study indicated that balance of individuals with CP was greatly affected by the visual scene movement. The reliance on visual information may indicate the potential deficits in the vestibular and/or somatosensory systems. The inability to compensate for changes in visual environment may hamper the maintenance of functional activity such as locomotion. Future studies are needed to investigate the engagement of vestibular and/or somatosensory systems in balance control in this population to further develop effective interventions.

P2-P-89 Comparison of postural control with different customized foot orthoses on isolated subtalar arthrodesis

Ceccaldi Edouard[1], Marc Janin[2]

[1]Podiatry office, [2]Podiatry clinic

Background and Aim: Studies describe subtalar and ankle arthrodesis as a factor altering the biomechanics of the foot during walking [1] whereas postural control appears physiological [1]. Furthermore, foot orthoses (FOs) are also recognized for their actions on dynamics [2] and balance [3] but not for their postural impact on an isolated subtalar arthrodesis (ISA). Previous studies have shown that depending on the type of FOs [4] and along the comfort felt by the subject [5], the variations induced by different FOs were significantly different. The aim of this study was to compare effects of different types of FOs on balance of patients with an ISA. Methods: Two subjects with ISA were volunteers for one session of three repeated measures: without FOs (Control), with Classical FOs (FOsC) and with Molded FOs (FOsM). After a clinical examination, these two types of FOs are custom-made including same posting. We compared postural variations through Center of Pressure (CoP) displacements. Three modalities have been demanded at each measure: Normal stance, One-leg stance on the ISA (OnISA) and One-leg stance on the control foot (OnControl).For each conditions Area, Sway and Mean speed of the CoP were data and compared. The perception of comfort was evaluated by 100mm visual analog scale (VAS) [5]. Results: VAS expose that, subjects did not feel a real comfort in their shoes without FOs (47,5mm). FOs increased comfort (>17,9mm). FOsM were perceived as significantly more comfortable than FOsC, respectively 97mm and 65,5mm. Postural assessment showed the CoP Area (Figure 1), Sway and Mean speed were improved by both FOs with Normal stance. For OnISA, the postural control was significantly altered by FOsC and improved by FOsM. In contrast, we observed for OnControl that postural control was more improved by FOsC. Conclusions: FOs induced different effects on postural control of subjects with ISA depending on orthoses type and parameters observed. FOsM appear as clearly preferable to improve postural control on an ISA. The comfort is significantly improved by FOs and much more by FOsM. The data suggests correlations between improvement of balance and perception of comfort for patients with an ISA. References 1. Flavin R and al.Comparison of gait after total ankle arthroplasty and ankle arthrodesis. Foot Ankle Int. 2013, 34(10):1340-8. 2. Telfer S and al.Dose-response effects of customised foot orthoses on lower limb kinematics and kinetics in pronated foot type. J Biomech. 2013, 46(9):1489-95. 3. Gross et al.Effects of foot orthoses on balance in older adults. J Orthop Sports Phys Ther. 2012; 42(7):649-657. 4. McPoil TG and al.Effect of foot orthoses contour on pain perception in individuals with patellofemoral pain. J Am Podiatr Med Assoc. 2011, 101(1):7-16. 5. Mills K and al.Influence of contouring and hardness of foot orthoses on ratings of perceived comfort. Med Sci Sports Exerc, 2011, 43(8):1507-12

P2-P-90 Gait kinematics after partial amputation of the toes due to the frostbite

Wanda Forczek[1], Yuri Ivanenko[2], Simon Taylor[3]

[1]University School of Physical Education , [2]IRCCS Fondazione Santa Lucia, [3]College of Sport and Exercise Science, Victoria University

Background Able-bodied gait requires stability of the body in the support phase, proper transfer of the limb in the swing phase, proper foot position at the end of this phase and employment of the steps proportionate to the length of the body. These features can be used as reference point for a thesis that the person's pattern of walking after amputation of the toes is pathologically altered comparing to normal ambulation. The purpose of the study was to identify the differences within gait kinematics of young man after bilateral partial amputation of the toes in two conditions: barefoot and in shoes on the background of normal data. The data from the literature served as the patient's control. Methods The subject was 30 yr old man (body height and mass: 186cm, 82kg, respectively) suffering a frostbite injury while practicing mountain climbing. During treatment process, the amputation occurred necessary. After 1.5 yr from the surgery the patient's state was as follows: in the right foot the absence of the half of distal phalanx of great toe, half of the distal phalanx of 2nd and 3rd toes, while in the left foot the absence of distal phalanx and 1/3 proximal phalanx of great toe, distal and medial phalanx 2nd, 3rd and 4th toes and distal phalanx of the 5th toe. Gait parameters were derived from a 3D motion capture system (Vicon 250) and Golem marker set-up. The gait test involved over-ground walking at self-selected speed. Walking trials were separated by footwear condition: barefoot and shod (participant's athletic shoes). Six trials were recorded in each condition, which provided 16 complete gait cycles for each limb. Gait parameters were derived from each cycle and then averaged across all trials. The gait variables of interest were spatio-temporal parameters, the joint range of motion in the sagittal plane, and the pelvic motion in all three planes. Results Comparison of the results showed that barefoot walking after amputation results in decreased values of velocity, step frequency and stride length, and increased values of double support phase and stride time. As to the movement amplitudes of the lower limb joints and pelvis they were smaller in barefoot gait than in the two resting conditions. The shoes provided increased joints mobility, close to the normal gait. Conclusions Partial amputation of the toes contributes to biomechanical pathology within the whole complex unit that is a lower limb. Since the toes are responsible for enlargement weight-bearing area during walking, it can be assumed that the differences noted between walking after amputation and healthy gait may be associated with a risk of loosing stability. Person after injury while moving barefoot must pay particular attention to the placement of the feet on the ground. This precaution manifests in a slower speed, shorter steps, or a reduction of the ankle joints mobility. The results clearly show the rationale for the use of proper footwear to provide more stable posture.

P2-P-91 Fear of falling is not elevated in younger patients after total knee replacement

Brian Street[1], William Gage[1]

[1]York University

Background: Fear of falling is an independent contributor to functional decline [1] and associated with decreased participation in mobility and social activities [2], precipitating health deterioration. Increased fear of falling has been associated with ageing [3] and has been shown to be further elevated in total

knee replacement (TKR) patients [4]. However, a recent Canadian joint replacement registry has suggested that the largest percent increase (≈300%) in those undergoing TKR is in the 45-54 age group [5]. Importantly, balance confidence and fear of falling of this quickly growing 'younger' TKR patient group may differ from the typical older patient, which may have important clinical implications. Therefore, the purpose of this project was to investigate fear of falling among the younger TKR patient group, and compare the younger and older TKR patient groups on measures of balance confidence and fear of falling. Methods: A convenience sample of 59 participants, including 29 primary knee replacement patients, provided informed consent. Participants formed four groups: 1) Younger Patient (n=15 (11 F), age: 54.3 ± 7.9 years), Younger Control (n=15 (13 F), age: 55.2 ± 4.0 years), Older Patient (n=14 (12 F), age: 76.9 ± 4.7 years), and Older Control (n= 15 (11 F), age: 77.7 ± 4.1 years). Data for the two patient groups were collected 6-months post-surgery (6.2 ± 0.6 months). Participants completed the Activities-specific Balance Confidence (ABC) Scale and the Balance Efficacy Scale (BES). Two-factor univariate ANOVA was used to test for differences between group (patients/controls) and age (young/old). Tukey post-hoc analysis was used to explore significant differences. Results: A significant interaction effect for ABC ($F_{1,58}=5.21$, $p=0.03$) revealed no difference between the control and patient groups among the younger participant; ABC scores were lower among the older patients compared to the young, and lower for the older patients compared with the older controls. A significant interaction effect for BES ($F_{1,58}=4.68$, $p=0.042$) revealed that while scores were lower for the older groups, and for patients compared to controls, younger patients demonstrated lower scores compared to the younger control group, but there was no difference between the older patients and the older control group. Conclusions: Previous research has shown TKR is associated with increased self-reported fear of falling. However, the findings of the current study show that TKR does not influence balance confidence among younger patients. Fear of falling and diminished balance confidence, two factors associated with reduced activity among older, typical TKR patients, may not so negatively influence the activity patterns of younger patients. Importantly, if the increase in physical engagement produces negative consequences related to prosthesis survival this would then help explain the elevated revisions rates that have been reported among younger TKR patients.

P2-Q-92 The effect of concussions on the loading phase of gait initiation

Michael Cinelli[1], Kaley Powers[1], Adam Harper[1]

[1]Wilfrid Laurier University

Background: Gait initiation perturbs the balance control system as an individual moves from a static position to a dynamic movement1. This is achieved through a rapid loading and unloading of the swing limb. Centre of pressure (COP) has been used to quantify gait initiation in young and older adults, as well as in certain patient populations (e.g., Parkinson's disease). Findings have revealed that with increasing age and PD, there is a reduction in the displacement of the COP in both the A/P and M/L direction1. Since concussed individuals demonstrate impairments during static2 and dynamic balance3,4, the objective of this study was to determine if these impairments were also present during a gait initiation task. Methods: Participants stood on a force plate with their feet shoulder width apart and hands by their side. Participants were instructed to step with their dominant foot toward one of three locations: straight-ahead (0°) and to the right and left of the participant at 30°. This created three stepping conditions: step narrow, step straight, and step wide. Each condition was performed 6 times in random order, for a total of 18 trials. Three of the 30 soccer players who had performed this task prior to the

start of their varsity season experienced a concussion during the season and returned for post-concussion testing. A 2x3 (time x step direction) repeated measures ANOVA was used to determine the effect of a concussion on the COP displacement and rate of change during the loading phase of gait initiation. Results: Posterior COP displacement was significantly greater following a concussion (4.58 ± 1.38cm) compared to baseline testing (3.36 ± 1.56cm), (p=0.02). However, the rate of loading was not different between the two time points. Additionally, there was neither a change in M/L COP displacement nor rate of loading in the M/L direction following a concussion. Stepping direction also had no impact on any of the dependent variables, suggesting a similar strategy was employed across all conditions. Conclusions: Unlike older adults and individuals with PD, concussed athletes demonstrate increased posterior COP displacement during the loading phase of gait initiation. This alteration is most likely produced to overcome the greater A/P sway previously observed during static stance, which is likely the result of impaired vestibulospinal information2. Isolating balance impairments in the A/P direction suggest that concussed athletes can effectively control M/L movement using somatosensory information from plantar cutaneous receptors. Therefore, a gait initiation task appears to be a sensitive measure to detect balance control changes following a concussion. References: 1 Halliday et al., (1998). Gait & Posture, 8, 8-14 2 Powers, K., Kalmar, J., & Cinelli, M. (2014). Gait & Posture, 39(1), 611-614 3 Parker et al., (2006). MSSE, 38, 1032-1040 4 Catena et al., (2007). EBR, 176, 23-31

P2-Q-93 Do load sensations at the foot sole contribute to enhanced postural stability when ankle feedback is increased?

Brian Dalton[1], Billy Luu[2], John Inglis[2], Michael Koehle[2], HFM Van der Loos[2], Elizabeth Croft[2], Jean-Sébastien Blouin[2]

[1]University of Oregon, [2]University of British Columbia

BACKGROUND AND AIM: Sensory afferents coding for proprioception at the ankle seem to be critical for standing balance control (Fitzpatrick et al. 1994). When ankle proprioception is reduced (i.e., sway referenced balancing), variability in postural sway is increased (Horak et al. 2002). However, it is unknown if increasing positive ankle feedback gain increases or decreases postural stability. Furthermore, load sensors of the foot sole may contribute to this altered feedback gain at the ankle and the automatic feedback control to the muscles involved in standing. For instance, when foot loading forces are unloaded rapidly, the soleus and gastrocnemius exhibit a short-latency drop in activation (van Doornik et al. 2011). Thus, the purpose here was to investigate the effects of a range of ankle feedback gains on the variability of whole body postural sway and whether this control is related to afferent feedback coding for load sensations at the foot sole. METHODS: Participants were braced upright while controlling an inverted pendulum-like motion of a robot platform that mimicked normal standing. An ankle-tilt platform mounted to the motion platform enabled independent control of ankle rotation. During all experimental trials, the participants were instructed to balance normally. From trial to trial, the gain of ankle joint rotation feedback varied. Each trial lasted 60 s, where the gain of the ankle tilt platform was set at ×0, ×1, ×2, ×-1, or ×-2 relative to body motion. A gain of ×0 meant that the ankle-tilt platform was fixed and the ankle joint was sway referenced to body motion; whereas a gain of ×1 resembled normal ankle rotation and ×2 represented twice the increase in ankle dorsiflexion for a given change in body angle. A gain of ×-1 produced plantar flexion of the ankle joint as the body rotated forward while a gain of ×-2 represented twice the increase in ankle plantar flexion when the body moved forward. These experiments were also repeated in a subset of participants who received a

complete bilateral block of the posterior tibial and sural nerves to remove sensation of foot loading forces. RESULTS: The standard deviation of the position of centre of mass for the normal (gain of ×1) condition was 0.5 ± 0.1° and was ~80%, ~100%, ~140% greater for the ×0, ×-1 and ×-2 conditions, but ~40% less for a gain of ×2 than the normal condition, respectively. The standard deviation values were ~13% and ~14% greater for a gain of ×1 and ×2, but ~10% and ~16% lower for a gain of ×-1 and ×-2 with the neural block than without, respectively. CONCLUSIONS: The results indicate that as the positive gain of ankle feedback increases, body motion becomes more stable and feedback from afferents coding for ankle rotation are critical in stabilizing whole-body sway. Because the bilateral block altered the variability of sway, load sensors of the foot sole likely play a role in the stabilization response to increasing positive ankle feedback.

P2-Q-94 Proprioceptive vibration effects on older healthy subjects

Noémie DUCLOS[1], Luc MAYNARD[2], Serge MESURE[1]

[1]Institut of Movement Sciences, [2]CRF Valmante

Background and Aim: Declines in proprioception function is part of aging process. However, the contribution of proprioceptive information in postural control seems to increase with age [1] and contributed to a greater risk of falling. The right hemisphere should be dominant for muscle spindle feedback process [2]. Nevertheless, age induced a larger recruitment of cerebral areas than young adults to realize a same level of performance. Our main objective is to determine if the increase of the asymmetry between hemispheres with age has some specific postural consequences. Our second objective is to determine if the medio-lateral balance particularly altered in older subjects during quiet standing could result from a modification in the sensory-motor integration of proprioceptive information. Methods: We applied bilateral (BiVib) or unilateral (UniVib) vibration (20 seconds, 80 Hz) on Achilles or Peroneus tendons, to young (n=21, 23.6 /- 4.7 years) and senior (n=15, 57.6 /- 6.5 years) adults in standing position, in their preferred side-by-side feet position and without vision. Y and X positions of the Center of Pressure (CoP) and the covered length were computed and their evolution along time. Statistic analyze was realized through a repeated measures ANOVA. Results: Vibration applied on Achilles tendons led to a backward shift of the CoP. This displacement was larger for senior (-25.6 /- 12.4 mm) than young group (-19.4 /- 6.6 mm) in BiVib. In UniVib, the Y displacement became significantly larger for vibration applied on the left limb than on the right one, for the senior group only. X displacement appeared during UniVib only and was larger for senior group, with a longer necessary time (4s more) to stabilize the displacement. There was no effect or interaction of group on analyzed parameters for vibration applied on Peroneus vibration, except on the covered length. For all conditions, vibration led to an increase of the instability. The effect of group appeared specifically for observations after vibration. The covered length stayed more important than initially during at least 4s more for senior than young group. This required time was increased after BiVib applied on Peroneus tendons. Conclusions: The sensory-motor integration of proprioceptive information is well affected by age. We highlight here some age-induced postural consequences reflecting an asymmetry in plays of hemispheres in the postural control. The age effect seems to be majored in the reweighting process, at the stop of vibration. It reflects a difficulty to down-regulate individual sensory modalities, possibly linked to a larger recruitment of cerebral areas. This difficulty seems increased after perturbation applied specifically along the medio-lateral axis. Rehabilitation programs with older people need to

consider all these post-effects of perturbation. [1] Maitre J & al. Eur J Appl Physiol. 2013;113(7):1821-31 [2] Goble DJ & al. J Neurosci. 2011;31(45):16344

P2-Q-95 Cortical activity during the planning to cross an obstacle in young healthy adults

Natsu Fujiwara[1], Kozo Ueta[1], Shu Morioka[1]

[1]Graduate school of health science,kio university

1. Background and aim of the study Humans use visual information for planning to step over obstacles (Patla, 1996). A previous study (Moraes, 2004) reported that adjustment of foot placement is initiated a few steps before reaching the area to be avoided. Increased activity has been observed in both the supplementary motor area and premotor cortex during imagination of crossing (Wang, 2009), and the parietal area shows increased activity just before crossing over an obstacle (Drew, 2011). However, the brain areas active during the planning to avoid an obstacle are unknown. Therefore, the purpose of this study was to examine brain activity during the planning to avoid an obstacle. 2. Methods We recruited eight healthy subjects (age, 26.7 ± 3.5 years). We set six different gait conditions by varying two factors: distance and height of the obstacle. For distance, the obstacle was placed either near (at step 4) or far (at step 8). For height, the conditions were no obstacle, an obstacle of 1 cm, and an obstacle of 20 cm. The subjects were asked to stand with their eyes closed for 10 sec and then to stand with open eyes for 6 sec before walking, starting with the right foot. They had to walk five times in each condition, in a random order. Using 64 electrodes placed according to the international 10-20 system, electroencephalographic (EEG) measurements were obtained for the time period from standing with closed eyes to standing with opened eyes (the time spent in planning to avoid the obstacle). Event-related desynchronization (ERD) for the á (8-13 Hz), â (13-30 Hz), and ã (30-70 Hz) bands were calculated using power spectrum analysis. We selected parietal area (P3, P4), supplementary motor area (FCz), and prefrontal area (Fz) electrodes for analysis. A force plate was used to measure step length during walking. Repeated measures two-way analysis of variance (ANOVA) was used to compare the ERD values and step lengths for different conditions of distance and height; Tukey's post hoc test was also applied. The level of significance was set at p value less than 0.05. 3. Results Height had a significant main effect ($F(2.4) = 4.66$, $p < 0.05$) on step length (3 foot point); the step length (3 foot point) was significantly increased for the near-obstacle of 20 cm condition compared to the near-no obstacle condition ($p < 0.05$). Both height and distance showed significant main effects ($F(2.4) = 12.11$, $p < 0.01$) on gamma ERD at P4 (left parietal electrode). The amplitude of gamma ERD recorded at P4 was highest for the near-obstacle of 20 cm condition, and it was significantly higher for the far-obstacle of 20 cm condition than for the far-no obstacle condition ($p < 0.01$). 4.Conclusions Our results for step length suggest the possibility that the planning to modify stride occurs near the obstacle. Our findings for activity in the left parietal area indicate the involvement of this region in the planning to modify.

P2-Q-96 Analysis of factors influencing the functional reach test in a cohort of 1102 elderly

Sandra Hasmann[1], Markus Hobert[1], Jana Staebler[1], Sebastian Kormeier[1], Gerhard Eschweiler[1], Daniela Berg[1], Walter Maetzler[1]

[1]University Hospital of Tübingen

Background and Aim: The functional reach (FR) test is a clinical measure of balance and margin of stability (Duncan et al., 1990). It is widely used to assess fall risk in elderly (Dibble et al., 2006, Spilg et al., 2012), as well as to assess mobility and rehabilitation effects (Granacher et al., 2013, Weiner, 1993). Factors known to be associated with FR distance are age, gender, height, weight and frailty (Duncan et al., 1992, Martins et al., 2012), but their impact on FR performance is not yet determined in detail. Methods: In this cross-sectional analysis we assessed the association of different demographic and clinical parameters with FR distance in a cohort of 1102 non-demented individuals between the age of 50 and 83 years (www.trend-studie.de). FR distance was determined by asking all participants to reach with their right arm forward as far as possible. Significantly associated parameters were included in a multifactorial model. Results: The mean FR distance was 26.75 cm. It was significantly associated with height (in particular leg length), demographic parameters (age, gender, education years) , motor parameters (fast walking speed, Timed-up-and-Go performance and grip strength), cognitive parameters (executive function, subtracting of serial sevens, Delta TMT), sensory parameters (visual acuity, pallaesthesia) and occurrence of hypertension, orthopaedic disabilities, and unspecific symptoms of fatigue and muscular weakness ("Are you out of breath while taking stairs?"). Inclusion of all factors in a model explained 25% of FR distance. Most contributing factors were (in descending order) leg length (10%), age (6%) and grip strength (6%). Parameters of physical (in)activity and frailty (apart from grip strength) did not relevantly contribute to the model. Conclusion: This analysis of factors associated with FR distance in a large cohort of healthy older adults confirms the previously described associations of this measure with age, gender and height. Moreover, it shows that FR distance is relevantly influenced by many additional systems, such as the motor, cognitive and sensory systems. . Importantly, all these factors explained only one fourth of the observed FR variance. Potential reasons and implications for research and clinical use will be discussed.

P2-Q-97 Reaching the limits of cognitive resources: Control strategies used by children during a multi-task paradigm.

Dorelle Hinton[1], Lori Ann Vallis[1]

[1]University of Guelph

BACKGROUND AND AIM: Dual motor tasks have been well studied in adults however there is a lack of knowledge concerning 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 can 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 a 'ceiling effect' in children aged 6 years [Guy et al,Inf Child Dev 2012,21:521-536;Jerger et al,Brain Lang 1988,35:86-104] suggesting 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 altered control strategies (e.g. slowing/stopping) would be used as attentional limit was reached in order to maintain balance and correctly answer the Stroop task. METHODS: Healthy children aged 7 years (n=5,7.22±0.28 years) were instrumented with Infrared diodes(Optotrak, Northern Digital Inc.,Canada) mounted on the head, trunk, pelvis and feet, anatomical points were digitized; single IREDs were attached to both elbows and wrists. First, while seated, subjects balanced a ball on a Frisbee

with the non-dominant hand and picked up a toy off the ground with the dominant hand (10 trials). To confirm their understanding of the cognitive task, subjects performed the auditory Stroop test while seated (8 trials). In the final task (12 trials) the child balanced the Frisbee and ball while walking, and then picked up a toy off the ground. The Stroop test was administered during the child's last step before the toy during 6 of 12 walking trials. Independent variables included posture (seated/walking) and auditory condition (Stroop/no Stroop). From kinematic data, trunk, upper arm (UA) and forearm (FA) absolute angle change were calculated; gait velocity during the approach and while answering the Stroop task were also compared. RESULTS: Unexpectedly, subjects successfully maintained Frisbee balance throughout all walking trials, despite the addition of the Stroop task. Absolute trunk, UA and FA angle changes were significantly different ($p<0.05$) suggesting articulated segmental control. Despite this observation, preliminary findings indicate children age 7 still partition concurrent motor-cognitive tasks; walking speed during toy approach was significantly slower while answering the Stroop task (0.50±0.54 m/s compared to 1.03±0.31 m/s;$F(1,87)=32.766, P<.001$). CONCLUSIONS: Our novel paradigm combines a complex locomotor task with an auditory Stroop task, exposing the cognitive and attentional resource limits of children aged 7 years.

P2-Q-98 Proprioceptive postural control and sit-to-stand-to-sit performance after first-time lumbar micro-discectomy: The effect of surgical approach and early individualized physical therapy

Lotte Janssens[1], Simon Brumagne[1], Kurt Claeys[1], Madelon Pijnenburg[1], Nina Goossens[1], Bart Depreitere[1]

[1]KU Leuven (University of Leuven)

BACKGROUND AND AIM: Despite the high success rate of first-time lumbar micro-discectomy (LMDT), residual functional complaints are not infrequent. Individuals with recurrent non-specific low back pain decrease their reliance on back muscle proprioception, enforcing the use of ankle muscle proprioception during postural control, which is associated with a decreased sit-to-stand-to-sit (STSTS) performance. However, the proprioceptive postural control (PPC) strategy of LMDT patients is still unknown. Transmuscular (TM) versus paramedian (PM) LMDT techniques, inducing different amounts of muscle damage, often lead to different clinical outcomes. Although physiotherapy (PT) is recommended after LMDT, the optimal content is still unclear. The aim of this study was to evaluate PPC and STSTS performance after two surgical approaches of LMDT, and the effect of early individualized active PT. METHODS: Twenty-five individuals after LMDT using a TM or PM approach, were randomly assigned into a PT (n=12) and control (n=13) group. The PT started 2 weeks after LMDT and was mainly oriented on patient education, ergonomics and motor control exercises. Primary outcomes were evaluated at 2, 8 and 24 weeks after surgery. The PPC strategy was evaluated by measuring center of pressure displacement in response to ankle and back muscles vibration, in upright standing on stable and unstable support surface without vision. The time to perform five consecutive STSTS movements without vision was recorded. RESULTS: Two weeks after LMDT, patients showed larger responses to ankle muscle vibration compared to back muscle vibration on unstable support surface, predominantly in the PM (ankle: 7.3±4.1cm; back: 2.4±2.9cm) compared to the TM group (ankle: 3.0±5.3cm; back: 3.2±1.8cm) ($p=0.043$). After PT, individuals showed significantly smaller responses to ankle muscle vibration on stable support surface (Ä 2.7cm, $p=0.032$ (at 8 weeks); Ä 3.8cm, $p=0.031$ (at 24 weeks)), and larger responses to back muscle vibration on unstable support surface (Ä 1.4cm, $p=0.016$ (at 24 weeks)).

Already eight weeks after LMDT, the PT group needed significantly less time to perform five consecutive STSTS movements compared to the control group (14±4s vs. 26±14s) (Ä 12s, p= 0.010). CONCLUSIONS: Two weeks after LMDT, patients show a higher reliance on ankle proprioceptive signals compared to back proprioceptive signals, similar to people with recurrent non-specific low back pain without surgical history. This was particularly pronounced when using the PM compared to the TM technique, suggesting muscle spindle integrity as a contributory factor to residual complaints after LMDT. However, PT induced an increased reliance on back proprioceptive signals and an early improvement of STSTS performance. Therefore, active PT starting 2 weeks after LMDT using a TM approach may play an important role in early improvement of function and return to daily activities.

P2-Q-99 Effect of light touch on quiet stance and reactive postural responses in post-stroke individuals

Alessandra Martinelli[1], Daniel Coelho[1], Fernando Magalhães[2], Andre Kohn[2], Luis Augusto Teixeira[1]

[1]School of Physical Education and Sport, University of São Paulo, São Paulo, [2]Biomedical Engineering Laboratory, University of São Paulo, São Paulo

BACKGROUND: Individuals who have suffered a cerebrovascular accident usually present balance deficits as observed by the increased postural sway (DICKSTEIN e ABULAFFIO, 2000). Use of additional somatosensory information could be an important strategy for the stroke individuals to enhance their postural stability. Reduction of body sway by light touch has been conceived as a result of the high haptic sensitivity from cutaneous receptors at the skin surface (JEKA, 1997), which are particularly dense on the fingertip. While the effect of light touch has been studied in post-stroke individuals in quiet stance (CUNHA et al., 2012), its potential benefit for reactive postural responses has not been addressed. The aim of the present study was to investigate whether post-stroke participants are able to use the additional somatosensory information provided by the light touch to reduce their postural sway after a mechanical perturbation. METHODS: Four post-stroke adults either with right (n = 2) or left (n = 2) hemiparesis participated in the study. Participants stood upright in bipodal support on a force plate. They were evaluated during quite stance and while they were pulled backward by a horizontal force (5% of body weight) (Figure 1). Unpredictable release of the load led to anterior sway of the participant's body. Evaluation was made on no finger touch, and light finger touch with the non-paretic hand, with instructions to do not applying a vertical force greater than 1 N on the touching surface. The effect of light touch was assessed contrasting vision versus no vision. RESULTS: Analysis of feet center of pressure (CoP) following mechanical perturbation showed a significant touch by vision interaction. Light touch with vision led to smaller amplitude of CoP displacement than no touch with vision. Light touch with vision led to smaller amplitude of CoP displacement than light touch without vision. Analysis of quiet stance indicated that area and amplitude of anteroposterior and midlateral directions of CoP sway indicated smaller values for the light touch in comparison with no touch. CONCLUSIONS: Our findings suggested the light touch reduced the postural sway of stroke survivors after a mechanical perturbation and during quiet stance. Participants were able to use the additional somatosensory information when the index fingertip touched the external bar. This additional sensory information can provide a spatial reference of the participant's body position with the vertical leading to a reduction of the CoP sway.

P2-Q-100 Subcortical structures in humans can be facilitated by transcranial direct current stimulation

Jorik Nonnekes[1], Anass Arrogi[2], Moniek Munneke[2], Edwin van Asseldonk[3], Lars Oude Nijhuis[2], Alexander Geurts[2], Vivian Weerdesteyn[2]

[1]Radboud University Medical Centre, [2]Radboud University Medical Centre Nijmegen, [3]Department of Biomechanical Engineering, MIRA, University of Twente

BACKGROUND: Transcranial direct current stimulation (tDCS) is a noninvasive brain stimulation technique that alters cortical excitability via application of a weak direct current. Interestingly, it was demonstrated in cats that tDCS can facilitate subcortical structures as well (Bolzonii et al., J Physiol, 2013). Here, we hypothesize that subcortical facilitation by tDCS is also possible in humans. We assessed the effects of tDCS on two responses that are evoked from subcortical structures, in particular the reticular formation. First, we examined the StartReact effect, in which a startling acoustic stimulus (SAS) accelerates movement responses to an imperative stimulus. The SAS-induced responses are thought to reflect a direct subcortical release of motor programs. Second, we examined automatic postural responses to external balance perturbations, with and without a concurrent SAS. These initial postural responses also arise from subcortical structures. METHODS: Ten healthy adults received anodal-tDCS (15 minutes, 2 mA) and sham-tDCS on two different testing days in a counterbalanced order. The anodal electrode was placed over the non-dominant motor region, the reference electrode over the contralateral supraorbital region. After stimulation, we instructed participants to respond as fast as possible to a visual imperative stimulus during (1) dorsiflexion of the dominant or (2) non-dominant ankle, and (3) flexion of the dominant wrist. Furthermore, using a moveable platform, we evaluated automatic postural responses to translational forward and backward balance perturbations (0.75 m/s2). A SAS (116 dB) was delivered simultaneously with the imperative stimulus and balance perturbations in 25% of trials. We assessed electromyographic and kinematic responses. RESULTS: During all tasks, response onsets were significantly faster (4-13 ms) following anodal-tDCS compared to sham-tDCS, both in trials with and without a SAS. A SAS accelerated latencies of the simple reaction movements as well as the responses to backward balance perturbations. The effect of tDCS did not differ between legs. CONCLUSION: Our results suggest that subcortical structures in humans, in particular the reticular formation, can be facilitated by tDCS. This effect may be explained by two mechanisms that are not mutually exclusive. First, the applied current may have directly stimulated the reticular formation. Second, subcortical facilitation may have resulted from enhanced cortico-reticular drive. As cortico-reticular tracts project bilaterally, the latter mechanism may explain the absence of tDCS-related effects between the legs. There is evidence that reticulospinal tracts play an important compensatory role in the recovery after corticospinal lesions. Application of tDCS may increase the number of activated reticulospinal neurons or result in a stronger subcortical output, both of which could be beneficial for the recovery of motor functions during rehabilitation.

P2-Q-101 The Effect of Conflicting Virtual Scenery on Leveled and Inclined Gait

Meir Plotnik[1], Yotam Bahat[2], Yoav Gimmon[1], Rivka Inzelberg[1]

[1]Sheba Medical Center, [2]heba Medical Center

Background and aim: The effects of visual flow on gait were studied mainly in relation to gait speed control. Our objective is to study the effects of visual scenery related to path inclination on gait. We hypothesize that visual cues related to path inclination during treadmill walking will trigger gait modulation, even in the absence of actual inclination. Methods: Eleven young healthy adults (7 women;

mean age ± SD: 29.5 ± 4.3 y; BMI: 23.0 ± 3.9) participated so far. We used the CAREN (Computer Assisted Rehabilitation Environment) - high end (Motek Medical©, the Netherlands) system, which has 6DF moveable platform is installed that contains an instrumented treadmill (TM), placed in a dome shaped space. TM speed was determined using 'self- paced' mode, i.e., the subject's center-of-mass (COM) position (calculated in real time from a motion capture system) feeds acceleration or deceleration commands to the TM controller. Uphill/downhill walking simulation was created when the platform was pitched up or down along with synchronous elevation of the projected road scenery. After walking straight and level (15 s), the condition either did not change or changed in : (A) synchronized visual-platform manipulation (SyncVPCs); or (B) conflicting visual-platform conditions (ConflVPCs). The effect on gait parameters was measured. Results: Here we report on the effect on gait speed (data from seven subjects was analyzed so far). From trail start, gait speed stabilized after ~ 30 s' for straight level walking, and after ~40 s', for uphill/downhill conditions. . Mean plateau values of gait speed (±SD) were 1.65 ± 0.15 m/s and 1.38 ± 0.11 m/s for the straight and uphill conditions, respectively (p=0.003). Immediately after the downward platform pitch (and the appearance of visual downhill road scenery), the subjects slowed their gait, and gradually increased it back, which probably reflects full control over the additional gravitational driving force (Fig 1A - Averaged speed from all subjects). In both conflicting conditions (Fig 1B), the subjects reacted already within the 5 s' of the transition in the visual scenery, by hastening their gait in the case of the uphill visual illusion (probably generating additional effort required for uphill climbing), and by reducing gait speed in response to the downhill visual illusion (probably restraining downward 'pushing' force) . In both cases the effect peaked at about 10 s' after the start of the change in the visual scenery, and subsides within the next 10 s', after which the subjects walked in their normal straight level speed. Conclusions: Conflicting visual flow related to path inclination can modulate gait speed, even when no change in actual inclination occurs, a finding that underscore the role of visual input in gait control. It remains to be seen if this, seemingly transient effect, can be utilized to facilitate gait rehabilitation programs.

P2-Q-102 Insoles Impact on Imagined and Actual Movement

PUIL Carole[1], Marc JANIN[2]

[1]Podiatrist Office, [2]Podiatrist Clinic

BACKGROUNG AND AIM: The posture is modified when we are in movement like walking. We know that insoles have an effect on posture and movement [1]. Previous studies exposed that duration of exercice such as physical practice (PP) or mental practice (MP) can change regarding a perturbation [2]. METHODS: As we were interested in the role of the foot sole in postural control we compared the perturbation induced by insoles (postural (PI), precise cues variation, and biomechanical (BI) global stimulation) on motor control during a walking task. 10 patients were asked to walk in place 30 feet [3] on PP an MP in 3 conditions: without insoles (control Ct), with IP and IB. We observed their effects on postural control, area, speed and variation of Speed of Centre of Pressure (CoP), posturodynamic test [4] and visual analogue scale (vas) comfort. We compared, for each condition, before and after PP and MP. RESULTS: they exposed diminution of CoP parameters after MP for each condition (12,988 mm/s², ó=12,251 to 8,106mm/s², ó=6,014). The area of CoP during PP increased for Ct and PI (441.597mm², ó=826.594 to 578,465mm², ó=509,769) but stay equal for BI (132,291mm², ó=207,369 to 146,568mm², ó=104,762). Insoles effects were controversy, no effects were observed on speed variation for MP. Also PI increased speed (12.851mm/s², ó=11,013 to 22,068mm/s², ó=14,973) and IB maintains it before and

after PP. Both are decreasing speed variation and speed if we compare PP and MP. Also in every condition, speed is slowing down, after MP (11,871mm/s², ó=8,507 to 9,157mm/s², ó=6.14). No variation is reported on the posturodynamic score in each condition (PP, MP, BI and PI). Subjects comfort with BI and PI were better than Ct. Score was less improved before and after practice by BI (PP,MP) than PI. CONCLUSION: Perturbations induce by insoles is depending on the feedback that they produce (BI high level, PI specific level). Clinical evaluation by posturodynamic test cannot objectify which one is the most efficient insole. However, comfort evaluation (vas) is improved by BI. It seems that more quantity of information (BI) is easier to manage than specific information (PI). BI bring a greatest quantity of sensation. This quality/quantity of sensory informations is used in postural control. When this feedback interfering with PP, only BI performed control and guide the overall structure of the action (speed and area CoP decreased). On MP, these sensory cues variations not only play a key role in guiding key biomechanical parameters but also performed postural control before mental representations. Also BI with their high level of sensory information are highly efficient on postural control during this task.

P2-Q-103 Decline in lateral step initiation in older adults: a longitudinal study

Patrick Sparto[1], J. Richard Jennings[1], Mark Redfern[1], Joseph Furman[1]

[1]University of Pittsburgh

BACKGROUND AND AIM: During voluntary lateral step initiation, older adults demonstrate step biomechanics characterized by one (direct unloading) or two (loading followed by unloading) postural adjustments in the vertical ground reaction force (VGRF) of the step leg. One postural adjustment is typically produced by young adults. In older adults, two postural adjustments have been seen and associated with retrospective history of falling. We hypothesize that producing more steps with two postural adjustments is an indicator of changes in postural control due to aging. In addition, delays in initiating the step would be an expected sign of aging. The purpose was to investigate changes in lateral step biomechanics in older adults over a three-year period. METHODS: Ten community ambulating older adults (range 70-80 y) performed a lateral step initiation task during two visits separated by three years. Subjects stepped laterally in response to left or right directional arrows displayed on a computer monitor, blocked by step direction, analogous to a simple reaction time task (24 stimuli per block). The VGRFs were measured separately under each foot using forceplates. Postural adjustments (PAs) were identified by deflection points in the VGRF. The proportion of steps with 1 and 2 PAs was computed. The onset of the initial postural adjustment (PA1) and liftoff time (LO) of the stepping leg were determined from the VGRF. The effect of time (baseline, post 3 years) on the proportion of steps with 2 postural PAs, and median onset of PA1 and LO was tested using nonparametric Wilcoxon signed ranks test. RESULTS: The change in proportion of steps from one to two PAs over three years was significant ($p = 0.028$). Six out of ten subjects had at least a 30 % increase in proportion of steps with two PAs. Three subjects had negligible change, and one subject had an 11% reduction of steps with two PAs. Nine out of ten subjects had an increase in the median onset of the initial postural adjustment over three years (mean 28 ms, SD 26 ms, $p = 0.012$). Eight of ten subjects had a delay in median liftoff time (mean 101 ms, SD 79 ms, $p = 0.013$). CONCLUSIONS: A majority of subjects displayed evidence of a decline in postural control over the three-year period, including increased number of postural adjustments and delays in the initial postural adjustment and liftoff time. These changes may be sensitive indicators of

aging of the postural control system, and could be related to risk of falling. Supported by NIH grants R01-AG031118 and P30-AG024827

P2-Q-104 The influence of the dorsal foot skin during a vestibular perturbation

Meghan Yip[1], Gagan Gill[1], Christopher Lam[1], Stephen Brown[1], Leah Bent[1]

[1]University of Guelph

BACKGROUND AND AIM: The skin and vestibular system provide independent proprioceptive cues that contribute to postural control and the perception of verticality1; however, our understanding of their relationship and interaction is incomplete. The vestibular afferents that run beneath the mastoid processes produce a collective vestibular signal to indicate linear and angular accelerations of the head2. The hairy skin that covers the finger, elbow, and knee joints contributes to accurate limb position awareness3, but the proprioceptive and functional role of the dorsal skin that covers the ankle, a joint of postural importance, remains to be established during stance. Notably, recent work has suggested that reduced feedback from the dorsal foot skin results in errors during a passive joint matching task4 and changes in locomotor pattern5. The aim of this project was to determine the influence of the dorsal skin of the feet on the recovery from a stationary vestibular perturbation. We hypothesized that reduced skin input from the dorsal foot would elicit an increased postural response following a vestibular perturbation. METHODS: Bilateral, binaural galvanic vestibular stimulation (GVS) produces a postural response towards the anode electrode2. Subjects stood quietly on a force plate (AMTI) with their heads turned to the left to induce an anterior-posterior perturbation (eyes closed). To reduce cutaneous input6 in healthy, younger adults, the top of the foot was cooled for 20 minutes (ice). Seven blocks of GVS were delivered for both the ice and control conditions. Each block was composed of 20 stimuli, each 2s in duration. Electromyography and kinetic measures were used to evaluate reflexive and postural responses across conditions. PRELIMINARY RESULTS: Cooling the dorsal foot skin reduced perceptual feedback (mean threshold increase: 2.7g to 63.0g). Reduced skin input resulted in increased peak centre of pressure (CoP) amplitude (control: 0.031m, ice: 0.039m) and increased average CoP velocity (control: 0.027m/s, ice: 0.036m/s) in the anterior-posterior direction in response to GVS. CONCLUSIONS: The vestibular perturbation induced a greater postural response when dorsal skin input was attenuated via cooling. These data suggest the dorsal skin of the ankle plays a role in vertical orientation and the final equilibrium position during stance; a role which has also been assigned to the vestibular system following whole body perturbations1. Since the body oscillates about the ankle joint during quiet stance7, we believe the dorsal skin of the foot provides sensory cues to delineate the limits of postural sway. REFERENCES: 1Inglis et al. J Neurophys.73:896-901, 1995; 2Fitzpatrick&Day. J Appl Phys. 96:2301-2316, 2004; 3Collins et al. J Neurophys. 94: 1699-1706, 2005; 4Lowrey et al. Neurosci Lett. 485:6-10, 2010; 5Howe et al. SFN proceeding Nov 2013; 6Lowrey et al. J Neurophys. 109:839-850, 2013; 7Winter et al. J Neurophys. 80:1211-1221, 1998.

P2-Q-105 The Relationship of Sensory functions with Head and Trunk Control during locomotion in healthy young and older adults

Fang Zhang[1], Nandini Deshpande[1]

[1]Queen's University

Background and Aim: We investigated the importance of sensory inputs for head and trunk control during normal and narrow-path walking condition (NP) that increases medio-lateral (M-L) postural challenge; and whether age is an influencing factor. Methods: Fifteen young (age=20-30) and fifteen older (age≥65) healthy adults walked 6 meters in normal and NP conditions which required walking between two lines 25 cm apart on the floor. Average angular displacement of the head roll (HdRoll) and trunk roll (TrRoll) and head-trunk roll correlation (H-Tcor) were calculated. Participants' visual, vestibular and somatosensory system functions were measured. Multiple linear regression analyses examined the associations of sensory functions with the head and trunk control, with/without age adjusted. Results: HdRoll in NP but not normal condition was negatively associated with visual acuity (R=-0.38, p=0.04). TrRoll in normal but not NP was positively associated with lower limb vibration perception threshold (R=0.43, p=0.02). H-Tcor in NP but not normal condition was negatively associated with the vestibular measure of subjective visual vertical (SVV) (R=-0.39 p=0.05). After adjusting for age, the association between H-Tcor in NP and SVV became marginal (p=0.06), while the other associations remained significant. Conclusion: The association of head and head-trunk coordination with visual and vestibular information in NP condition, respectively, may suggest the importance of "top-down" model when M-L challenges are imposed. In normal condition, the reliance of trunk control on lower limb somatosensation supports the possible role of the "bottom-up" model. Healthy older people may retain sensory strategies for head and trunk control that are similar to young adults. Acknowledgement: Thank you to Dr. Alison Novak, Mika Yoshikawa, and Patricia Hewston for assistance with data collection. This study was supprorted by Senate Advisory Research Committee grant to Dr. Deshpande.

P2-Q-106 Brain activation during staircase and plane locomotion

Andreas Zwergal[1], Florian Schöberl[1], Phillip Werner[1], Guoming Xiong[1], Christian la Fougere[2], Klaus Jahn[1]

[1]University of Munich, [2]University of Tübingen

Background and aim: Staircase walking is a very specific mode of locomotion and represents a considerable problem in the elderly. Consequences of falls are often more dramatic. In the present study, we attempted to compare the brain activation patterns during staircase and plane walking. Methods: 14 healthy persons (7 women, mean age 51 years) performed a locomotion paradigm in a 15-level-staircase of our hospital. [18F]-Fluoro-desoxyglucose ([18F]-FDG) was injected and subjects walked up- and downstairs for the next 10min at their preferred speed. PET scans started 30min post injection. A second group of age- and sex-matched healthy persons performed a similar locomotion paradigm in a walkway of our hospital for 10min. Brain activation patterns of staircase vs. plane locomotion were analysed by means of SPM. Results: During staircase as compared to plane locomotion the regional cerebral glucose metabolism (rCGM) was higher in the prefontal, supplementary motor and precentral motor cortex as well as in the right insula and bilateral vestibular nuclei. During plane locomotion a relative rCGM increase was found in the bilateral primary visual cortex, MT/MST, posterior parahippocampal cortex and the pontomesencephalic brainstem tegmentum. Conclusions: Our data suggest that staircase locomotion needs more prefrontal motor control than plane locomotion. Staircase locomotion could therefore be a more sensitive marker of frontal locomotor changes during aging. The cerebral sensory representations point to predominantly vestibular activations during staircase and visual activations during plane locomotion, which may reflect differences in sensory inputs during the respective locomotion modes.

P2-R-107 The effect of accelerometer mass in the mechanomyography measurement

Soonjae Ahn[1], Youngho Kim[1]

[1]Yonsei University

BACKGROUND AND AIM: The mechanomyography (MMG) signal records and quantifies low-frequency lateral oscillations of active skeletal muscles. These oscillations reflect the ''mechanical counterpart'' of the motor unit activity measured by EMG. Accelerometers were commonly used to measure MMG, because there are some advantages of inexpensive price, light weight and the easiness to convert to a physical unit. However, the mass of accelerometer would affect the MMG signal. In this study, we evaluated the effect of the accelerometer mass in the MMG signal. Methods: Fifteen normal volunteers conducted the maximum voluntary contraction (MVC) of leg extension using Biodex System 3 (Biodex Medical System, USA). MMG signals were obtained from rectus femoris muscle using SCA 620 accelerometer (VTI technologies, Finland). For each subject, mass of the accelerometer was varied from 3g, 8g, 13g, 18g, 23g and 28g. There was a 5-minute rest between every trial. MMG signals were measured for 3 seconds with a sampling rate of 1,000 Hz. Using the Matlab (MathWorks Inc., USA), raw MMG signals were bandpass-filtered at 5-150 Hz (4th order Butterworth) and the frequency analysis was performed using the fast Fourier transform(FFT). Results: As the mass of accelerometer increased, MMG signal amplitude increased (3g: 0.2 ± 0.2m/s2, 8g: 0.5 ± 0.3 m/s2, 13g: 0.9 ± 0.3 m/s2, 18g: 1.0 ± 0.2 m/s2, 23g: 1.0 ± 0.3 m/s2, 28g: 1.1 ± 0.3 m/s2). But the median frequency (MF) of MMG signal decreased (3g: 35.7 ± 0.8Hz, 8g: 31.6 ± 0.9Hz, 13g: 21.4 ± 0.7Hz, 18g: 20.1 ± 0.7Hz, 23g: 20.0 ± 0.8Hz, 28g:19.8 ± 0.7Hz,) with the increased mass of accelerometer. When the mass accelerometer increased from 8g to 13g, the amplitude of the MMG signal was the most increased, and MF of MMG signal was the most decreased. However, for heavier accelerometers than 13g, no significant change in both the amplitude and MF was observed. Conclusions: In this study, we evaluated the effect of the accelerometer mass in the measurement of the MMG signal. We recommend that mass of the accelerometer should not exceed 10g to measure MMG.

P2-R-108 Relation between Vestibular-ocular Reflex tests, and Stance and Gait Posturography after an Acute Unilateral Peripheral Vestibular Deficit.

John Allum[1], Flurin Honegger[1]

[1]University Hospital Basel

Background: Typically acute unilateral peripheral vestibular deficit (AUPVD) patients have balance deficits at acute onset and for several weeks later. Changes to vestibule-spinal reflex (VSR) deficits and any improvement with recovery and central compensation should be used to judge the patient's capacity to work. However, clinically various vestibular ocular reflex (VOR) tests are commonly used for this purpose. The question thus arises, which, if any, VOR tests are related to the unstable balance control and its improvement over time in AUPVD patients. If none are related, which stance and gait tests should then be used. To answer these question, we examined changes in and correlations between head impulse tests (HIT), whole body rotation tests (ROT), caloric tests of the horizontal VOR, and compared these with and stance and gait posturography tests in cases of AUPVD. That is, we examined whether the effect of peripheral recovery and central compensation was the same for VORs and VSRs. Methods: HIT was performed with short ca. 200º/s head turns, ROT with triangular velocity profiles of

acceleration 20º/s2 and 5º/s2 and caloric tests with bithermal (44 and 30°C) water irrigation of the external auditory meatus. Eye velocities were measured with a video camera system. To measure balance control during 14 different stance and gait tasks, body-worn gyroscopes mounted at lumbar 1-3 recorded the angular velocity of the lower trunk in the roll and pitch directions. These signals were integrated to yield angle deviations. Results: VOR, stance and gait tests results generally improved to normal by 12 weeks. Eyes closed stance tests and levels of spontaneous nystagmus improved most rapidly and were normal after 3 weeks. However correlations between these measures were weak (R=0.3, p=0.05). Visual contributions to stance control and HIT decreased with vestibular recovery over 12 weeks but were not correlated (R<0.1). Instability during gait tests with improved in line with ROT results acquiring normal values between 6 and 12 weeks. Correlations were best, R=0.4 p<0.01, between gait pitch velocity and ROT results for 5º/s2 accelerations. HIT results for the deficit side were better correlated with caloric tests (R=0.8 p<0.01) than those of ROT tests. But measures of central VOR compensation (responses of the normal side) were best indicated with 5º/s2 ROT tests (R=0.6, p<0.01). Conclusions: These results indicate that stance and gait tests of VSR function following vestibular loss improve over time but are not correlated with tests results of VOR function. These findings indicate that stance and gait tests should be performed clinically at 3 and 6 weeks post onset in order to assess an ability to work following vestibular loss.

P2-R-109 Multi-Segment Kinematic Assessment of Human Trunk: Sensitivity to Skin Artifacts

Sara Mahallati[1], Hossein Rouhani[1], Kei Masani[1], Richard Preuss[1], Milos Popovic[1]

[1]University of Toronto

BACKGROUND AND AIM: Kinematic assessment of the trunk based on a multi-segment trunk model is valuable in clinical evaluations in a wide range of back pathologies and conditions, such as low back pain, scoliosis and spinal cord injuries. Previous studies on lower-limb kinematic assessment have found that skin artifacts are the major source of error in motion analysis. A study that investigated the role of skin artifacts in trunk motion analysis is not yet available. We hypothesized that due to small ranges of angular displacement in the multi-segment trunk the skin artifacts could considerably affect kinematic measurements. Our goal was to investigate the propagation of skin artifacts to the 3D joint angles assessments in the seven-segment trunk model. METHODS: 11 healthy subjects performed trunk bending in five directions (left, anterior-left, anterior, anterior-right and right) up to 45° based on trunk movement as an inverted pendulum. Six Vicon Cameras recorded the trajectory of 22 reflective markers placed on the trunk anatomical landmarks. We adopted a non-invasive approach and simulated the skin artifact induced errors based on the task-related skin movements' characteristic. The error in the coordinate of each marker, in the maximum excursion point, was modeled as an independent Gaussian variable and then the coordinate trajectories changed with the rate of the relative motion. The mean and standard deviation of these variables were selected based the maximum skin movements at the point of peak trunk motion. The simulated skin artifacts were added to original marker trajectories and the relative errors for each joint's range of motion (ROM) were calculated in 3D space. The relative error of each ROM was compared to the coefficient of variation for the range of motion for the same angle for the given subject population. RESULTS: Inter-subject variability of the joint range of motions was in the range from 25 to 60%, where the majority was in the range around 60%. The induced errors in the sagittal, transverse and frontal planes were, <15%, <15% and > 500%, respectively. Exception was errors

in the transverse plane for sacral joints where the errors were about 100%. CONCLUSIONS: From the above analysis we can conclude that kinematic assessments of the trunk in the sagittal and transverse planes can be used in clinical evaluations, while the kinematic assessments in the frontal plane have substantial errors (>500%) and should be used with caution for clinical decision making.

P2-R-110 Postural responses to closed-loop angular perturbations of support surface

Jan Babic[1], Luka Peternel[1]

[1]Jozef Stefan Institute

BACKGROUND AND AIM: The purpose of the study was to investigate postural responses of healthy adult participants to support surface rotations in pitch and roll planes. Contrary to the traditionally used methods in the previous studies where the researchers randomly perturbed the support surface beneath the participant's feet in an open-loop fashion, we used a novel experimental approach where the participant's reactions to perturbations actually produced effects on the state of the support surface. METHODS: Instead of a simple tilting platform to induce rotational perturbations of the support surface used in the previous studies, we used a Stewart parallel platform with a top-mounted force platform that enabled the participants to actively control the orientation of the platform by shifting their centre of mass position. In effect, the muscular responses of the participants to the rotational perturbations actually corrected the induced perturbations. RESULTS: Using polar diagrams, we show the responses of four muscle groups during the stretch and proprioceptive reflex and the muscular responses based on the visual stimuli. Compared with the results from the previous studies, muscular responses, particularly the responses of the soleus muscle, based on the stretch and proprioceptive reflexes are more equally distributed in all directions of the perturbation. The kinematical responses to perturbations in multiple directions were stereotypical and direction dependant. The maximum deviation of the centre of mass is oriented in the mediolateral direction due to the greater ability of maintaining the balance in the anteroposterior direction by using the "ankle" strategy. In the mediolateral direction, the contribution to maintain the balance is due to the "hip" strategy. The role of the "hip" strategy does not prevail because of the inability to generate a sufficiently corrective torque in the ankle. CONCLUSIONS: The muscular responses of the participants due to the balance perturbations actually physically corrected the induced perturbation. In contrast to the previous studies where the muscular activity had no effect on the motion of the subject and was in some sense an isometric response, our reported muscular responses result in the subject's body sway and offer a better approximation of the real life situation.

P2-R-111 Construct validity and internal consistency of the Mini BESTest in individuals with Parkinson's disease

Martin Benka Wallén[1], Niklas Löfgren[1], David Conradsson[1], Maria Hagströmer[1], Erika Franzén[1]

[1]Karolinska Institutet

BACKGROUND AND AIMS: The Mini BESTest is a clinical balance test encompassing 14 items that are assumed to reflect the one-dimensional construct dynamic balance1. The test was developed to provide a more condensed and time-efficient alternative to the original BEST-test that comprises 36 items representing six different domains of balance control. Since its introduction in 2010, the Mini BESTest has become increasingly utilized for evaluating balance control in different conditions, e.g. in

Parkinson´s disease (PD); however the validity of the test has not been fully evaluated in this population. In this study we examined the construct validity and internal consistency of the Mini BESTest in 112 individuals with mild to moderate PD. METHODS: Forty-seven women (73.5 ± 5.6 years) and 64 men (73.0 ± 5.4 years) with idiopathic PD (Hoehn & Yahr 1 to 3) were assessed in a laboratory setting by trained physiotherapists. A confirmatory principal component analysis (PCA) with Oblimin rotation was used to extract components with eigenvalues larger than one. Internal consistency of each component and the whole test was evaluated with Crohnbach´s alpha (Cα). RESULTS: The PCA extracted five components (C1 - C5). Upon visual examination of a scree plot, a marked bend was observed between C3 and C4; hence a PCA with four fixed components was estimated subsequently. Items were allocated into the component in which they loaded most strongly. The four-component model accounted for 52.2 % of the total variance, with each component (C1 - C4) explaining 24.4 %, 12.1 %, 8.9 % and 7.7 %, respectively. Each component included one gait-item except C4 which included two. Internal consistency was good for C1, C2 and the whole test (Cα ≥ .700), fair for C3 (Cα = .532) and poor for C4 (Cα = .201). Correlations between components were generally low (≤ .260), indicating acceptable discriminant validity. Correlations between the total score and each component ranged between .547 (C4) and .809 (C1). CONCLUSIONS: This study identified four underlying dimensions of balance control implicated in the Mini BESTest. These dimensions partially overlap with the subdomains of the original BEST-test. One important distinction, however, is that gait tasks were dispersed over all four components, suggesting that dynamic balance is not an isolated subdomain of balance control. Moreover, C4 consisted of only two items, one of which (no. 14) can be described as a combined cognitive-motor task. Cognitive interference is particularly relevant in relation to gait in individuals with different neurological disorders, since it affects balance control2,3. These results suggest that items assessing dual-tasking capacity during walking should be included in tests of balance control in this population. 1. Franchignoni, et al. J Rehabil Med. 2010;42(4). 2. Sheridan, et al. J Am Geriatr Soc. 2003;51(11). 3. Lundin-Olsson, et al. Lancet. 1997;349(9052).

P2-R-112 Assessment of gait pattern in individuals with knee osteoarthritis classified by WOMAC questionnaire

Roberta Brunelli[1], Marcello Nogueira-Barbosa[1], Carina Junqueira[1], Elisa Libardi[1], Jaqueline Porto[1], Ana Claudia Rennó[2], Daniela Cristina Abreu[1]

[1]University of São Paulo, [2]Federal University of São Paulo

BACKGROUND AND AIM: Osteoarthritis (OA) is a chronic-degenerative disease with symptoms: pain, decrease muscle power and change of gait velocity. The aim of this study was to evaluate and compare the clinical repercussion of OA of knees, evaluated by WOMAC on temporal gait variables. METHODS: fourteen individuals of both sexes were evaluated, with ages between 41 and 66 years, who signed an informed consent form and the study was previously approved by the local ethics committee. Participants underwent a radiograph of bilateral knees for confirmation or not of osteoarthritis (OA), and all were diagnosed with some degree of OA (I, II and III in both knees, using the method of Kellgren and Lawrence) by an experienced radiologist. The WOMAC questionnaire was applied to evaluate symptoms and physical incapacity associated with OA in all participants, which were divided in two groups: Group 1: mild impairment (n=7) and Group 2: moderate impairment (n=7). For analyses of the variables of gait (velocity and cadence) the equipment GAITRite Platinum 26´ Portable Walkway System was used. The participants were instructed to walk (simulating habitual gait) on the carpet of the

equipment, the gait starting 1 meter before and finishing 1 meter after the carpet to enable acceleration and deceleration (repeating this task 3 times). For statistical analyses the T test of Student with level of significance p ≤ 0,05 was used. RESULTS: individuals in Group 1 showed velocity (1.20 ± 0.12 m/s) and cadence (1.19 ± 0.07 steps/minute) significantly higher (p <0.01) than group 2 (0, 96 ± 0.15 m/s 1.05 ± 0.10 steps/minute). In group 1 there were individuals with grade I and II OA (6 subjects with grade II and 1 grade I) and in group 2 there were subjects with grades I to III of OA (3 subjects with grade I, 2 with grade II and 2 with grade III), and only the individuals with grade III had a direct relation with the clinical evaluation. CONCLUSIONS: It was concluded that different physical impairments reported by people with OA (mild versus moderate by WOMAC) interfere in the gait pattern, suggesting the importance of physical rehabilitation in order to prevent greater losses for these individuals.

P2-R-113 Motor behavior and influence of pathological state to movement characteristics across different movement classes

Massimo Cenciarini[1], Christoph Maurer[1], Maren Bennewitz[1], Hannah Bast[1]

[1]Albert-Ludwigs-Universität Freiburg

Motor disorders as result of a disease or an injury are often untreatable, and the symptoms can be ameliorated. Movement disorder patients have difficulty moving around the environment, are subject to higher risk of falls and injuries, and depression among other symptoms. In this work, we intend to derive meaningful and interpretable information about the pathological state of movement disorder patients using 3D motion data. Moreover, this work can help to address an open question of whether the observed motor behavior of patients is a direct result of a disease or compensation to the debilitating effects of the disease. An attempt in this direction is the suggestion that increased sensory noise would explain the motor behavior of PD patients (Maurer et al., EBR 2004). However, the direct effects associated to the disease are still not fully understood. To address this problem, we investigated four complimentary movement classes: voluntary lean and postural control, straight gait, complex locomotor tasks, and free "every-day" motor behavior (hand-coordination). The effect of a motor disorder is often studied with a single movement class (e.g. walking, standing, or coordination tasks). However, it is not clear whether the pathological state of a patient affects motor behavior similarly across different motor classes leading to correlated movement characteristics across different body segments and motor classes. In the exploratory phase of this project, we developed high-level features we believe are clinically relevant for Parkinson's disease (PD) patients. We have investigated the variability and smoothness of foot movements during walking and hand movements during a hand coordination task and tried to correlate the two movements. The RMS of movement trajectories, which included linear velocity, acceleration, and jerk, quantified variability. This approach is motivated by the hypothesis that movement behavior of PD patients may be linked to higher internal noise in the sensorimotor system. Lastly, we investigated segmental coordination during gait by using ratios of variability across trunk segments (pelvis, shoulder, and head) in all anatomical directions (a-p, m-l, and vertical). Preliminary results showed that PD patients walked like they "cruised" at a constant speed with very little deviation from the cruising motion. This aspect is consistent with a lower RMS of the acceleration data of PD patients both in the 10-m walk and in the hand coordination. These similarities across movement modalities support our hypothesis. A clear understanding of the control mechanisms responsible for human movements is critical to the successful design and implementation of any system

for neural rehabilitation and mobility assistance. This work leads the basis investigation to gain more knowledge about how can we learn more about the pathology from studying whole-body movements.

P2-R-114 Fractal Dynamics While Walking on Conventional and Feedback-Controlled Treadmill

Gyerae Tack[1], Jinseung Choi[1], Dongwon Kang[1]

[1]Konkuk University

BACKGROUND AND AIM: Gait fluctuation during long time walking has shown fractal dynamic characteristics [1]. Walking speed is controlled through proper combination between spatiotemporal variables (stride length and stride time). It has been reported that during ground walking these variables showed fractal dynamic characteristics. In fractal dynamics study, which needs long walking data, treadmill has several advantages such as little restriction by time and space, and easy control of walking speed and gradient. Therefore, it is necessary to investigate fractal dynamic characteristics during walking between different types of treadmill condition. The purpose of this study was to compare fractal dynamics during between conventional treadmill (CTM) and the feedback-controlled treadmill (FTM) walking. METHODS: Seven male subjects without any disorder on lower extremities participated in this experiment (age: 25.4±2.1 years, height: 176.7±6.3 years, weight: 78.4±18.6 kg). Belt speed of FTM (RX9200S, TOBEONE, Korea) is controlled by walker's anterior-posterior location with installed loadcell under treadmill floor. All subjects walked for 8 min on 3 different conditions; FTM, FTM with metronome (MET) and CTM with the average speed of FTM. Mean and fractal dynamics of stride time, stride length and stride velocity, were used for the analysis. Fractal dynamics were represented by alpha of detrended fluctuation analysis (DFA). To identify the relationship among gait variables, 3 kinds of surrogate methods such as Random shuffled surrogate, Phase-randomized surrogate, and Cross-correlated surrogate by averaging 50 iterations for each were used [2]. RESULTS: There was no difference in mean of all variables (CTM: stride time 1.19±0.15 sec, stride length 1.04±0.07 m, stride velocity 0.88±0.11 m/sec; FTM: stride time 1.20±0.17 sec, stride length 1.03±0.08 m, stride velocity 0.87±0.11 m/sec; MET: stride time 1.19±0.15 sec, stride length 1.09±0.10 m, stride velocity 0.93±0.14 m/sec). In FTM walking, all variables showed fractal dynamics (alpha>0.5), while fractal dynamics of stride time during CTM and stride velocity during MET walking were disappeared as in Fig 1. In addition, surrogate results showed that the relation among stride variables may be similar to cross-correlated relationship. CONCLUSIONS: Results showed that fractal dynamics in spatiotemporal variables during FTM walking were persisted, unlike in those of CTM. These findings revealed the applicability of FTM to gait dynamics study in natural walking point of view, and FTM walking is more similar to the ground walking than CTM. REFERENCES: [1] Hausdorff J.M. (2007) Gait dynamics, fractals and falls: Finding meaning in the stride-to-stride fluctuations of human walking. Hum Mov Sci, 26(4), 555-589. [2] Dingwell, J.B. & Cusumano, J.P. (2010). Re-interpreting detrended fluctuation analyses of stride-to-stride variability in human walking, Gait Posture, 32(3), 348-353.

P2-R-115 Postural control stabilises over the first 30 seconds of quiet standing in Parkinson's disease: time series analysis.

Silvia Del Din[1], Shirley Coleman[1], Alan Godfrey[1], Brook Galna[1], Lynn Rochester[1]

[1]Newcastle University

BACKGROUND AND AIM: Postural control (PC) during quiet standing is a key component of clinical evaluation in Parkinson's disease (PD). Accelerometer-based sensors have been introduced as an objective measure to examine PC [1]; however it is difficult to compare results across studies due to variation in protocols. For example, data is collected over time frames that extend from 0 to 120 seconds (s) without due consideration for how PC may change over the duration of the test. The aim of this study was to examine PC in people with PD with respect to test duration, by focusing on changes in accelerometer-based outcomes over a 2 minutes balance test. METHODS: Twenty-six PD participants (67±11 years, UPDRS III: 26±10), together with 31 healthy controls (CL, 68±7 years) were recruited. PC was measured with an AX3 (Axivity, York, UK) accelerometer (50Hz, ±4g) placed on lumbar vertebrae (L5) while participants were standing for 2 minutes with eyes open. Accelerometry signals were transformed and filtered by MATLAB (R2012a) with a low-pass Butterworth filter (3.5Hz cut-off frequency) [1]. Anterior posterior (AP) and mediolateral (ML) Jerk, root mean square values, ellipsis including the 95% of the ML and AP trajectories, and the frequency below 95% of the sensor data power spectrum (f95%) were evaluated, and time normalised during consecutive (not overlapping) bouts of 2 s along the test. Piecewise linear regression was used to fit the data during the first 30 s and the subsequent 90 s of the trial. GLM was adopted to look at the group effect on variability of PC (i.e. the slopes of the two sections evaluated with the linear regression analysis). RESULTS: Subjects with PD and CL were comparable for age and gender ($p>0.08$). There was an effect of time for all outcomes apart from f95% in AP direction and ML Jerk. Inspection of fit lines showed that postural adjustment occurred most in the first 30 s, followed by a period of stability which lasted for the remainder of the test (Fig. 1). There was a significant group interaction (PD and CL) for Jerk and ML Jerk: CL decreased their total and ML Jerk more than PD participants during the first 30 s. Jerk was stable in both groups over the last 90 s (Fig. 1). CONCLUSIONS: Our results suggest that PC strategies vary over a 2 minutes standing test, thus implying the need to look at the changes occurring over time rather than at the results across the whole test duration. The first 30 s of the test appear to be critical for stabilising balance, however people with PD do not stabilise Jerk and ML Jerk as quickly as CL. This might give further insight into the effect of PD on PC. REFERENCES: [1] Mancini M, Horak FB, Zampieri C, Carlson-Kuhta P, Nutt JG, Chiari L. Trunk accelerometry reveals postural instability in untreated Parkinson's disease. Parkinsonism Relat D, 2011; 17: 557-62.

P2-R-116 Lyapunov exponents in the nonlinear analysis of falls and frailty

Timothy Foran[1], Richard Reilly[2], Rose Anne Kenny[2]

[1]St. James's Hospital, [2]Trinity College Dublin

BACKGROUND AND AIM: Gait performance declines with age, leading to an increased risk of falls and decline in mobility. Early detection of increased falls risk is a major goal of geriatric medicine as even a single fall can have devastating consequences and initiate pathways to frailty. While mathematically the lyapunov exponent is a measure of sensitivity to initial conditions in the context of dynamical systems theory; it is plausible that the exponent could relate to perturbations that naturally arise during locomotion and the ability of the body to counteract these perturbations appropriately. Although modelling studies have shown it to be associated with increased falls risk, its investigation in older clinical cohorts is limited. The objective of this study is to compare the lyapunov exponent acquired from walking trials of frail and robust older adults. METHODS: Community dwelling older adults were recruited for a comprehensive geriatric assessment research program, TRIL (www.trilcentre.org). For

gait analysis subjects (N=383) wore body worn inertial sensors(www.shimmersensing.com) one on each lower limb and completed four walks of 30 meters length on a long corridor, at usual walking pace.The angular velocity signal in the A-P direction was extracted and a 6-dimensional state space was constructed. The lyapunov exponent was calculated using the method of Rosenstein and averaged over the four walks. Subjects that were considered frail or prefrail by Fried's criteria and who also had a history of falls (N=76, age=76±6 years) were compared with robust nonfallers (N=168, age=71±5 years). RESULTS: The lyapunov exponent ranged from 0.44 - 1.22 (mean 0.73±0.13) and was significantly larger in the frail faller group (mean 0.76 vs. 0.72, p=0.032), but showed poor correlation with grip strength(r=-0.1, p=0.08), BMI (r=0.1, p=0.08) and more moderate correlation with gait velocity (r=-0.3, p< 0.01). CONCLUSIONS: The larger lyapunov exponent exhibited by frail fallers supports the hypothesis that the structure of gait variability is altered in this cohort and may reflect intrinsic changes in the neural control of gait and ability to control dynamic balance. The exponent did not correlate strongly with physiological measures associated with frailty e.g. grip strength and BMI but showed a moderate increase as gait velocity decreased (r=-0.3). Investigation of the behaviour of the lyapunov exponent in clinical cohorts (and under different conditions e.g. dual tasking) has the potential to elucidate mechanisms contributing to falls and enhance the predictive ability of falls risk estimation.

P2-R-117 Towards Detection of Freezing of Gait in Parkinson's Disease Patients during Daily Living Activities

Eran Gazit[1], Ariel Tankus[2], Talia Herman[3], Sinziana Mazilu[4], Gerhard Troester[4], Nir Giladi[5], Anat Mirelman [3], Jeffrey Hausdorff[6]

[1]TLVMC, [2]Neurosurgery Unit, Tel-Aviv Sourasky Medical Center, [3]Laboratory for Gait and Neurodynamics, Movement Disorders Unit, Tel-Aviv Sourasky Medical Center, [4]Wearable Systems Laboratory, Swiss Federal Institute of Technology , [5]Dept. of Neurology, Sac

Background and aim: Automatic detection of Freezing of Gait (FoG) in Parkinson's disease (PD) has drawn much attention. This is a very challenging task due to the great variability of FoGs. At first glance, all FoGs appear to be different from one another. They can occur in various situations, for example: initiation of gait or turning. They are affected by patient state (e.g. "On" or "Off" medication), environment (e.g. narrow passages) and may differ considerably in their duration. As a result many studies limit their attempts to detect FoGs to laboratory data. However, patients frequently behave differently in the lab than at home due to the white coat syndrome. We therefore aim to detect FoG episodes from data recorded at the patient everyday environment. Methods: A device located on the lower back measured 3-axis acceleration data from 108 patients (mean age: 65.0 years; std: 9.3) for 72 hours. In addition, similar data were acquired from 10 patients during a FoG provoking gait protocol in the lab, yielding a well annotated dataset with 175 FoGs (mean: 9.02sec, std: 15sec). A first step in processing these large datasets was gait detection due to the assumption that FoG occurs only during gait, including gait initiation. Results: We first examined a widely used feature for FoG detection, called FoG Index (FI), defined as the ratio between the power in the "freeze" frequency band (3-8Hz) and power in the gait band (0.5-3Hz) in a running window. FI obtained low accuracy (sensitivity 75.7% and specificity 72.15%) in the lab and no correlation was found between FoG detections at home and nFoG-Q scores (Spearman's, p>0.23). We therefore switched to a novel, more complex, model which automatically selects the optimal features for FoG detection using an SVM classifier. To get a realistic estimate of the performance of the algorithm, we employed strict statistical analysis, which included

double cross-validation for the prevention of data over-fitting. Our algorithm achieved sensitivity of 89.9% and specificity 91.6% on the lab data using only 5 features. Conclusions: The suggested algorithm improves upon the commonly used FI. The applied strict analysis ensures the validity of the algorithm when applied to data gathered in the lab. This is a first step toward the application of the model to data from the patient's natural environment. Acknowledgment The research leading to these results was supported by the European Union-Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n. 288586 (CuPiD Project)

P2-R-118 Motor Assessment of Parkinson Disease Patients Following Deep Brain Stimulation Surgery Using Gait Analysis Technology

Greydon Gilmore[1], Mehdi Delrobaei[1], Kristina Ognjanovic[1], Mandar Jog[1], Fariborz Rahimi[1], Billy Xian[1]

[1]Western University

Background and Aim: Parkinson's disease (PD) motor assessment is commonly conducted using various clinical scales and clinician observation. While these avenues have proven useful they are often criticized for lacking sensitivity and being subjective, left to the clinicians' discretion. Deep brain stimulation is a new treatment approach for PD being investigated for its clinical efficacy. The programming of the device is very complex making the task very challenging even for the most skilled clinician. An objective measurement of gait, while programming, will allow the clinician to more easily determine the correct setting for each patient. Gait capture systems are a new avenue being explored to capture the gait changes in PD patients during DBS treatment sessions. We are approaching DBS programming from an objective view, allowing the input from the gait analysis system in conjunction with the commonplace clinical scales. Our goal is to systematically and objectively measure the clinical effects on the motor symptoms of patients over successive sessions of DBS programming. Methods: We will be studying 24 PD patients alongside 24 healthy age-matched controls. 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 6 months post-operatively. During each programming visit the patient is set to various pre-determined setting parameters (Voltage, frequency, pulse width) and asked to complete a set of motor tasks. The patients gait is captured using the PKMAS gait analysis carpet. The carpet asses various aspects of gait, including: cadence, stride length and functional ambulation profile (FAP). From this we can determine which setting showed to be most beneficial for the patient. The study has been approved by the university ethics committee and each participant has signed informed consent. Results: So far we have 6 active patients in our study, and we have 4 patients undergoing the DBS surgery. We have conducted full-day programming visits on the active patients and have obtained gait data for each session. Preliminary analysis of the FAP scores suggests that a setting of medium voltage (3V), high pulse width (210 µs) and low frequency (60Hz) is the most variable among patients ($F(2,3) = 22.3$, $p=.016$). While a setting of medium voltage (3V), low pulse width (60 µs) and medium frequency (120Hz) is stable across each patient's FAP scores ($F(2,3)= 7.35$, $p=.070$). Conclusions: Following preliminary data analysis we have found that a medium voltage, medium frequency and a lower pulse width is more stable across patients. This stability suggests that the setting is beneficial for all patients analyzed thus far. Further analysis, following future programming sessions, is needed to confirm these findings. Our method provides the first objective measure of long-term gait variances in PD patients undergoing DBS treatment.

P2-R-119 A new wavelet-based assessment of inter-joint coordination in walking of young and healthy older adults

Espen Alexander Ihlen[1], Beatrix Vereijken[1], Tobias Goihl[1], Per Bendik Wik[1], Olav Sletvold[1], Jorunn Helbostad[1]

[1]Norwegian University of Science and Technology

A new wavelet-based assessment of inter-joint coordination in walking of young and healthy older adults Background and aim Inter-joint coordination in human walking has been assessed with several methods. However, extant methods are unable to define 1) how instantaneous coordination changes within the stride cycle, 2) inter-joint coordination between multiple joints, or 3) the coupling strength of joint rotations rather than their phase relationships. The present paper introduces generalized wavelet coherence analysis (GWCA) that solves these three fundamental limitations of previous methods. The aim of the present study is to use GWCA to assess age- and speed-related differences in the inter-joint coordination of human gait. Methods Nine young (mean age: 31.7 ± 5.2 years) and nineteen healthy older persons (mean age: 80.5 ± 6.5 years) walked 5 minutes on a treadmill at 3 different gait speeds. Joint rotations of the lower extremities were defined from the measurements of a Vicon 3D motion capture system. GWCA combines wavelet coherence analysis with a matrix correlation method to define the instantaneous correlation coefficient, R_t, as the coupling strength for an arbitrary number of joint rotations. The intra-stride changes in inter-joint coordination were defined as the intra-stride change of the median R_t across all strides. Results The young and older persons had no significant differences in their preferred walking speed. The older group had a significantly smaller median R_t in the double support unloading phase compared to the younger group at all gait speeds (see Fig. 1). The age-related differences in median R_t were more pronounced than age-related differences in the rotation of the individual joints. Conclusion The weaker intra-joint coordination coupling during the unloading phase in the older compared to the younger group coincides with an increase in local dynamical instability [1]. Furthermore, the intra-stride changes in joint coordination seem to coincide with recent findings of intra-stride modulations in neural activity in the sensorimotor cortex [2]. Thus, GWCA can be used to further investigate the relationship between age-related alterations in inter-joint and corticomuscular coordination and age-related increases in gait instabilities. [1] Ihlen et al., 2012. Older adults have unstable gait kinematics during weight transfer. J Biomech 45, 1559-1565. [2] Gwin et al., 2011. Electrocortical activity is coupled to the gait cycle phaseduring treadmill walking. Neuroimage 54: 1289-1296.

P2-R-120 Age-related changes of verticality perception during upright stance

Klaus Jahn[1], Jeannine Bergmann[2], Antoanela Kreuzpointner[1], Carmen Krewer[3], Andreas Schepermann[1], Stanislavs Bardins[1], Friedemann Müller[4], Eberhard Koenig[4]

[1]University of Munich, [2]University of Munich and Schoen Klinik, [3]Schoen Klinik , [4]Schoen Klinik

Background and aim: Impairment of vertical body orientation hampers the rehabilitation process in stroke patients (pusher behavior in roll and retropulsion in pitch) and causes secondary injuries due to falls. Further, progressive neurological disorders like normal pressure hydrocephalus (NPH) and Parkinsonian syndromes as well as normal aging are associated with plane specific disequilibrium. Patients and the very old often fall because of their impaired sense of verticality. Specific diagnostic tools and treatment options are urgently needed to improve participation and quality of life in this

group of balance disorders.The internal estimate of verticality can be assessed through the visual, the haptic, and the postural subjective vertical (SPV). Abnormalities of the SPV show correlation with postural impairments. So far, SPV assessment was mainly done in a sitting position. However, verticality perception in standing is very relevant for postural control and locomotion. The objective of this study is to investigate age-related changes of the SPV in standing in healthy subjects using a new diagnostic tool. Methods: The SPV of 60 subjects (aged between 20 and 79 years; 10 subjects per age decade) was assessed in the sagittal (pitch) and the frontal (roll) plane using a 3D cardanic device (Spacecurl). Subjects stood blindfolded in the device and indicated, when they felt in a earth vertical position (7 runns for pitch, 7 runs for roll; randomized order). Results: Healthy subjects tended to show a slightly forward tilted SPV. With increasing age there was deviation towards the earth vertical (and backwards). The variation in SPV estimations gradually increased with age, especially in the pitch plane, less in the roll plane. Normal values (mean ± 2SD) ranged for the between -1.3° to 2.5° (pitch) and -1.5° to 0.8° (roll) for subjects <50 years, and between -1.8° to 2.1° (pitch) and -1.4° to 1.4° (roll) respectively for subjects ≥50 years. Conclusions: The human's sense of verticality is constructed and updated by integrating vestibular, somatosensory, and visual input. The internal estimate of verticality can be assessed through the visual, the tactile, and the postural modalities. Estimation of verticality during stance is well possible over the whole adult age range. With increasing age there is a tendency to deviate backwards and data show higher variation rates. Further studies have to show if these age related changes correlate to mobility or fall frequency.

P2-R-121 Dynamic Gait Instability Occurs at Different Time Scales for Young and Older Adults

Brittney Muir[1], Jeffrey Haddad[1], Shirley Rietdyk[1], Richard Van Emmerik[2]

[1]Purdue University, [2]University of Massachusetts

BACKGROUND AND AIM: Current gait stability analyses provide average stability over the entire gait cycle. However, stability likely fluctuates throughout the step. In order to assess stability during gait we adapted time-to-contact (TtC), a common measure used in postural stability research, to walking. TtC represents the time it would take the center of mass (COM) to reach the base of support given its instantaneous position and velocity. By assessing the fluctuations in TtC during the gait cycle, we can identify the phases of gait that are least stable. Further, we can identify if there are age-related changes in the TtC fluctuations across the step. Therefore, the purpose of this study is to identify the differences in TtC during gait between young and older adults. METHODS: Two age groups were examined: young adults aged 20-35 (N=10) and older adults aged 65-79 (N=10). Typical gait measures and TtC were assessed across 30 steps. The base of support was a six-sided boundary connecting the toes, fifth metatarsals, and heels of both feet. The percentage of the step with TtC larger than 0, 50, 100, 150, 200, 250, 300, 350, 400, 450, and 500 ms was calculated. RESULTS: Older adults decreased gait speed and step length compared to young adults ($p<0.01$), consistent with previous literature. The shortest TtC values occurred at double support for both age groups. This could explain instabilities that occur during weight shifting. Older adults had a larger percentage of step where TtC was in the 250-500 ms range ($p<0.05$), however, no difference between groups was observed in the percentage of step when TtC < 250 ms ($p>0.1$). It is commonly accepted that reductions in gait speed and step length are strategies to improve stability. However, these changes did not decrease the percentage of the step spent with a shorter TtC, when there is less time to recover from a loss of balance. Interestingly, differences between

age groups occurred at time scales greater than 250 ms, the approximate delay associated with a voluntary reaction time. This observation may relate to the ability of an older adult to recover balance if perturbed. CONCLUSION: The decreased gait speed and step length observed, provide more time for older adults to recover when balance is less threatened (TtC > 250 ms). However, when balance is more threatened (TtC <250 ms), older adults were not different from young adults.

P2-R-122 The coordination of gait and cane use in people post-stroke

Claire Perez[1], Valeri Goussev[1], Joyce Fung[2]

[1]Jewish Rehabilitation Hospital , [2]McGill University

BACKGROUND AND AIM: In the post-stroke population, canes are commonly used during both the gait training process and as a long term mobility aid. Recently, more knowledge has been acquired about how canes are used by people post-stroke. It has been demonstrated that canes can help stabilize gait even under complex walking conditions (slope walking) through haptic feedback (1). Moreover, a novel measure has been developed to examine the coordination of cane use and foot trajectories over the gait cycle (2). The aim of this study is to further explore this measure of coordination in people post stroke. METHODS: Participants with post-stroke gait impairments (n=18) and healthy controls (n=10) walked on a servo-controlled, self-paced treadmill and used an instrumented cane which was previously described (3). All participants walked for approximately 40m at comfortable (self-paced) speeds immersed in a virtual environment rear-projected onto a 244x182cm screen placed 135cm in front of the treadmill. Only the middle section of steady- state walking (10-20m) was used for analysis. Gait kinematics were recorded using a 6-camera Vicon-MX system and processed with customized Matlab programs. The loading forces (Fz) applied through the cane were normalized to the gait cycle. Coordination was then computed as the covariance between the antero-posterior toe displacement of each foot with the cane loading force. RESULTS: Preliminary results reveal that people post stroke exhibit a different pattern of coordination of cane use compared to the healthy controls. It appears that more pronounced differences are evident in people with more severe walking impairments. Ongoing analysis will seek to characterize the coordination patterns and to develop a coordination index. Additionally, data from some post-stroke participants walking overground with an instrumented cane will enable the comparison of the coordination measure between treadmill and overground walking. CONCLUSION: This study will provide greater insight into how canes are utilized during gait in people post-stroke. A measure of cane-gait coordination may offer a new way of viewing and analyzing an important aspect of gait which has not yet been considered. 1.Perez, C, Oates, A, McFadyen, B and Fung J. Enhanced somatosensory input for gait rehabilitation post-stroke. Arch Phys Med Rehab 90(10):e25. 2010. 2.Patterson KK, Goussev V, Perez C and Fung J. Cognitive load does not interfere with the coordination of cane use during locomotion. In proceeding of: International Society for Posture and Gait Research (ISPGR)/Gait & Mental Function 1st Joint World Congress. P1-F-126. 2012. 3.Perez C, Fung J. An instrumented cane devised for gait rehabilitation and research. Journal of Physical Therapy on Education 25(1):36-41. 2010.

P2-R-124 Measurement of relation between plantar skin friction and plantar skin slipped area during a walk

Takayuki Shiina[1], Akira Obara[1], Yuka Iijima[1], Shogo Shibasaki[1], Hiroshi Takemura[1], Hiroshi MIzoguchi[1]

[1]University of Science

Walk is fundamental motion in daily life. However, walk always involves risk of falling. Falling does not become the serious problem for the young people, however it becomes a serious problem for infant and elderly people. In particular, the 10% - 40% elderly have experienced falling for one year and 5% of fallers have a serious fracture accident. It is a serious problem for the aging society of Japan. However there are many unexplained parts of a walking mechanism. An elucidation of the uncertainty walking mechanism is urgent necessity. In this study, we developed plantar skin friction measurement device and investigated the relation between plantar skin slipped area during a walk and plantar skin friction. Plantar skin slipped area and plantar skin friction ware measured by plantar skin deformation calculated by images of plantar skin. A total of 10 normal elderly person were recruited in the research. Main components of plantar skin friction measurement device are a transparent force plate and a high speed camera. The plantar skin friction was measured when the transparent force plate moved only one direction (left or right) while the subject's foot was fixed to not move and put on the transparent force plate. The plantar skin images of the both feet while the force plate moving was collected by the high speed camera located under the force plate. Main components of the plantar skin slipped area measurement device are a transparent force plate and a high speed camera and a walkway. Subjects ware asked throughout the experiment to walk at a comfortable speed on a walkway four times per one trial. The plantar skin images of the right foot while stance phase were collected by the high speed camera located under the transparent force plate. The change of plantar skin slipped area during a walk was measured by calculating feature points movement in plantar skin. Feature points movement ware measured by using Harris-corner method and KLT method. The plantar skin deformation image was corrected by using the high speed camera. In future, we will investigate effect of plantar skin slipped area for plantar skin friction during a walk.

P2-R-125 Using the Systems Framework for Postural Control to Analyze the Components of Balance Evaluated in Standardized Balance Measures: A Scoping Review

Kathryn Sibley[1], Marla Beauchamp[2], Karen Van Ooteghem[3], Sharon Straus[4], Susan Jaglal[4]

[1]Toronto Rehabilitation Institute, [2]Harvard Medical School, [3]University of Waterloo, [4]University of Toronto

Background and Aim: Comprehensive balance assessment is recommended for designing optimal exercise programs for fall prevention, and use of valid tests is a key part of evidence-based practice. However, extensive variation in the use of balance measures has limited the ability to synthesize data on the effects of balance interventions, stimulating calls for consensus on use of standardized balance measures. In the absence of a gold standard, direction is needed to inform recommendations for balance measurement. Content validity should be a primary consideration, and there is a need to systematically examine the theoretical basis of existing measures. The objective of this project was to identify the components of balance evaluated in available standardized balance measures. Methods: A scoping review methodology was used. Inclusion criteria were measures with a stated objective to assess balance in adult populations, included at least one standing task, had both a standardized testing protocol and evaluation criteria, minimum of one psychometric property evaluated, and available in English. Measures were identified through a systematic database search and hand search of grey literature by two independent reviewers. The systems framework for postural control, a conceptual model emphasizing the physiological systems required for balance, guided the analysis. Six domains of

postural control were operationalized into nine distinct components of balance. Two reviewers independently coded the components of balance evaluated in each measure, and a third reviewer resolved discrepancies. Descriptive summary statistics were calculated. Results: Sixty-two standardized balance measures for adult populations were included in the review. Components of balance evaluated were underlying motor systems (100% of measures), anticipatory postural control (71%), static stability (68%), dynamic stability (67%), sensory integration (52%), functional stability limits (29%), reactive postural control (24%), cognitive influences (18%), and verticality (6%). Thirty measures evaluated less than three components of balance, and only one measure evaluated all nine components of balance: the Balance Evaluation Systems Test (Phys Ther 2009, 89: 484-98). Discussion: Understanding the theoretical content of balance measures is important for test selection when designing exercise programs and evaluating interventions. The finding that the majority of standardized balance measures do not evaluate all components of postural control has implications for both comprehensive evaluation and clinical practice. Continued work is required to develop standards for balance evaluation including appropriate hierarchies of tasks within and across components.

P2-R-126 Clinical assessment of trunk muscle and balance function in persons with spinal cord injury

Jordan Squair[1], Anna Bjerkefors[2], Mark Carpenter[1]

[1]University of British Columbia, [2]The Swedish School of Sport and Health Sciences

BACKGROUND AND AIM: Maintaining or regaining maximal amounts of trunk motor function is crucial following a spinal cord injury (SCI), since many daily activities are performed in a seated position and require some level of static or dynamic postural control. Unfortunately, in the current clinical examination for SCI, a trunk muscle assessment is not included. Such assessments are crucial as they are often predictive of functional and independence outcomes. Therefore, the purpose of this study is to a) use a carefully designed manual muscle assessment to determine the function of trunk musculature in people with an SCI, b) compare the results from the manual examination to neurophysiological measures of trunk muscle activity, c) examine the relationship between trunk muscle function and static and dynamic balance control, and d) assess the relationship between trunk muscle function and independence for people with SCI. METHODS: Five persons with SCI participated in the study to date (injury level from C4-T10). Participants performed six different trunk tasks targeted towards activating specific trunk muscles and were graded on a scale of 0-5 with a score of 5 reflecting full function and a score of 0 reflecting no observable activity (max score=30). During the exam, muscle activity over trunk muscles was recorded with surface EMG bilaterally to confirm muscle preservation in cases of minimal activity. Participants were then asked to complete a functional exam (max score=51) beginning with static tasks (sitting upright), progressing to dynamic tasks (moving through a range of motion), and finishing with perturbation recovery (push from various directions). Results from the manual muscle assessment were compared to the functional examination score and the independence score, as measured using the SCIM III (max score=100). RESULTS: All individuals completed the protocol with no adverse effects. All participants were able to voluntary activate their trunk muscles to some degree and this activity was confirmed as being present in the EMG analysis. A score of 3 or less on the manual muscle assessment was predictive of deficits in the corresponding static and dynamic postural tasks. The score on the manual muscle assessment (mean=24±7) was strongly related (R^2=0.997) to the score on the functional assessment (mean=38±20) and moderately related (R^2=0.519) to the independence score

(mean=73±13). CONCLUSIONS: Preliminary results suggest manual muscle testing is able to provide a comprehensive assessment of trunk muscle function in persons with SCI. Minimal levels of function were accurately detected and were confirmed using EMG. Scores on the manual trunk muscle assessment were predictive of balance, functional, and independence outcomes. Although a larger sample is still needed, consideration should be taken to carefully examine the trunk musculature in order to provide a better understanding of each person's postural abilities following their SCI.

P2-R-127 A comparative study on different posturographic descriptors to assess standing balance in young children

Ann Hallemans[1], Evi Verbecque[1], Paula Lobo da Costa[2], Marcus Fraga Vieira[3], Luc Vereeck[1], Peter Aerts[1]

[1]University of Antwerp, [2]Federal University of Sao Carlos, [3]Federal University of Goias

BACKGROUND AND AIM: The ability to control standing balance in young children is considered one of the foundations to motor development. Different approaches have been suggested: global descriptors estimate the overall size of the center of pressure (CoP) sway, while sway density curve (SDC) analysis recognizes anticipatory control strategies [1]. Since it is not known whether global and structural posturographic parameters discriminate age-related changes equally well in young children, the aim of this study is to assess standing balance in children aged 3 to 6 years-old using different posturographic descriptors. METHODS: So far, 33 children (mean age = 4.45 ± 0.67 years-old) without any known developmental problems, participated in the pilot study after their parents have given written informed consent. Postural sway data was collected during 40 seconds trials in 4 conditions: rigid support with eyes open (1) and closed (2) and standing on foam with eyes open (3) and closed (4) while standing bipedal and barefoot on a force platform. CoP data were analyzed using global stabilometric descriptors [2] and structural stabilometric descriptors [3]. The variables computed were: CoP mean velocities, ranges, area of oscillation, frequency ranges with 50% and 80% of the area under the CoP power spectrum curve, rate of torque production (MT), mean distance between successive peaks (MD) and mean peak amplitude (MP). For statistical analysis a 2 x 2 (surface x vision) repeated measures ANOVA was performed and significant level was set at 0.05. RESULTS: Vision and surface showed main effects as well as interaction effects on area, velocities, ranges, MD and MP; significantly more sway is observed on an unstable surface and with eyes closed. MD increases and MP decreases from the eyes open to closed and from rigid to foam surfaces. F50, F80 and MT are not significantly affected by vision or surface (Table 1). DISCUSSION: In the present study the experimental conditions performed did not affect the frequency aspects of the postural corrections for the children tested, which is also in agreement with the absence of significant effects found for the MT descriptor. This means that regardless of the conditions the timing between successive postural commands did not change. The MP and MD results from the least (rigid + eyes open) to the most challenging condition (foam + eyes closed) reveal decreasing capacity for postural stabilization (MP), while it was necessary to produce larger amount of changes in torque (MD). Additional data will be collected to identify the most reliable descriptor to better evaluate development-related changes. 1. Baratto, L, Morasso PG, Re C, Spada G. Motor Control, 6:246-270, 2002 2. Duarte M, Freitas, SMSF. Brazilian Journal of Physical Therapy, 14(3): 183-192, 2010 3. Jacono, N, Casadio, M, Morasso, PG, Sanguineti, V. Motor Control, 8:292-311, 2004

P2-R-128 Is Kinect suitable for measuring whole body movement patterns during exergaming?

Mike van Diest[1], Jan Stegenga[1], Heinrich Wörtche[1], Klaas Postema[2], Gijsbertus Verkerke[2], Claudine Lamoth[2]

[1]INCAS[3], [2]University Medical Center Groningen

BACKGROUND AND AIM:Fall injuries are responsible for significant disability among elderly[1]. Exergames based on full body movements provide a challenging opportunity for training and evaluation of postural control[2], but affordable sensor technology and algorithms for assessment of whole body movement patterns are scarce. Aim: to evaluate the suitability of Kinect, an affordable motion capture system (MCS), for evaluation of balance ability during exergaming. To this end we compared Kinect with a marker based (MB) MCS by 1) detecting common features in whole body MCS data, 2) identifying the contribution of individual anatomical landmarks (ALs) to movement patterns, and 3) by computing outcome measures representing balance ability. We hypothesize that the MB MCS outperforms Kinect, but that evaluation of movement patterns by Kinect is feasible. METHODS:Twenty healthy adults (age 36.95±16.64) performed five different 1-min task-embedded mediolateral weight-shift exergame trials while 2D position data of 10 ALs in the frontal plane was obtained using a 12 camera Vicon V8 system and Kinect. Game conditions included: neutral, lifting a leg and increased game speed, sway amplitude (SA) and sway frequency (SF). Principal Component Analysis (PCA)[3] was performed on normalized Vicon and Kinect data. Common features were identified by projecting data on the three main principal components (PCs). Vicon and Kinect data were combined in a PCA and the contribution of each AL to the three main PCs was quantified by eigenvector analysis. Finally, outcome measures representing balance ability, including SA, SF, RMS and index of harmonicity (IH)[4], were computed from identified common features. RESULTS:Variance explained (VE) by common features for Vicon and Kinect is 94.3±3.8% and 93.6±3.3% respectively, indicating that both systems can cover most of the signal features within three PCs. The contribution of ALs to the movement patterns showed differences in VE ranging from 5% for trunk ALs up to 25% for extremities in all conditions. Differences ranging 4-52% were observed for SA, RMS and IH, while SF difference was within 1-6% range (fig1). CONCLUSION:For the first time PCA was used to compare movement patterns during exergaming. Kinect and Vicon identify common features in MCS data with similar accuracy. However, differences in the contribution of ALs to PCs are observed between devices, thereby affecting accuracy of balance evaluation. These limitations should be taken into account when adopting Kinect for whole body motion capture for balance assessment during exergaming. 1. Sterling DA, et al. J. Trauma 2001, 50:116-9 2. Van Diest M, et al J. Neuroeng. Rehabil. 2013, 10:101 3. Daffertshofer A, et al. Clin. Biomech. 2004, 19:415-28 4. Lamoth CJC, et al. Gait Posture 2002, 16:101-14 Fig1. Balance outcome measures computed from Vicon and Kinect PCA projections along the three main PCs. Vicon and Kinect are indicated by black and grey bars respectively

P2-R-129 Rotation Amplitude Dependency of the Intrinsic Ankle Stiffness during Standing

Mark Vlutters[1], Herman van der Kooij[1], Alfred Schouten[1], Tjitske Boonstra[1]

[1]University of Twente

BACKGROUND AND AIM: To ensure upright balance the ankle joint stiffness must be sufficient to resist the gravitational pull. This stiffness arises from both intrinsic and reflexive components. Determining their individual contribution might give insight in neuromuscular and balance related disorders. Ankle joint stiffness is often investigated by fitting a parametric model to a torque response, obtained from an

applied joint rotation. Direct, non-parametric estimation is often not applicable because the applied rotations cannot rule out reflex activity. Here the rotational amplitude dependency of the intrinsic ankle stiffness was estimated in standing, using fast ramp-and-hold stretches to circumvent reflexive contributions. METHODS: Eight healthy subjects participated in the study. Subjects stood on the Bilateral Ankle Perturbator (BAP, figure top), with which 0.08-0.005 rad plantar- and dorsiflexion rotations were applied to the individual ankle joints. Rotations consisted of 40 ms ramp-and-hold minimum jerk profiles [1]. The intrinsic stiffness was obtained by dividing the difference in torque exerted on the platform before and after rotation onset by the rotational amplitude. These values were normalized to the critical stiffness [2]. EMG data of the triceps surae and tibialis anterior muscles were recorded to investigate reflex activity. RESULTS: The EMG signals of the streched muscles showed short latency reflex activity starting approximately 5 ms after the rotation ended (figure middle). The EMG of the gastrocnemius medialis is shown. The intrinsic ankle stiffness decreased non-linearly with increasing rotation amplitude. There was no significant difference in stiffness between plantar- and dorsiflexions. A fit to all subjects' pooled data in comparison with other values in literature [2-4] is shown (figure bottom). CONCLUSIONS: The intrinsic ankle stiffness is insufficient to ensure balance, hence changes in muscle activation are required to realize upright stance. Reflex activity is not expected to have influenced the stiffness estimates due to the short latency of the perturbations and the electro-mechanical delay of muscle tissue. The decrease in stiffness is attributed to muscle cross-bridge breakage leading to sliding of filaments, decreasing the overall stiffness. References: [1] Burdet e.a.-2000-J.Biomech. [2] Casadio e.a.-2005-Gait Posture [3] Loram e.a.-2002-J.Physiol. [4] Loram e.a.-2007-J.Physiol.

P2-R-130 Correct method to measure knee angle in standing phase of gait

Hiroyuki Yamamoto[1]

[1]HImeji Dokkyo Unuiversity/Faculty of Health Care Sciences

[Background and aim] Gait analysis is performed on a routine work by clinicians, physical therapist and researchers. A known validate methods are 3-dimention electronic motion analysis and electrical goniometer. They aren't used frequently in clinic and hospital as too expensive. And, to measure the knee angle, usually marks are attached to the greater trochanter, lateral epicondyle of femur, and lateral malleolus. However, knee axis is known as flexible moving shaft during gait and other motions, and soft tissue artifacts are commonly considered the most troublesome source of error in measurements of human motion carried out using stereo-photogrammetry In case of electrical goniometer, thigh fixed with bandage to attach the lever arm. There is a possibility that knee angle do not be measured exactly for these problems. The aim of this research was to establish the correct method to measure knee angle in standing phase of gait. [Method] Five young females participate in experiments. We developed the new following methods and carried it out by the method. Marks are attached to proximal 1/3 and 2/3 of the femur, and proximal 1/3 and 2/3 of the lower leg. Angle between a straight line passing through the two points of femur and lower leg were measurement as knee angle. And, we measure by two the traditional method, too. [Results] In the traditional method, the knee bending angle of mid stance phase is larger than our new method, and knee extension angle of initial contact and acceleration phase is less than our new method. Overall, the traditional method of the knee angle change is calculated large, our new method is calculated small. [Conclusions] Than before, humans take so-called double knee action in one gait cycle. But, our new method doesn't show

it. True knee angle is the angle between the centerline of the femur and the lower leg. As a result, importance of how do you think about the axis is suggested.

P2-R-131 Analysis of the tilt of the main axis in normal subjects using the Body Tracking Test

Tomoe Yoshida[1], Fuyuko Ikemiyagi[2], Masahiko Yamamoto[2], Mitsuya Suzuki[2]

[1]Toho University Sakura Medical Center, [2]Toho University (Sakura)

BACKGROUND AND AIM:The Body Tracking Test (BTT) is a system that evaluates dynamic body balance by having a subject independently moves the center of pressure (COP) relative to a visual stimulus created by a moving target, In order to know what is being done on how to move the COP when a tracking, principal component analysis was performed. In normal subjects, the tracking axis of the A-P BTT was not parallel to the Y- axis. The tilt of the main axis in normal subjects was hypothesized to be related to the dominant foot. In the present report, we discuss the investigation of this hypothesis. METHODS:The participants included 261 healthy participants who did not have vertigo or a history of balance disorders.Among them, 233 participants had an unknown foot dominance and 28 were left-foot dominant. As 90% of people are right-foot dominant, we assumed that the other 233 participants were right-foot dominant. The participants ranged in age from 20- to 40-years old. In this time the BTT evaluated tracking in the A-P and lateral directions. BTT analysis was performed using the main axis as the first principal component for evaluating the tracking of the A-P and, lateral BTT movements. The main axis direction in this test was calculated using the tilt of the Y- and X- axis coordinates and the measurement of the axis tilt. In the A-P BTT, the displacement angle was expressed using the Y- axis coordinates as the base axis (0??); a clock-wise tilt was expressed as a plus value , and a counter-clockwise tilt was expressed as a minus value. Furthermore, in the lateral BTT, the displacement angle was expressed using the X- axis. RESULTS:The A-P BTT in the right-foot dominant group demonstrated a clockwise tilt (positive values) with a mean displacement angle of 2.070?? (SD, 4.809); in contrast, the group with left-foot dominance demonstrated a counter-clockwise tilt (negative values), with a mean displacement angle of -0.945?? (SD, 4.271) (Figure) These differences showed significant displacements ($p < 0.01$). In the lateral BTT, mean displacement angles of -0.323?? (SD, 5.830) in the right-foot dominant group and -0.214?? (SD, 6.429) in the left-foot dominant group were observed; these differences were not significant (Figure). CONCLUSIONS:Because the moving visual stimulus was only shown in a straight line, in the antero-posterior or left-right directions, the subjects could not recognize their own movement axis tilt. However , the A-P BTT in healthy subjects demonstrated a clockwise tilt (positive values). Habitual postural movements are typically considered to significantly influence this tilt in healthy subjects. We believe that spatial perception significantly influences this phenomenon. Differences between the dominant foot groups are believed to represent the spatial perception of each group.

P2-S-132 Mechanisms of Gaze Stability During Walking: Differences Between Active and Passive Walking

Eric Anson[1], John Carey[2], Tim Kiemel[3], John Jeka[4]

[1]UMD, [2]Johns Hopkins Medical Institute, [3]University of Maryland, [4]Temple University

BACKGROUND & AIM: Traditional vestibular testing relies on artificial or isolated stimuli presented with the individual seated in a rotating chair or lying down. These tests are unable to completely characterize functional deficits in gaze stability encountered during walking. Active head movements have been suggested as a more natural probe of vestibular function, but movement predictability limits the interpretability of those tests. Head movement during walking includes 6 degrees of freedom; however, traditional vestibular measures of gaze stability are restricted to one degree of freedom. Recording eye and head movement during walking may provide a window for assessing functional limitations to daily activities that result from impaired gaze stability in a more natural way. METHODS: Healthy subjects aged 24-40 walked on a treadmill at 2 km/hr while fixating a target presented on a widescreen LCD 2.2m in front of them. Head kinematics were recorded (Optotrak) and converted offline to control motion of a 6-degree of freedom platform mounted chair (Moog, Inc). All subjects sat on the Moog and passively experienced their head trajectories from the walking trials while performing the same fixation task. Head velocity and eye motion were recorded (EyeSeeCam) while walking and on the Moog. Frequency response functions (FRFs) were calculated to describe the input/output relationships that characterize gaze stability. A multiple input single output (MISO) gaze stabilization system including angular and linear velocity and the relationship between each head movement was compared to more traditional single input single output (SISO) FRFs. Active and passive MISO FRFs were compared to determine if walking enhances gaze stability in a way not predicted by passive motion. RESULTS: Below 1 Hz, "passive seated walking" MISO responses are equivalent to passive pitch SISO responses; however, above 1 Hz pitch SISO and MISO responses are not equivalent. Differences between treadmill walking and "seated passive walking" conditions in healthy adults were primarily an under-estimation of low frequency (< .3 Hz) gaze stability during "seated passive walking." Increased phase lag is also evident at higher frequencies (> 3 Hz). CONCLUSION: There may be a low-frequency, locomotion-specific augmentation to gaze stabilization not identified during passive vestibular testing. Future work will examine if individuals with vestibular loss have better gaze stability during locomotion than is predicted by traditional passive testing. ACKNOWLEDGEMENTS: This work has been supported in part by a 2013 PODS II Scholarship, Foundation for Physical Therapy. FIGURE 1. Gain and phase of pitch angular eye velocity in response to isolated passive head pitch velocity (blue circles), passive angular and linear head velocity (black circles), and active angular and linear head velocity (red diamonds). The dashed lines represent ideal gain and compensatory response timing.

P2-S-133 Unilateral vestibular loss impairs external space representation

Liliane Borel[1], Christine Redon-Zouiteni [1], Pierre Cauvin [1], Michel Dumitrescu [1], Arnaud Devèze[2], Jacques Magnan[2], Patrick Péruch [1]

[1]CNRS/Aix-Marseille University , [2]ENT Department

Background and aim: Vestibular signals measure head angular and linear accelerations, allowing the coding and representation of head movements in space. Based on the physiological and anatomical properties of vestibular signals, it is reasonable to propose that these signals are critical for the accurate perception of self-orientation through sensations associated with whole-body location and motion in space. In addition, studies have recently shown that vestibular signals are necessary for the accurate estimation of perceived movement in the environment during visual navigation. However, it remains unknown whether the vestibular system is involved in the representation of the extrapersonal space or if the properties of extrapersonal space are appropriately encoded after vestibular loss, even in the

absence of subject motion, i.e., the absence of vestibular stimulation. Methods: Patients with Menière's disease and healthy participants were instructed to point to memorized targets in near (peripersonal) and far (extrapersonal) spaces in the absence or presence of a visual background. These individuals were also required to estimate their body pointing direction. Menière's disease patients were tested before unilateral vestibular neurotomy and during the recovery period (one week and one month after the operation), and healthy participants were tested at similar times. Results: Unilateral vestibular loss impaired the representation of both the external space and the body pointing direction: in the dark, the configuration of perceived targets was shifted toward the lesioned side and compressed toward the contralesioned hemifield, with higher pointing error in the near space. This impairment was associated with an impairment of representation of body pointing direction. Performance varied according to the time elapsed after neurotomy: deficits were stronger during the early stages, while gradual compensation occurred subsequently. Conclusion: This study provides strong evidence that vestibular signals are involved in external space representation for spatial location of visual memorized targets in the dark. This evidence further supports the hypothesis that deviations in the representation of body pointing direction are partially responsible for the inaccurate location of targets. The results suggest that vestibular signals are essential for the proper integration of sensory information to elaborate accurate spatial representation and provide new insight into vestibular syndrome as a disorder of space representation.

P2-S-134 Electrophysiological Recording of Jerk Component of Linear Vestibulo-ocular Reflex in Humans

Hugh Nolan[1], John Butler[2], Isabelle Killane[3], Heinrich Bülthoff[4], Richard Reilly[2]

[1]TILDA, [2]Trinity Centre for Bioengineering, Trinity College Dublin, [3]Trinity Center for Bioengineering, Trinity College Dublin, [4]Max Planck Institute for Biological Cybernetics

BACKGROUND AND AIM: The aim of the experiment was to investigate the dynamics of the vestibular system by studying components of the translation vestibulo-ocular reflex (VOR). The vestibular system is essential in maintaining balance and posture. The VOR is a way of measuring vestibular responses. The vestibular system has been mostly associated with a response to the acceleration component of the motion profile but there is evidence in the literature that the derivative of the acceleration signal (jerk) also plays a role [1, 2]. Here, electrophysiological recordings allow recording of eye movement during linear translations with high temporal precision. METHODS: A Stewart platform was used to provide linear motion stimuli to 16 subjects. The setup was previously validated [3, 4]. The stimulus was a 1.5s naso-occipital sinusoidal acceleration. Forwards (F) and backwards (B) motions were presented sequentially, with an inter-stimulus interval of 3s±0.5s (uniform distribution). Each subject was presented 6 blocks of 50 trials of F and B stimuli. Subjects fixated on a target which remained a fixed distance. Electronystagmographic (ENG) recordings of eye movement during motion were made using electrodes were placed below and at the outer canthi of each eye. Recordings were made at 512Hz using a Biosemi ActiveTwo amplifier. A high-pass Butterworth filter at 0.5Hz and notch filters at 50Hz, 100Hz and 150Hz were applied. Recordings were divided into F and B epochs lasting 2000ms (300ms baseline). Each epoch was normalised by the baseline RMS and the baseline mean was subtracted, and averages created. The signals were decomposed using principal component analysis (PCA) to investigate the underlying processes generating the recorded ENG signal. Cumulative sums were used to approximate integration, to characterize the integral of the response. Correlation with a recorded

acceleration signal along with visual identification was used to characterize the response. RESULTS: For B and F conditions, the ENG responses visually resemble the jerk profile of the motion stimulus (mean Pearson's ρ = 0.81 (F), 0.85 (B), p<0.001 (both)), and the first integrals appear as sinusoids (mean Pearson's ρ = 0.53 (F), 0.55 (B), p<0.001 (both)). The PCA decomposition revealed a primary jerk-like component - particularly for backwards motion - and another acceleration-like component. CONCLUSIONS: Initial results support a jerk response for eye movements during translation. This may be an effect of fixation - jerk may be used to anticipate the acceleration profile. Alternatively, the response may be a coincidence of fixation. Further experimentation with targeted motion profiles can determine this. References [1] Soyka et al., Exp Brain Res (2011) 209:95-107 [2] Mergner et al., Ann. N. Y. Acad. Sci. (1999). 871:430-434 [3] Nolan et al., Exp Brain Res (2012) 219:1-11 [4] Nolan et al., IEEE Neural Engineering (2009) 585-588.

P2-S-135 THE EFFECTS OF SELF-PERCEIVED MOTION IN THE PRESENCE OF VIRTUAL STIMULI AND GALVANIC VESTIBULAR STIMULATION ON POSTURAL CONTROL

Fabricio Saucedo[1], Rebecca Reed-Jones[2]

[1]University of Texas at El Paso, [2]University of Prince Edward Island

BACKGROUND & AIM: Maintaining posture requires the input from three primary sensory systems. These systems include somatosensory, visual, and vestibular components. Of these three systems, the visual and vestibular systems work closest to maintain balance and posture due to visual-vestibular interactions that take place during static and dynamic activities. They are mainly responsible for identifying stimuli and using sensory information to orient the body in space. Thus, understanding how visual and vestibular components integrate may be critical to understand how visual and vestibular sensory information is weighted to control balance. The purpose of this investigation was to determine if visual stimuli alters central vestibular function, modifying postural control when interacting with screen-simulated activities. METHODS: Fifteen young adults performed 45 randomized standing trials (60-seconds) consisting of 6 conditions (EYES CLOSED GVS, VISUAL GVS, EYES OPEN GVS*, EYES CLOSED, EYES OPEN*, VISUAL ONLY*). While standing, subjects were positioned with the head turned at a 90-degree angle, while focusing gaze on a screen. Subjects were outfitted with lower-limb bilateral EMG on the soleus, tibialis anterior, and gastrocnemius to assess short and medium latency reflexes elicited by 30 seconds of galvanic vestibular stimulation (GVS). Stimulus dependent muscle responses were analyzed to determine short and medium reflex latencies (onset) during activity. Force plate data were used to calculate deviations, and velocity shifts in COP over the trials. RESULTS: Results revealed a significant increase in COP velocity for the VISUAL ONLY condition (dynamic visual) (p =.002) when compared to the EYES OPEN* (static visual) condition. A similar increase (p = .001) was also observed when comparing the VISUAL ONLY condition to EYES OPEN GVS* (static visual) condition. Finally, a significant difference was noted between the VISUAL GVS and EYES OPEN GVS* conditions with an increase observed in the VISUAL GVS condition (p= .003). Overall, dynamic conditions (VISUAL GVS & EYES CLOSED GVS) elicited greater COP velocity when compared to the EYES OPEN* condition. CONCLUSIONS: The main findings from this study revealed that when presented with a dynamic visual stimulus, participants increased COP velocity about the BOS, regardless of whether or not GVS was administered. These findings are in line with previous literature, which indicates that visually induced linear vection increases postural control regulation, thus resulting in the readjustments necessary to maintain balance. This suggests that although vestibular input is important to controlling balance and

posture, visual sensory information is utilized to a greater extent when the visual field or visual stimuli is dynamic in nature. A closer look at vestibular evoked muscle responses may provide greater insight into how information from the vestibular system is utilized when presented with dynamic stimuli.

P2-S-136 High rate of falls among patients with vertigo and dizziness - data from a tertiary care center

Klaus Jahn[1], Cornelia Schlick[1], Roman Schniepp[1]

[1]University of Munich

Background and aim: Gait instability and dysbalance are common in patients with vertigo and dizziness. However, little is known about the fall risk in these patients and data on falls frequency are lacking for most of the underlying disorders. This study aimed to determine the prevalence of falls and fall-related injuries among patients with the key symptoms of vertigo and dizziness. Method: A cross-sectional study was conducted at a tertiary care unit (German Center for Vertigo and Balance Disorders in Munich). 506 consecutive patients completed a self-administered questionnaire. The questionnaire was designed according to international recommendations for falls assessment and included all fall events and resulting injuries over the past 12 months. Fall-related injuries were defined as any injury requiring medical attendance. Disease groups were classified as follows: unilateral vestibular disorder (n=99), bilateral vestibular failure (n=11), somatoform vertigo (n=143), central oculomotor disorder (n=11), cerebellar ataxia (n=21), vestibular migraine (n=53), neurodegenerative disease (n=29) and multifactorial vertigo and balance disorder (n=132). Results: The annual rate of falls is highest in the groups of neurodegenerative diseases, including Parkinsonian syndromes (n=21, 72%), multifactorial vertigo and balance disorders (n=83, 63%), and cerebellar ataxia (n=13, 62%). In bilateral vestibular failure and central oculomotor disorders, 45% of the patients reported at least one fall event during the past 12 months (n=5 , both groups). Fall-related injuries occur in 30-35% of all fall events in these 5 groups. The proportion of fallers in the group of unilateral vestibular disorders is 26% (n=26), 20% of the fall events result in injuries. The groups of somatoform vertigo and vestibular migraine show the lowest annual rate of fallers (n=24, 17% and n=10, 19%). Fall-related injuries are reported in about 15% of the fall events. The latter correspond well to prevalence in normal controls. Conclusion: Falls are frequent in patients with vertigo and dizziness. The frequency depends on the underlying disorder. Highest fall rates are found in central syndromes. The fall risk in dizzy people has so far been largely neglected. Specific risk factors need to be identified in these patient groups in order to design and implement fall prevention strategies.

P3-A-1 Pre-impact fall detection using an inertial sensor unit

Soonjae Ahn[1], Isu Shin[1], Jeseong Ryu[1], Youngho Kim[1]

[1]Yonsei University

BACKGROUND AND AIM: Falls are a major cause of injuries and deaths in older adults. As for intervention strategies, one of the important problems in preventing or reducing the severity of injury in the elderly is to detect falls in its descending phase before the impact. If a fall can be detected in its earliest stage in the descending phase, more efficient impact reduction systems can be implemented with a longer lead-time for minimizing injury. In this study, we implemented a pre-impact fall detection algorithm using an inertial sensor unit positioned at waist. Methods: Totally, forty male volunteers

participated in the experiment (three types of falls and seven types of ADLs). An inertia sensor unit, placed at waist, was used to measure subject's acceleration, angular velocity and vertical angle during various activities. For rapid detection before the impact, threshold of acceleration and angular velocity was set to 0.8g and 30°/s, respectively, based on the data from twenty subjects. Furthermore, the threshold of vertical angle was set to 30° because the maximum angle in the ADL did not exceed beyond 30°. This fall detection algorithm was evaluated for another twenty subjects. Results: The results showed that both acceleration and angular velocity during three different falls were greater than the threshold during several ADLs and the vertical angle did not exceed 30°. The vertical angle exceeded 30° only during sit-lying activity, but the acceleration did not reach 0.8g. Based on the pre-impact fall detection algorithm, no false detection was found (100% sensitivity) for all falls. Furthermore, no incorrect detection was found (100% specificity) for all ADLs. The lead time was 474 ± 38.3ms, 590.3 ± 122.6ms and 527 ± 62.3ms in the backward, the forward and the side falls, respectively in order. Conclusions: In this study, a pre-impact fall detection algorithm was developed using an inertial sensor unit. Our pre-impact fall detection algorithm can be implemented with a wearable fall injury minimization system to track a user's body movement.

P3-A-2 Levels and patterns of physical activity and inactivity in elderly individuals with Parkinson's disease

Martin Benka Wallén[1], Håkan Nero[1], Erika Franzén[1], Maria Hagströmer[1]

[1]Karolinska Institutet

BACKGROUND AND AIMS: Parkinson's disease (PD) is a progressive, neurodegenerative disorder characterized by rigidity, tremor, impaired postural stability, decreased walking ability and an increased risk of falls. Many of these symptoms affect movement abilities in everyday tasks, leading to decreased physical activity (PA)-levels and increased time in sedentary behaviors. The extent to which persons with PD meet current guidelines of 150 minutes PA at moderate intensity per week is currently unknown. Therefore, the aim of this study was to provide a detailed description of the levels and patterns of PA, with an hour-to-hour precision, in a sample of elderly individuals with PD. METHODS: Movement sensors (Actigraph GT3X+) were handed out to 95 elderly individuals (42 women) with idiopathic PD (age = 73.4 ± 5.7 years), to be worn for 7 consecutive days. Minutes per day were retrieved for sedentary behaviors, low intensity activities (Low), lifestyle activities at moderate intensity (LM) and moderate-to vigorous intensity ambulatory activities (MVPA). Means ± SDs were calculated for each hour between 6 AM to 11 PM for each day. Differences in activity levels between weekdays and weekends were estimated with paired sample t-tests, or a Wilcoxon signed rank test in the case of MVPA. Proportions with 95 % confidence intervals (CI) were estimated to determine the percentage that meets the guidelines of PA. RESULTS: 85 individuals provided valid data (4-7 days with > 10 hour wear time per day). Mean (± SD) time per day spent sedentarily was 567.6 ± 84.5 minutes, whereas time in Low, LM and MVPA was 135.1 ± 61.0, 29.1 ± 20.7, and 16.1 ± 21.4 minutes, respectively. No differences in PA-levels were found between weekdays and weekend-days. Patterns over the day were characterized by an increase in Low starting at approximately 7 AM, peaking at 10-11 AM before gradually tapering off and reaching a low plateau at approximately 8 PM. Similar patterns were found for LM and MVPA, although a decline in these activities was observed earlier in the afternoon. Only 28% (CI = 18-38%) met the guidelines of 150 min MVPA per week. CONCLUSIONS: To our knowledge, this is the first study to provide a detailed description of PA levels and patterns, based on accelerometer data,

in a representative sample of elderly individuals with PD. The single most important finding was that almost ¾ failed to meet the recommended guidelines of PA. This finding largely agrees with previous studies demonstrating that the PD-population is less physically active than the elderly population in general. The results also indicate that the patterns of PA fluctuate little over different days of the week and hours of the day. Taken together, this study emphasizes the need to develop strategies that will increase PA-levels and reduce sedentary time in this population. Future studies need to determine which strategies are best suited for achieving this goal.

P3-A-3 An Instrumented Version of the Berg Balance Scale to Assess Postural Control

George Fulk[1], Wenlong Tang[2], Edward Sazonov[2], Stacey Zeigler[1]

[1]Clarkson University, [2]University of Alabama

BACKGROUND AND AIM: Advances in wearable sensor technologies and signal processing techniques may provide a way to instrument common clinical tests of functional balance in order to provide clinicians with accurate and precise data in an efficient manner and may also provide a method to monitor falls risk in the home and community. The purpose of this study was to develop an instrumented version of the Berg Balance Scale (BBS) using a novel shoe based sensor and to determine its ability to identify fallers and non-fallers in community dwelling older adults. METHODS: 30 community dwelling older adults participated. Participants performed the BBS while wearing a shoe-based sensor. The shoe-based sensor consisted of an insole imbedded with 3 force sensitive resistors, a 3D accelerometer attached to the side of the shoes and a 3D accelerometer on their right hip. Participant self-reported falls history over the previous 6 months was obtained. A faller was defined as a participant with 2 or more falls in the past 6 months. A Support Vector Machine (SVM) regression model was built based on significant sensor features to estimate the BBS scores. A Leave One Out cross validation method was used to evaluate the performance of the SVM regression model. The validity of the sensor estimated BBS scores was assessed by calculating the mean error and by comparing the sensitivity and specificity of the therapist scored BBS score and shoe sensor estimated BBS in identifying self reported fallers from nonfallers using a BBS cut off score of <43. RESULTS: The SVM regression model used signal features from 4 of the 14 items on the BBS to estimate the total BBS score. These were: number of mean crossings in AP direction from the shoe accelerometer during item 12 (place alternate foot on stool), dominant frequency in ML direction from the shoe accelerometer during item 3 (sitting), number of mean crossings of shoe pressure sensors in vertical direction during item 5 (transfers), and number of mean crossings of the hip accelerometer in the ML direction during item 10 (turn to look behind). The mean error of the shoe sensor estimated BBS scores was 3.3 (2.0) points and the range of absolute error was 6.5 to 0.15. The sensitivity and specificity for identifying fallers and nonfallers was similar between the therapist scored BBS (0.40 and 0.80) and the shoe sensor estimated BBS score (0.50 and 0.80). DISCUSSION: The novel shoe based sensor utilizing pressure and acceleration data was able to accurately estimate BBS scores in this sample of community dwelling older adults using signals from 4 items of the BBS. The shoe sensor may offer a method to efficiently assess postural control. The mean error of the shoe sensor for estimating the BBS is within the range of error/variability. This shoe based sensor may also provide a means to assess falls risk in the home and community. Further research is necessary to examine this.

P3-A-4 Prevalence and circumstances of falls in young adults: 29% fell in a five week observation period

Michel Heijnen[1], Shirley Rietdyk[1]

[1]Purdue University

BACKGROUND AND AIM: It is well know that slips, trips and falls result in substantive injuries for all age groups. However, the prevalence and circumstances of falls is based mainly on the accuracy of the recall of people who have fallen, and fall memory is known to be problematic. Therefore, a daily online survey of slips, trips, and falls may improve knowledge of the prevalence and circumstances of these perturbations. This study not only examined the circumstances of falls, but also examined the slips and trips that did not result in a fall. This study was a pilot to examine the frequency and circumstances of slips, trips and falls as well as the response rate with a daily online survey in young adults. METHODS: Fourteen young adults (23.7±2.8 yrs) participated in a daily online survey for 5 weeks. Subjects received a daily email asking whether they had slipped, tripped or fallen in the past 24 hours. If "yes" was selected, follow-up questions were presented about the number and the circumstances of their slips, trips and falls. Subjects may slip, trip or fall more than once per day. In order to decrease the length of the survey, subjects were asked to only report the circumstances of the slip, trip or fall that resulted in injury or interrupted their movement the most. Data collection is ongoing; results from 16 weeks will be reported at the conference. RESULTS: Twelve falls were observed in four people (29%). The percentage of falls was similar to the typical observation that one in three older adults fall each year; however, the data presented here are only for five weeks, compared to one year for older adult observations. The average response rate was 88%. One hundred and fifty-six slips and trips were observed in 431 observations, highlighting the prevalence of these perturbations. When reporting on the most interrupting slip, trip or fall, subjects tripped more frequently (77%) than they slipped (23%) and 11% of these slips and trips resulted in a fall. The main cause of the fall was a slip (46%) followed by a trip (31%). The two most common activities associated with the fall were walking (31%) and running (23%). Subjects were either talking to a friend (46%) or not doing anything else (31%). Stairs and an icy/slippery floor were the main environmental causes of the fall (38% each). Interestingly, young healthy subjects tripped more frequently but more falls resulted from a slip. This is consistent with the observation that it is more difficult to recover from a slip than from a trip. CONCLUSION: Fall rates in young adults (29% in five weeks) were much higher than fall rates reported in the literature for older adults. The high response rate indicates that daily online assessments can be used for most young and middle-aged participants, but would be limited to older adults that check their email daily. As this population is growing, online daily assessments are a viable future tool for tracking slips, trips and falls in older adults.

P3-A-5 Low physical activity is associated with impaired cognitive function in PD

Inga Liepelt-Scarfone[1], Bernhard Cerff[2], Malte Kampmeyer[2], Jos Prinzen[3], Markus Hobert[2], Menno Zuidema[3], Susanne Graeber[2], Daniela Berg[2], Walter Maetzler[2]

[1]German Center for Neurodegenerative Diseases and Hertie Institute for Clinical Brain Rearch, [2]Hertie Institute for Clinical Brain Rearch and German Center for Neurodegenerative Diseases, [3]McRoberts B.V

Background and aim: Low physical activity predicts onset of dementia and preclinical conditions such as mild cognitive impairment (Hamer & Chida, 2009). However there is only scarce literature available that report about physical activity in specific dementia subtypes, and almost none of these studies used

quantitative assessment strategies to assess physical activity. We therefore aimed to assess physical activity using an unobtrusive wearable sensor in Parkinson's disease, which is associated with a high risk for concomitant dementia (PDD). Our particular aim was to investigate whether PD patients with a precondition of dementia, i.e. mild cognitive impairment (PD-MCI) can be distinguished from PDD as such a marker could serve as an indicator of increased risk for future dementia in PD. Moreover we examined which cognitive functions and tasks are correlated to the accelerometer-derived measures. Methods: In this explorative cross-sectional study, 55 PD patients and 18 controls were included. Based on a comprehensive neuropsychological test battery, PD patients were classified as cognitively non-impaired (n=21 PDND), PD-MCI (n=23) and PDD (n=11). Physical activity was measured with the DynaPort® MoveMonitor® (McRoberts, The Netherlands) which the participants were asked to wear in their home environment for a period of at least two consecutive days. For each participant the first full-day 24h registration period was analysed. The following parameters were calculated: duration and intensity of sedentary (lying, sitting) and active (standing, locomotion and shuffling) periods, the metabolic equivalent of task (MET) and the energy expenditure profile. Due to technical problems, 2 controls, 2 PDND, 1 PDD patient(s) were excluded from data analysis. Motor performance, age at examination and severity of depressive symptoms differed significantly between groups and were thus included as covariates for mean group comparison. Results: The following physical activity parameters were lower in PDD patients compared to PD-MCI patients: standing time, shuffling time) (both $p>0.05$), time spent with active periods ($p=0.06$) and vigorous activities (>=6.0METs, $p=0.06$). Visual performance, psychomotor speed and executive function correlated significantly with the accelerometer-derived parameters. Conclusions: Our results indicate that the objective and unobtrusive assessment of physical activity in PD is possible, even in advanced disease stages to discriminate PDD from PD-MCI. They underscore the importance and potential of objective assessment of physical activity in PD, and, more specifically, may bear the potential to pave new ways in the diagnosis and prediction of cognitive impairment in this chronic condition. References: Hamer M. & Chida Y, Psychol Med, 2009, 39: 3-11

P3-A-6 Accelerometer filter choice - effects on measures of elderly with Parkinson´s disease

Håkan Nero[1], Martin Benka Wallén[1], Erika Franzén[1], Maria Hagströmer[1]

[1]Division of Physiotherapy

BACKGROUND AND AIM: Accelerometers are widely used to characterize physical activity (PA) in different populations. Since individuals with movement disorder such as Parkinson's disease (PD) often present slower-than-normal movement, accelerometer manufacturer ActiGraph provides a low frequency extension filter (LFE) that increases the sensitivity of measurement. To our knowledge, no-one has studied how the LFE affects PA-measurement in individuals with movement disorders. The aim of this study was to compare physical activity parameters assessed with the Actigraph GT3X+ accelerometer and processed with normal and LFE filter settings, in a sample of elderly individuals with PD during controlled and free-living conditions. METHODS: 66 elderly (28 women) (mean age 73 ± 6 years) with mild to moderate idiopathic PD (Hoehn & Yahr 2 to 3) carried a GTX3+ accelerometer for seven consecutive days. Mean number of steps and minutes per day in sedentary behavior, low intensity-, lifestyle-, and moderate-to vigorous activities were obtained in ActiLife 6 with the normal- and LFE filter setting, respectively. In addition, a subgroup of 15 (4 women) (mean age 74 ± 4.8 years) were videotaped while walking with an accelerometer at self-selected speed for three minutes. Manually calculated steps from the video were compared with steps from the normal and LFE filter

outputs. RESULTS: The subgroup results demonstrated that manually calculated steps did not differ from the normal- or LFE filter setting accelerometer derived steps (mean 333, 311 and 332 steps, respectively, $p>0.05$). In the free-living setting the LFE consistently generated significantly ($p<0.001$) larger values compared to the normal filter on all outcome variables, with the exception of MVPA. The largest difference was observed for mean (SD) steps per day (normal filter setting: 4730 (3210) steps; low frequency extension filter setting: 11117 (4553) steps). Pearson´s correlations were consistently high, ranging from 0.901 to 0.997; however, intraclass correlation confidence intervals and limits of agreement (95 %) were generally wide, indicating poor agreement. CONCLUSION: The discrepancies found between the two filter settings during free-living condition might be explained by an overestimation of the results obtained with the LFE filter. Since the subgroup comparison indicates that number of steps derived from the LFE filter is similar to actual number of steps, the filter might interpret other types of movement during free living conditions as steps. These errors could lead to misclassification of important PA parameters, a problem particularly relevant for individuals who do not meet the daily recommendations of PA. Until new evidence supporting an extension of the lower band is presented, it is recommended that the normal filter setting be used when assessing PA in elderly individuals with PD.

P3-A-7 Targeting Sedentary Behaviour Using Sensory Feedback to Change Posture

Daniel Rafferty[1], Carol Makarios [1]

[1]Glasgow Caledonian University

Background and Aim: Time spent in sedentary behaviours (SB), seated/lying, has increased in our daily lives as a result of changes in the working environment or using effort saving devices such as remote controls. Our leisure time is increasingly dominated by SB that is screened based, usually watching television or computer based activities. Irrespective of attaining recommended guidelines for physical activity time spent in SB is an independent risk factor for chronic disease, morbidity and mortality. Evidence also suggests it is not only the volume of time spent in SB that is the risk factor but also how it is accrued and that changing the distribution of SB with regular interspersed postural change from seated to standing could have a significant impact on reducing the risk of chronic conditions. The aims of this work are to explore if in addition to education on SB that introducing sensory feedback: a) increased the number of breaks in SB and b) resulted in a reduction in total time spent in SB. Methods: ActivPAL is a commonly used monitor for measuring free living physical activities providing valid information on: SB, upright, and ambulatory activities. The ActivPAL VTaP has the same utility but additionally provides a vibro-tactile feedback to alert the wearer of predetermined prolonged periods of SB. All participants (n=10) were females with an average age of 47.1±10.1 yrs and a BMI of 24.3±4.6 received a brief education session and written material on the importance of reducing prolonged SB. A cross over design (AB: BA) was employed and for the first seven day period of free living data collection five participants wore the ActivPAL (A) without feedback and the others wore the ActivPAL VTaP (B). The devices were then crossed over and a further seven days of data collected. The ActivPAL VTaP was programmed to deliver a feedback after 30 minutes of continuous SB. The number of sit to stand transitions and total time in SB were the main outcome measures and data were assessed for normality and tested appropriately using a 3-way ANOVA (subject - weekday - with or without feedback). Results: Providing the wearer with a vibro-tactile feedback proved effective in increasing the number of sit to stand transition from 63±19 to 70±24 per day (a 9% increase) over education alone ($p=0.039$). However there

was no statistical difference in the overall sedentary time with or without the prompt (16,5±2.2, 16.6 ±2.1 hrs (p=0.65)). A significant difference between subjects for breaks in SB (p<0.001) was observed however there was no difference attributable to day of the week (p=0,93) or the A-B design (p=0.57). Conclusions: This study has demonstrated that sensory feedback significantly increased the number of breaks in SB in comparison to education alone. Although a modest effect was observed sensory feedback could prove an effective intervention in achieving breaks in SB potentially reducing health risk associated with prolonged SB.

P3-B-8 Gait and Postural Sway Deteriorate Differently with Age

Patricia Carlson-Kuhta[1], Jeong-Ho Park[2], Carolin Curtze[1], Martina Mancini[1], Fay Horak[1]

[1]Oregon Health & Science University, [2]Soonchunhyang University, Bucheon Hospital

Background and Aim. To accurately understand the changes in balance and gait in neurological diseases, it is important to identify age-related changes across the adult age span. The Instrumented Stand and Walk test (ISAW) has recently been developed to provide a quick, quantitative assessment of standing balance, step initiation, gait and turning. Our aim was to quantify the relationship of age with balance and gait, and to identify key age-related factors of balance and gait in the community-dwelling, healthy population. Methods. A total of 135 healthy subjects (47 men; mean ± SD, 57.7±17.1; range, 21-89 years) were enrolled from the community. Subjects wore 6 inertial sensors (MTX Xsens or Opals, APDM) on the wrists, ankles, sternum and lumbar area of torso; measures of sway, gait initiation, gait and turning were computed. Participants performed 3 trials of the ISAW, consisting of standing quietly for 30 seconds, followed by walking 7 meters, turning 180 degrees, and walking back to the initial starting position. Among more than 100 metrics of ISAW, 37 metrics were selected and then 6 factors were extracted using exploratory factor analysis. Univariate and multivariate data analyses were performed using SPSS (v18). Statistical significance was set to p<0.05. Results. There were distinct patterns of the correlations between age and the metrics: linear deterioration, decline after plateau, and relatively consistent across ages (see Figure 1). The strongest correlation with age was found for centroidal frequency of sway ML (r=-0.50, p<0.001, Pearson's correlation coefficient; ML = medial-lateral). After adjusting for weight and height, centroidal frequency of sway ML and peak swing velocity of gait, stride length of gait showed the strongest correlations with age (partial correlation coefficients of |r*|>0.4, in descending order). Six factors were identified from the factor analysis: sway area, gait-temporal, sway anteroposterior (AP), sway mediolateral (ML), gait-spatial, and gait-turn. Of the above six factors, the sway ML factor showed a "linearly deteriorating" pattern with increasing age (R2=0.184, p<0.001), while gait-spatial factor showed a pattern of "deteriorating after plateau" (R2=0.146, p<0.001). Conclusions. Results from this cross-sectional study suggest that not all metrics change in the same way with age and the metrics can be grouped into six independent balance and gait factors. Sway ML is a key factor affected by age. The results highlight the importance of measuring both balance and gait to fully characterize changes in mobility. Acknowledgements. Supported by NIH grants- RC1-NS068678, R41-HD071760 and R37-AG006457 and the Oregon Clinical and Translational Research Institute, grant # UL1 RR024140. Figure 1. Example of two patterns of age-related change in sway and gait.

P3-B-9 Balance and mobility deficits in older adults with Type 2 Diabetes Mellitus who do not report mobility disability

Nandini Deshpande[1], Patricia Hewston[1], Karyna Figueiredo - Ribeiro[2], Tessa Elliott[1], Sebastian Spears[1]

[1]Queen's University, [2]Universidade Federal do Rio Grande do Norte

BACKGROUND AND AIM: It is reported that older adults with Type 2 Diabetes Mellitus (T2DM) have significant declines in balance and higher prevalence of mobility impairment when compared to older adults without T2DM. These deficits have been primarily attributed to diabetic peripheral neuropathy (PN). However, worse lower limb sensory functions have also been reported in T2DM without overt PN. This study examined the subtle differences in balance and mobility function between the elderly without T2DM, those with controlled T2DM (glycated haemoglobin <0.07) and with uncontrolled T2DM (glycated haemoglobin =>0.07) who did not report overt mobility disability. METHODS: Twenty-five healthy controls (HC, age:74.6±5.4 yrs) and 40 older adults with T2DM for at least 5 years (15 controlled T2DM, age:70.5±5.3 yrs and 25 uncontrolled T2DM, age:71.0±4.9 yrs) were recruited. Participants were excluded if they reported mobility disability defined as the inability to walk a quarter mile without resting or climb a flight of stairs unsupported. Standing balance was assessed with the modified Clinical Test of Sensory Integration for Balance (mCTSIB) and Frailty and Injuries: Cooperative Studies of Intervention Techniques balance test (FICSIT). Functional mobility was assessed using modified Timed-up and Go (mTUG) on a compliant surface with blurring goggles. Self report measures included Activity-specific Balance Confidence (ABC) Scale and Human Activity Profile (HAP) scores. ANOVAs and multinomial logistic regressions were used to explore between group differences. RESULTS: As HCs were significantly older than T2DMs (p<.05) all analyses were adjusted for age. FICSIT and mTUG scores were not different between groups (p>.05). However, a higher proportion of T2DMs (>55%) were unable to complete mCTSIB condition 4 than HCs (25.0%) (p=.02). Within self report, ABC scores were comparable between groups but HAP scores were significantly higher in HCs (p<.05). CONCLUSIONS: Older persons with T2DM demonstrate subtle differences in balance and mobility-related functions even without overt PN or overt mobility disability. Higher prevalence of failure in mCTSIB condition 4 suggests a possible impairment in the vestibular system or sensory reweighting process when 2/3 sensory systems are compromised. Differences in HAP score suggest that T2DM may stop performing mobility tasks requiring high functional capabilities even before clinically reporting mobility disability. Sensorimotor/psychosocial factors responsible for these deficits should be explored to prevent further spiral of the disablement process.

P3-B-10 Exploring measures to better assess the effect of cold on dynamic balance in a young and older female population

Dwight Waddell[1], Harish Chander[1], Christi Brewer[2]

[1]University of Mississippi, [2]University of Eastern Washington

Summary: In an ongoing study, clinical measures are compared with center of pressure (COP) trajectories/velocities, and approximate entropy to determine which outcome measure may be most sensitive in identifying stability costs due to cold in a female population. Background and Aim: A decline in the functional capacity of the neuromuscular system is an inevitable consequence of aging. Cold has been identified as preferentially affecting an older population in various measures including: slower onset latencies of reflexes, a reduced Hoffman-reflex, and lowered nerve conduction velocities. Epidemiological research has shown a direct relationship between the daily minimum temperature and the risk/occurrence of falls in the elderly female population. The aim of this study is to determine in what capacity cold might influence postural stability in female subjects. Methods: To date, seven older

(aged 70.5 2.7 years) and seven younger (aged 23.9 2.4 years) females were recruited from the University of Mississippi and locally in Oxford, Mississippi. Dynamic balance was measured using a NeuroCom System. Standard sensory organization tests (SOT) were used under thermally neutral and cold conditions. Leg temperatures were varied through the use of liquid circulating garment (LCG) pants designed by MedEng" (Ontario, Canada). The LCG pants are composed of kermel fabric lined with Tygon® tubing and are part of a three piece liquid cooling garment typically used in military settings. Water temperature through the pants was maintained with circulating chillers (Brinkmann LAUDA, Westbury, NY) containing either thermally-controlled neutral (33ºC) or cool (3ºC) water. SOT composite scores were used for data analysis. The COP data for each individual SOT test were used to calculate root mean square (rms) Sway and peak Sway velocity in both anterior/posterior (A/P) and medial/lateral (M/L) directions. COP trajectories were also used to calculate approximate entropy (ApEn) and serve as a measure of randomness in COP oscillations. 2x2 (Age by Temperature) Repeated Measures ANOVAs were run in both the A/P and M/L directions for rms Sway, Swat Velocity, and Sway ApEn. A 2x2 ANOVA was conducted on SOT composite scores. Results: Age related differences for SOT tests were revealed from NeuroCom composite scores, rms Sway A/P, M/L Sway Velocity, M/L Sway ApEn, and A/P Sway ApEn. However of all the tests, only A/P Sway ApEn revealed significant temperature effects (specifically, SOT2 = quiet standing, visual surround stable, eyes closed). There were no significant age*temperature interactions for any test. Conclusions: There is presently too little data. However, ApEn has recently been used to differentiate between pre/post concussion, and it is our contention that entropy values may reveal subtle differences in stability as a function of temperature/age, and subsequently help explain observations regarding higher falls in elderly women during the winter season.

P3-B-11 Analysis of muscle power and postural control in elderly women of different age groups

Matheus Gomes[1], Daniela Abreu[1], Júlia Reis[2]

[1]University of São Paulo, [2]Federal University of Sergipe

BACKGROUND AND AIM: the literature on gerontology clearly demonstrates that the elderly exhibit poorer balance and decreased muscle strength and power compared to young individuals. Nevertheless, little is known about the influence of age on muscle power and their relationship with the postural control performance in elderly individuals of different age ranges. The muscle power, compared to muscle strength, was shown to be a better predictor of functional ability and susceptibility to falls in the elderly. To maintain balance after an external disturbance, strength must be generated in association with velocity. There is a gap in the literature concerning the ability of elderly individuals in different age ranges to generate muscle power, especially, at different intensities relative to the maximum load. OBJECTIVE: the aim of the present study was to evaluate the ability of elderly individuals of different ages to produce muscle power at specific relative intensities and to analyse the correlation of muscle power with postural control performance. Methods: eighty women were divided into four groups: the young group (which comprised women aged 18 to 30 years, n=20); the 60-64-year-old group (n=20); the 65-69-year-old group (n=20); and the 70-74-year-old group (n=20). The participants underwent maximum strength (one repetition maximum - 1-RM) and muscle power tests to assess the knee extensor and flexor muscles at 40%, 70%, and 90% 1-RM intensity. The performance of the postural control system was assessed using a force plate (Synapsys Posturography System - Synapsys S/A, Marseille, France) with 100-Hz sampling frequency. The participants stood barefoot on the platform,

placing their feet approximately 10 cm apart according to the manufacturer's instructions. Once a trial began, the platform moved translationally in the anterior-posterior (AP) and medial-lateral (ML) directions, disrupting the participants' balance. The time required by participants to recover their balance after disturbing their base of support was measured. RESULTS: the elderly women in the 60-64-, 65-69-, and 70-74-year-old age ranges exhibited similar muscle strength and power; however, these values were lower than those of the young women group. In all three age ranges, the elderly women exhibited similar postural control, but their control was less than that of the younger participants. There was a positive correlation between muscle strength and power and the postural control performance. The results reveal that the greater the strength and power of the knee extensor and flexor muscles, the shorter the balance recovery time. CONCLUSIONS: despite the age difference, elderly women aged 60 to 74 years exhibited similar abilities to generate strength and power with their lower limbs, and this ability results in similar postural control performances by these women.

P3-B-12 Comparing Compensatory Reactions in Young and Older Adults in Response to Platform Perturbations During Gait

Emily McIntosh[1], John Zettel[2], Lori Ann Vallis[2]

[1]University of Waterloo, [2]University of Guelph

BACKGROUND AND AIM: Contradictory to self-reported falls literature, a recent observational study showed that the majority of falls in older adults recorded for two assisted living facilities were the result of incorrect weight transfers; most taking place during forward walking [1]. Another related study showed lateral instability as a predictor for prospective falls risk [2], however few studies have examined stabilizing responses following a lateral support surface perturbation during gait. The purpose of this study was to examine differences between young and older adults when responding to frontal and sagittal plane perturbations during gait. It was hypothesized that lateral surface translations (frontal plane) would be most difficult for both age groups, and that older adults would require larger compensatory reactions than young adults. METHODS: Eleven young adults (7 females, age 23.8 ± 3.1 years, height 176.2 ± 8.9 cm, mass 71.2 ± 12.4 kg) and ten older adults (8 females, age 71.1±3.1 years, height 167.6 ± 8.9 cm, mass 72.6 kg ± 11.1) completed a general health questionnaire, Mini BESTest, hip strength tests, and 45 walking trials. These trials were completed in a randomized block design on a 5m pathway that moved after heel contact on a force plate imbedded in the pathway. During perturbations the platform moved 15 cm at a peak velocity of 31.6 cm/s. The session consisted of five trials each of forward, backward, left, and right perturbations, in addition to 15 non-perturbed walking, and 10 catch trials (motions with a time delay). RESULTS: Young adults were significantly stronger at hip abduction and adduction ($p<0.05$) than the older adults. Medial-lateral centre of mass (COM) velocity was six times larger during the most destabilizing perturbation (leftwards) than the non-perturbed trials. This was a greater change than anterior-posterior COM velocity during forward and backward perturbations (increased less than two fold). One step following perturbation, both groups decreased their step length, however on the second recovery step the young adults increased their step back to their original values, while the older adults continued making adjustments. As expected, medial-lateral COM displacement ranges were larger during frontal plane motions than sagittal perturbations. Older adults, however, were affected more during the rightwards perturbations than the young adults, resulting in them having larger COM displacement ranges. CONCLUSIONS: Frontal plane perturbations during gait were more difficult to respond to for both young and older adults perhaps due to a decrease in the lateral base of

support during forward progression. Young adults were able to recover quickly following perturbations while their older adult counterparts required multiple steps. This difference could be attributed to many changes which occur with aging, one of which is strength decline. [1] Robinovitch et al. (2013) Lancet. [2] Maki et al. (1994) J Gerontol.

P3-B-13 Effect of higher muscle coactivation on standing postural response to perturbation in older adults

Koutatsu Nagai[1], Yusuke Okita[2], Shinya Ogaya[3], Yuichi Nakamura[4], Tadao Tsuboyama[4]

[1]Kyoto Tachibana University, [2]Kyoto University, [3]Osaka prefecture University, [4]Kyoto University

Background and aim Recently, several studies have reported that muscle coactivation during postural control increases with age. While an increase in muscle coactivation during quiet standing enhances joint stability, it may negatively affect dynamic postural control. However, the effect of higher muscle coactivation on standing postural response to perturbation has not been clarified. The purpose of this study is to investigate whether higher muscle coactivation affects standing postural response to perturbation in older adults. Methods Thirty four community dwelling older adults (73 ± 5 years) participated in this study. They were randomly assigned to the coactivation group (CG: n = 17) in which muscle coactivation was increased intentionally, or to the non-coactivation group (NCG: n = 17). Participants were made to stand on a force plate, 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 force plate with a constant amplitude (6 cm) and velocity (15 cm/s). After a trial of 15 perturbations, we requested the participants in the CG to increase the activity of their tibialis anterior, antagonist muscle to maintain a standing posture, at the level of 50% maximal voluntary contraction determined by visual biofeedback, and to maintain this posture during the perturbation tasks. We added 10 perturbations, randomly for each direction, for each group. Two-dimensional motion analysis was performed with a digital video camera positioned perpendicularly to the sagittal plane. We analyzed the differences between group parameters at 100 ms intervals from the onset of perturbation to 1000 ms. Results Three participants in the CG were excluded because they found it difficult to intentionally increase antagonist activation while standing. Finally, forty (72 ± 5 years) participants from the CG and 17 (72 ± 6) from the NCG were included in the analysis. During forward transfer, the ankle angle did not differ significantly between the groups, and knee extension after perturbation did not occur in the CG ($p < 0.05$). Hip flexion around the peak of the joint movement decreased in the CG, and the trunk extension angle increased within the same duration ($p < 0.05$). The amount of center of pressure (COP) displacement decreased around the peak of the movement in the CG. During backward transfer, ankle dorsal flexion decreased at 100-200 ms after perturbation and increased at 800-1000 ms. Earlier knee flexion after perturbation decreased in the CG ($p < 0.05$). There was no significant difference in the hip and trunk angle between the groups. Conclusions Our study found that higher muscle coactivation inhibits the movement of lower limbs, and in the case of forward perturbation, subjects with higher coactivation recruit a compensatory strategy by increasing trunk extension, which may be called "trunk strategy."

P3-C-14 Functional Electrical Stimulation of Trunk Muscles Increases Trunk Stiffness during Quiet Sitting

Matija Milosevic[1], Kei Masani[2], Noel Wu[1], Kristiina Valter McConville[3], Milos Popovic[1]

[1]University of Toronto, [2]Toronto Rehabilitation Institute - University Health Network, [3]Ryerson University

BACKGROUND AND AIM: Functional electrical stimulation (FES) activates muscles by applying short electric pulses on the skin surface over the muscle nerve. The effects of application of FES on trunk muscles during sitting are not completely understood. We hypothesized that FES of the trunk muscles will stiffen the trunk and improve sitting postural stability. The objectives of this study were to: 1) characterize changes in sitting postural stability that result from application of surface FES on trunk muscles in an experimental study; and 2) investigate the mechanism of changes in a simulation study. METHODS: Fifteen able-bodied individuals (age 26.7±4.6 years) participated in the experimental study. Subjects were seated such that their legs did not touch the ground and center of pressure (COP) on the seat was calculated to evaluate sitting postural stability in natural and FES-assisted quiet sitting. Surface stimulation was applied bilaterally on the rectus abdominis (20.3±3.8 mA) and lumbar erector spinae at around L3 (24.6±7.4 mA) to generate co-contractions (pulse duration 300 µsec and frequency 40Hz). In the simulation study, a feedback model of the control system during quiet sitting was built using an inverted pendulum model with the neural controller (proportional and derivative (PD) controller with a time delay modeling the neural control system including transmission delays) and passive damping and stiffness contributions (modeling the mechanical support such as joint ligaments). Controller gain combinations that stabilized the entire system were used to simulate the COP fluctuations. Relationship between each COP measure and controller gains were assessed using partial correlation analysis. RESULTS: Analysis of COP fluctuations between natural and FES-assisted sitting showed that the mean velocity of anterior-posterior (AP) fluctuations was significantly larger ($p=.020$) in the FES condition. Comparison of frequency domain fluctuation parameters indicates that frequency dispersion was smaller ($p<.001$) and that 50% power frequency was larger ($p=.038$) for AP fluctuations in the FES condition. These results suggest that COP fluctuations were faster during FES-assisted sitting. The simulation study showed that mechanical stiffness correlated positively with the mean velocity, and 50% power frequency and negatively with frequency dispersion, which matches our experimental findings for the FES condition. CONCLUSION: Our results indicate that FES of the trunk muscles could increase velocity of the COP during quiet sitting by increasing trunk stiffness. These changes were prevalent in the AP direction because the stimulated trunk flexor and extensor muscles control AP stability. Overall, the utility of FES to affect postural stability during quiet sitting among able-bodied individuals was shown in this study. Further investigation will confirm that the system could be used to improve sitting of individuals with neurological impairments.

P3-C-15 Early identification of declining balance in higher functioning older adults

Katie Sheehan[1], Barry Greene[2], Lisa Crosby[3], Clodagh Cunningham[4], Rose Kenny[4]

[1]Vancouver Coastal Health Authority, [2]University College Dublin, [3]Trinity College Dublin, [4]Technology Research for Independent Living

BACKGROUND AND AIM:Higher functioning older adults are those over 60 years, community dwelling, independent, cognitively intact and have little morbidity. These adults rarely have balance assessed clinically and as such early decline in balance is not captured. Early identification of declining balance may facilitate earlier intervention and management of the ageing process. Technology based methods are potentially more sensitive. Quantitative measures collected during a 'Timed Up-and-Go' (TUG) recently demonstrated improved accuracy in falls risk assessment. With a known relationship between

balance and falls this study aimed to determine if changes in these parameters (measured at two time points one year apart) reflect decline in balance for higher functioning older adults. METHODS:Higher functioning participants attended the TRIL Clinic (www.trilcentre.org) for a comprehensive baseline assessment. Follow-up assessments were completed on average 12.9 months later. At both sessions measures included the Berg Balance Scale (BBS) and the quantitative TUG. Decline in balance was defined as a negative change of two or more in the BBS subcomponent single leg stance. Wireless sensors attached to the anterior tibia of each leg during the TUG contained a tri-axial accelerometer and gyroscope and sampled at 102.4 Hz (SHIMMER Research, Ireland). Data were transmitted wirelessly via Bluetooth to a PC. All sensor data analysis was performed offline using MATLAB (Mathworks, USA). Quantitative TUG parameters were derived for the changes in sensor data between baseline and follow-up TUG. Logistic regression odds ratios with 95% confidence intervals were described for a decline in balance using both quantitative TUG parameters and TUG time alone. The area under (AUC) the receiver operating characteristic (ROC) curve was used as an indicator of each model's predictive capability. This study received ethical approval and participants provided informed consent. RESULTS:119 subjects (58 male; age 72.5 ± 5.8 years) participated. Median BBS at baseline was 55 (min,max: 45,56). A decline in single leg stance was demonstrated by 24 (20.2%) participants. Results from the logistic regression analysis indicated that the change in two quantitative TUG parameters between baseline and follow up (change in angular velocity ML mean (Odds ratio 0.6, 95% CI: 0.4, 0.8); change in angular velocity V mean (Odds ratio 0.7, 95% CI: 0.5,0.9)) were strongly associated with balance decline. Change in TUG time between the two assessments was not a predictor of decline in balance (Odds ratio 0.9, 95% CI: 0.9, 1.0). The AUC for the change in quantitative parameters over time was 0.9. This represented a marked improvement over the change in TUG time alone (AUC 0.6). CONCLUSIONS:Quantitative TUG parameters better identified older adults who declined in balance than TUG time alone. Such measures may be used clinically to monitor changes and identify early decline in balance function.

P3-D-16 Adaptability of reactive postural responses as a function of voluntary task constraint: influence of aging

ANDREA CRISTINA DE LIMA-PARDINI[1], DANIEL COELHO[1], MARINA SILVA[2], FAY HORAK[3], ALESSANDRA MARTINELLI[1], NAMETALA AZZI[1], LUIS TEIXEIRA[1]

[1]UNIVERSITY OF SAO PAULO, [2]UNIVERSITY ANHANGUERA, [3]OREGON HEALTH AND SCIENCE UNIVERSITY

The ability to respond to a sudden, unexpected balance perturbation, such as a slip, depends on effective postural reactive responses, which are triggered automatically. Even having a short latency, postural reactive responses can be influenced by high-order cortical processing. This study assessed the effects of stability constraints of a voluntary task on the adaptation of postural reactive responses to an external perturbation in healthy young and elderly people. Participants performed a dual task, combining perturbed upright stance and manually holding a movable cylinder on a wooden tray. The manual component of the task consisted of keeping the upper arms parallel to the trunk and elbows bent at approximately 90 degrees, while the hands were supinated to hold the tray. The aim of the manual task component was to keep the cylinder on the tray as motionless as possible in response to postural perturbation. In the low constraint condition (LC) the cylinder was lying on its flat side, so that slow horizontal movements of the tray would not lead to a slide of the cylinder on the tray. In the high constraint condition (HC), the cylinder was placed on its round surface, so that it was free to roll in the anterior-posterior direction, limited in motion to around 90 degrees by a weight of 10g attached to its

bottom. Participants wore a harness positioned at the lumbar-sacral region. In the posterior side of the harness an electromagnetic system was coupled to a load through a steel cable, passing through a pulley attached to a height adjustable support. With that arrangement the pulling force applied to the subject's torso through the apparatus was approximately horizontal with the ground. The load had approximately 7% of the subjects' weight, and it was used to pull upright stance in the backward direction. The posterior pulling force applied through the load required a constant activation of anterior muscles and inhibition of posterior muscles. Load was unexpectedly released by the experimenter through a remote switch. Load release induced a forward postural sway, requiring the establishment of a new point of postural equilibrium through a phasic contraction of the posterior muscles of the body as a reactive response. Both groups diminished tray velocity in the context of HC compared to the context of LC. The most significant results showed that while the young group adapted muscular latency, muscular magnitude, coactivation level and interarticular coordination according to the sequence, the elderly group was more sensitive to the current context of voluntary task constraint. These results suggest that aging lead to changes from a more generalized adaptation to a more specific postural reactive responses adaptation.

P3-D-17 Focusing attention on reaction time improves postural control and reaction time in young adults

Deborah Jehu[1], Alyssa Desponts[1], Nicole Paquet[1], Yves Lajoie[1]

[1]University of Ottawa

Background and Aim: Flexible and appropriate allocation of attention resources is important during dual-tasking to achieve task goals while maintaining postural safety. However, limited research has focused on the implications of prioritization of attention on reaction time or postural control. This study aimed to examine the influence of explicit prioritization of attention on the dual-task paradigm by employing two levels of difficulty for the postural tasks and reaction time (RT) tasks. Methods: Twenty healthy young adults (10 male, 10 female; 21.6 ± 2.3 years) stood with two feet or one foot on a force platform, attended to posture or RT, and completed a simple (S) or choice (C) RT task. Participants verbally responded "top" as soon as the light cue illuminated. For the SRT condition, a red light was presented seven times at random during each trial and only appeared in the center light emitting diode (LED) with no distracting lights. For the CRT condition, participants responded verbally once a blue LED was presented on the left or a green LED was presented on the right. There were also a series of other lights, blue, green or red, that were randomly displayed during the CRT task to increase the difficulty and to avoid anticipation of the stimuli. Four trials that were 45 seconds in length were completed for each of the eight conditions. Center of pressure (COP) Displacement in the AP and ML directions (cm), COP standard deviation (SD) in the anterior-posterior (AP) and medial-lateral (ML) directions (cm), COP Path Length (cm), and 95% Area Ellipse (cm2) measures were calculated for each postural test. Results: In general, attending to RT produced faster RTs ($p<0.001$), less COP Displacement ($p<0.05$) and less 95% Area Ellipse ($p<0.05$). Additionally, standing on one leg produced significantly greater COP SD ($p<0.05$), COP Path ($p<0.05$) and 95% Area Ellipse ($p<0.05$) compared to standing on two legs. Lastly, the SRT tasks showed increased COP SD ($p<0.05$) and 95% Area Ellipse ($p<0.05$) compared to the CRT conditions. Conclusions: These findings, in part, substantiate the constrained action hypothesis which suggests that focusing away from internal processes, such as posture, facilitates unconscious control leading to greater automaticity of RT and posture. As expected, standing on one leg produced significantly greater

postural sway compared to standing on two legs. Another interesting finding was that CRT produced significantly less postural sway compared to SRT, as the CRT involved visual-spatial requirements. Accordingly, perhaps a facilitatory pattern was observed during CRT whereby postural sway was attenuated in order to stabilize gaze and head position to accommodate for the increased cognitive demand.

P3-D-18 Postural task difficulty decreases the regularity of center of pressure

Kimberlee Jordan[1], Zheng Wang[2], John Challis[2], Karl Newell[2]

[1]Callaghan Innovation, [2]The Pennsylvania State University

Background and aim: The attention-constraint interpretation of regularity in standing balance proposes a positive relation between the degree of attention required for balance and the regularity of the Center of Pressure (COP) time series (Borg & Laxabak, 2010; Donker et al 2007). Linked to this is the hypothesis that the degree of postural task difficulty is positively related to the regularity of the COP - Roerdink and colleagues have shown that the regularity of COP in standing posture is greater than that in seated posture (Roerdink et al 2011). Arguably, because the task requirement and end effectors are not the same for seated and standing postures, this comparison is less informative than comparing two standing postural tasks that vary in their difficulty. Thus we sought to examine the influence of postural task difficulty on the regularity of COP in standing balance in two different standing postural tasks. Methods: In 12 healthy young adults we investigated 3 upright postural stances: side by side foot position; and tandem (one foot in front of the other - both left and right leading) under both vision and no vision conditions in 60 s standing trials. We collected data from 2 force platforms simultaneously from which we calculated the COP under left and right feet separately (COP_L and COP_R) as well as the net COP (COP_net). We examined COP in both anterior-posterior (AP) and medial-lateral (ML) dimensions. The regularity of each time series was examined using Detrended Fluctuation Analysis (DFA). A 3 way (COP variable (3) by vision (2) by stance (3)) repeated measures ANOVA was used to analyze the data, with post-hoc analysis done using the Bonferroni correction. Results: In the M-L dimension, there were significant main effects for COP variable, vision, and stance, with the regularity of the right COP being significantly higher than that of COP_L and COP_net; the regularity of COP during the eyes open condition being significantly more regular than during the eyes closed condition; the regularity of COP being significantly greater in feet side by side compared with both tandem stances. A similar pattern of results emerged for the A-P dimension, with significant main effects observed for the regularity of COP variable, vision, and stance. Regularity was greatest for COP_L, followed by COP_R and COP_net; the eyes open condition resulted in greater regularity of COP than eyes closed; the COP in feet side by side stance was again significantly more regular than in the tandem stance conditions. Conclusions: These results are counter to the attention-constraint interpretation of regularity in COP time series and show that as the postural task becomes more challenging (vision is removed and stance is less stable), the COP time series become less regular. We propose that during tandem stance a greater number of adjustments in the COP are needed to maintain control of the center of mass, thereby reducing the regularity of the COP.

P3-D-19 Slow Gait does not protect against distractions

Hyun Gu Kang[1], Dan Thap[2]

[1]California State Polytechnic University, Pomona, [2]Western University of Health Sciences

BACKGROUND AND AIM: Slow gait in older adults predict dementia, disability, and falls. Slow gait is associated with fear of falls and appear to be a behavioral adaptation. Impairments in cognitive function, specifically executive function and attention, negatively affect gait in older adults, especially when cognitive distractions are present. However, it is not clear which of these changes are due to a pathology and which are due to the adaptations around them. With self-paced protocols on a gait mat, the specific effects of the pathology on gait are difficult to isolate since the walking individual also controls the speed at the same time as the other gait variables. Therefore, we tested to see if slow walking in older adults minimizes the effect of dual taking on gait variability, by controlling for walking speed using a treadmill. METHODS: Nine healthy older adults (age 72.2 ± 4.9) and 12 height- and weight-matched young adults (23.4 ± 1.9), with no orthopedic, neurological, or cognitive impairments, participated with informed consent. Each subject walked for 5 minutes on a L7 treadmill at each of three different speeds: 80%, 100%, and 120% of their preferred speed (PWS)4. Participants also performed serial subtractions as a dual task during walking. By using a treadmill to impose a walking speed, we controlled for behavioral adaptations that can occur when subjects perform the secondary cognitive task while attending to the pacing and velocity during walking. VICON was used to measure the motion of the bilateral heel markers and trunk. Step length (SL), Step length variability (SLV), Step width (SW), Step width variability (SWV) were calculated. Local dynamic stability of trunk motions in state space were quantified using finite-time divergence exponents (λ). RESULTS: Both groups exhibited PWS of 1.1 m/s ($p=0.6$). Older adults exhibited longer average SL, SLV ($p=0.008$), SW ($p<0.001$) but not SWV ($p=0.6$). SL lengthened with DT at fast speeds, and shortened at slow speeds. SLV, SW, SWV did not change with DT ($p<0.8$). Change in SL with dual tasking was more at faster speeds in older adults ($p=0.056$). λ was lower during dual task. CONCLUSIONS: When we directly controlled for walking speed, walking speed did not influence the changes in gait parameters due to dual tasking except at the fast walking speed. Slower walking did not reduce the impact of dual tasking on gait. However, they may be less likely to walk fast as their change in gait is exaggerated by dual tasking, eventually leading to slow gait. This phenomenon may occur in an older population with gait pathologies at slower speeds, and thus further work is needed. The increase in SL due to DT at fast speeds suggests that step time is becoming slower. Yet during slow walking, the adaptation appeared to be the opposite. This suggests that the externally imposed walking speed required a different stepping strategy due to dual tasking.

P3-D-20 Effects of cognitive dual-tasks on postural sway in older adults with Mild Cognitive Impairment

Julia Leach[1], Martina Mancini[1], Jeffrey Kaye[1], Tamara Hayes[1], Fay Horak[1]

[1]Oregon Health & Science University

Background and aim: An individual's ability to maintain postural stability during cognitive loading decreases with age and with cognitive impairment. Cognitive loading impairs postural control by redirecting neural attentional resources away from the postural task and to the cognitive task. Cognitively impaired older adults may not have sufficient neural resources to adequately regulate both tasks. This study's aim was to elucidate the relationship between cognitive status and postural stability in older adults during quiet stance with cognitive loading. Methods: 29 subjects, 19 with mild cognitive impairment (MCI) and 10 with no cognitive impairment (NCI), enrolled in the Oregon Brain Aging Study were recruited for this study. A series of cognitive dual-tasks, designed to tax specific cognitive domains,

were administered to each subject while standing in place. Accelerometry (Acc) data was acquired using an inertial sensor mounted to the subject's lumbar spine; center of pressure (CoP) data was acquired as each subject stood in place on a Wii balance board. Summary and variability measures of postural sway were derived from both datasets. Results: No postural sway measures differentiated between MCI and NCI under single-task conditions. The mean and variability of sway velocity were significantly lower in the MCI group under all dual-task conditions ($p<.05$). The dual-task cost in postural sway (expressed by sway path length, sway jerkiness, and sway frequency) was significantly lower in MCI compared to NCI ($p<.05$). The cognitive dual-task that specifically taxed attentional shifting, information processing, and working memory best differentiated dual-task costs between groups. Our significant findings were consistent across both the Acc and CoP datasets. Conclusions: We show that postural sway assessments under dual-task conditions are necessary to differentiate between MCI and NCI, and further, to elucidate the relationship between cognitive status and postural control in older adults. Our findings suggest lower and less variable sway velocities during cognitive dual-tasking may be sensitive to MCI status. Furthermore, a lower percent change in sway path length, sway jerkiness, and sway frequency between single- and dual-task conditions may be indicative of mild cognitive decline. Older adults with MCI had lower dual-task costs compared to older adults with NCI. If the older adult has insufficient neural resources to regulate both the cognitive and postural task, he/she will likely choose the "posture first" strategy, resulting in slower postural sway and a lower postural sway cost. Lastly, tests that tax attentional shifting, information processing, and working memory may best serve as sensitive cognitive dual-tasks for identifying older adults with limited cognitive reserve. Grant Support: NIH grants 5 R37 AG006457, P30-AG008017, P30-AG024978, 5T32-AG023477, and T32 HS017582, and by the Oregon Tax Check-Off Program for Alzheimer's Research

P3-D-21 Effects of transcranial direct current stimulation (tDCS) to right posterior parietal cortex (PPC) on visuospatial attention and obstacle crossing in young adults

On-Yee Amy Lo[1], Li-Shan Chou[1]

[1]University of Oregon

BACKGROUND AND AIM: How posterior parietal cortex (PPC) contributes to the utilization of visuospatial attention in obstacle crossing remains unclear partially due to the lack of an on-line brain-imaging tool during walking. Transcranial direct current stimulation (tDCS) modulates the excitability of cortical membrane and its aftereffects allow the examination of cortical contribution to obstacle crossing. We aimed to 1) investigate the cognitive and gait performances while individuals perform a visuospatial attention (VA) task when approaching an obstacle; and 2) examine the aftereffects of the tDCS on PPC. METHODS: Five young healthy subjects performed a VA task during standing and obstacle crossing before and after a 20-min tDCS on right PPC. Each subject visited the laboratory twice for anodal and sham stimulations. Dependent variables were the accuracy rate (%Acc) of the VA task, toe-obstacle clearance of leading and trailing legs and changes in aforementioned parameters between pre and post tDCS. RESULTS: The mean accuracy rate tended to be higher in the standing (81.25±10.62%) than during obstacle crossing (76.25±17.13%). The mean toe-obstacle clearances tended to decrease when responding the VA task while approaching the obstacle for both leading (with VA: 14.74±1.56 cm v.s. no VA: 15.68±1.46 cm) and trailing (with VA: 14.35±4.51cm v.s. no VA: 16.13±2.72cm) legs. After anodal tDCS, the accuracy rate tended to improve in obstacle crossing condition (from 75±15.31% to 90±10.46%) but decrease in standing (from 85±10.46% to 70±20.92%). After sham tDCS, accuracy rate

had an opposite trend and the change was less than the anodal stimulation [Obstacle crossing: from 77.5±20.54% to 72.5±20.54%; Standing: from 77.5±10.46% to 87.5±17.68%]. No consistent trends were found in the change of toe-obstacle clearances after tDCS stimulation. CONCLUSIONS: The aftereffects of the anodal tDCS over right PPC potentially enhanced visuospatial attention performance when approaching an obstacle but depressed in standing. How these changes affect the gait performance needs further investigation.

P3-D-22 Attentional allocation to visually guided walking depends on age and executive function

Masood Mazaheri[1], Melvyn Roerdink[2], Robert Jan Bood[2], Jacques Duysens[3], Peter Beek[2], C. (Lieke) Peper [2]

[1]MOVE Research Institute Amsterdam, Faculty of Human Movement Sciences, VU University Amsterdam, Amsterdam, The Netherlands, [2]MOVE Research Institute Amsterdam, Faculty of Human Movement Sciences, VU University Amsterdam, [3]Department of Kinesiology, KU-Le

Background and aim: The ability to modify attentional resources to variations in terrain complexity is of critical importance for safe community ambulation. Age-related changes in cognitive and visual control of walking may influence this ability among elderly people. As executive function (EF) affects the ability to efficiently deal with changes in walking task demands, this study was designed to investigate the effects of age and EF on attentional costs of walking onto regularly and irregularly spaced visual stepping targets. Our secondary goal was to examine the influence of age and EF on stepping accuracy in visually guided walking. Methods: Two groups of elderly adults with higher EF (n=16) and lower EF (n=10) and a group of young adults (n=15) walked on a treadmill at their most comfortable walking speed under different conditions: uncued walking and walking on regular and irregular patterns of stepping stones projected onto the belt. A probe reaction time (RT) task was used to assess attentional demands. Attentional costs of each walking condition were determined by subtracting sitting RT from walking RT, yielding ΔRT. Stepping accuracy was quantified by the standard deviation of the distance between center of stepping stone and the corresponding center of pressure position at midstance. Results: In young participants, ΔRT increased from uncued to regularly cued walking and from regularly cued to irregularly cued walking. In the higher EF group of elderly, ΔRT was significantly higher for irregularly cued than uncued and regularly cued walking. In the lower EF group of elderly no change in ΔRT was observed. For uncued walking, ΔRT was significantly lower for young participants than for both elderly groups. Stepping was less accurate for elderly than for young participants. Moreover, stepping was less accurate for irregular than regular patterns of stepping targets. This deterioration in stepping accuracy with pattern irregularity did not vary with age or EF. Conclusions: Elderly, especially those with lower EF, were less able to invest extra attentional resources to increased walking task demands than young adults. This may be explained by the already elevated attentional demands of uncued walking, presumably due to increased visuomotor and/or balance control requirements. EF had a stronger effect on secondary task performance than on the performance of the primary (walking) task. This may suggest that, due to increased visuomotor and/or balance demands, foot placement was controlled in a more automated manner in elderly people, at the expense of stepping accuracy.

P3-D-23 The "Stroop Walking Task": An innovative dual task for detecting executive function impairment.

Anaick Perrochon[1], Gilles Kemoun[2], Eric Watelain[3], Benoit DUGUE[2], Alain Berthoz[4]

[1]UFR STAPS, University of Poitiers, [2]University of Poitiers, [3]Université de Toulon , [4]Collège de France

BACKGROUND AND AIM: Various types of dual task (DT) conflict paradigms are used to detect executive function cognitive impairment. There is growing evidence that suggests that these tasks would be more relevant if they mimicked everyday life situations. METHODS: We consequently developed the "Stroop Walking Task," which is a DT that is similar to making a decision of whether to cross a street based on a pedestrian traffic light. Fifty-one participants (young and old participants, some of whom were cognitively impaired) had to respond to a visual signal (pictogram) with an appropriate motor response (walk or stop). We used an electronic walkway system to record the gait parameters and performed a cluster analysis. RESULTS: This DT enables the detection of executive function impairment with 89% sensitivity and 87% specificity. This test also helped to detect impairments in aging participants that are not detectable with traditional psychometric tests. The use of a DT that is inspired by an everyday event as an evaluation tool seems to facilitate the early detection of cognitive impairment in aging participants. CONCLUSIONS: Early mild cognitive impairment could be diagnosed by analysing everyday life situations, such as DT walking, using a cell phone, using public transportation or crossing the street. This task could be used to assess other forms of cognitive impairment, including that which occurs during development. KEYWORDS: stroop; dual task; gait; mild cognitive impairment

P3-D-24 Influence of cognitive demand on center-of-pressure sway and coactivation of ankle muscles during quiet standing in individuals with stroke

Kozo Ueta[1], Moe Kikuchi[2], Ryo Sakamoto[2], Michihiro Osumi[1], Hideki Nakano[1], Koichi Mukai[3], Sadaaki Yata[2], Shu Morioka[1]

[1]Kio University, [2]hoshigaoka koseinenkin hospital, [3]shijonawate gakuen University

BACKGROUND AND AIM: Influence of cognitive demand on postural control during quiet standing in hemiparetic patients has drawn interest. In particular, cognitive demand has been reported to either increase or decrease total COP sway. However, the cause of COP sway change and the influence of COP sway in each limb have not been elucidated. Previous studies reported that increased coactivation might help to maintain postural stability in hemiparetic patients (Chow 2012), and that cognitive demand decreases the soleus H-reflex in healthy subjects (Weaver 2012) and ankle stiffness in older adults (Kang 2010). From these reports, we considered that cognitive demand may change coactivation, and that a change in coactivation can change postural control. The purpose of this study was to investigate influences that cognitive demand gives to total COP sway, COP sway and coactivation of ankle in each limb during quiet standing in hemiparetic patients. METHODS: Seven individuals of unilateral stroke (69.4 years; 5 men; 5 left affected limb; Brunnstrom stage4-6) participated in this study. Subjects stood with one foot on each stabilometer. Subjects performed the Control and Dual conditions. In the Control condition, subjects were instructed "please stand as usual". In the Dual condition, subjects performed the cognitive task (short term digit span memory task). Each condition was constituted 20sec, performed 2 times respectively. COP data were used to calculate mean velocity and mean amplitude, peak amplitude of total AP and ML COP, and mean velocity of AP and ML COP in each limb (Paretic Side [PS] and non Paretic Side [nPS]). EMG data of tibialis anterior and gastrocnemius muscle in each limb that recorded during sitting (rest) and Control and Dual conditions, were used to calculate coactivation duration (CD) and coactivation index (CI) (Chow 2012). Paired t test was used to compare each of

variable of COP data, CD and CI during two standing conditions. Statistical significance was set at $p<0.05$, and trend was set at $p<0.10$. RESULTS: In the Dual condition compared to the Control condition, mean velocity of total AP COP increased significantly, and mean amplitude decreased significantly, peak amplitude trended decreasing. Each variable of total ML COP did not show significant different. Mean velocity in each limb AP and ML COP did not show significant different. CD in each limb did not show significant different, CI only trended decreasing on the nPS limb. CONCLUSIONS: The results of total COP showed that total COP change smaller and quicker sway in the narrower range only AP direction by cognitive demand. However, the change in each limb was only decrease tendency of CI in the nPS. Since changes of total COP were showed, it is suggested that cognitive demand change postural control in hemiparetic patients. But, it is thought that only neither coactivation nor change of COP in each limb can explain change of postural control.

P3-D-25 Falling Head Over Heels: Assessing the cognitive and electrophysiological processes underlying gait and falls.

Elizabeth Walshe[1], Sean Commins[1], Richard A. P. Roche[1]

[1]National University of Ireland Maynooth

BACKGROUND AND AIM: Recognition of the role of cognition in gait and balance is steadily growing due to increasing evidence of attentional demands in dual-task (DT) studies and the association between cognitive decline and fall-risk in older adults and patient samples (Holtzer et al., 2007; Plummer-D'Amato, et al., 2008). The dual-task paradigm permits that when two tasks tax the same domain, exhausting the process capacity, performance on one or both of the tasks will decline. Cognitive-motor dual-tasks have been utilised to predict falls and disability in older adults and in rehabilitation (Beauchet, et al., 2009). However, cognition is not a unitary construct, but rather a complex domain of multiple and varied processes. Therefore, it is not surprising that different DTs have varied effects on gait performance, eliciting debate surrounding the efficacy of their use (Plummer-D'Amato, et al., 2012;Taylor et al., 2011). The specific higher-cognitive processes underlying gait and fall-risk, must be identified in order to develop targeted/effective assessment and rehabilitation techniques. METHODS: Two experiments were conducted with young (aged 18-35) and healthy community-based older adults (aged 55). Gait speed and variability were assessed using wireless IMUs (SHIMMER sensors). Experiment 1 compared performances on a range of DTs targeting motor processing, executive functioning (n-back and serial subtraction), visuo-spatial processing (clock task), and simple language processing (alphabet recitation). Experiment 2 correlated higher-cognitive performances of executive control, motor processing, multisensory integration and pre-attentive processing with normal walking gait speed and variability. EEG/ERP analysis was implemented during sit-down cognitive task performance to investigate the electrophysiological correlates of the processes underlying gait. Comparisons were also made between older adults with and without a history of falls, and follow-up report of falls 6 months post-testing. Correlation and regression model analyses were utilised to identify the specific cognitive processes underlying gait performance and fall-risk. RESULTS: Both experiments revealed age-related differences in normal walking gait speed and variability. Experiment 1 exhibited a change in speed and variability from single to DT conditions for both age groups, with older adults exhibiting a greater dual-task cost. Experiment 2 evidenced cognitive differences between young and older adults, some of which were reflected in diverse ERP peak latencies and amplitudes. These differences correlated with gait performances, particularly in the older adult group. CONCLUSIONS: This research specifically assesses

the role of various higher-cognitive processes in gait and falls, highlighting the complex nature of walking behaviour. Our findings have implications for developing targeted assessments and interventions for those at risk in the community, as well as clinical populati

P3-D-26 Do individual traits and characteristics influence postural strategy under conditions of height-induced postural threat?

Martin Zaback[1], Taylor Cleworth[2], Mark Carpenter[2], Allan Adkin[1]

[1]Brock University, [2]University of British Columbia

BACKGROUND AND AIM: Height-induced postural threat elicits changes in perceived anxiety, fear, and conscious control of posture which are accompanied by changes in postural strategy [1]. Depending on the extent of fear reported, individuals adopt a postural strategy characterized by an increased frequency of either smaller or larger amplitude centre of pressure (COP) adjustments [2]. It is unclear what factors contribute to individuals responding more fearfully under these conditions or why they adopt unique postural strategies. Differences in individual traits and characteristics may influence how one experiences and behaves when threatened. This study aimed to determine if a unique combination of individual characteristics could explain the variance in perceptions, cognitions, and postural strategy elicited by height-induced postural threat. METHODS: Eighty young adults completed questionnaires to assess trait anxiety, conscious control of movement, and movement self-consciousness, and recreational risk-propensity and previous experience with height. Participants then stood as still as possible for 60-s on a forceplate positioned at the edge of a hydraulic lift. Postural threat was manipulated by changing the height of the platform on which the participants stood (80cm above ground without step restriction and 320cm above ground with step restriction). Mean position (MP), root mean square (RMS), and mean power frequency (MPF) of COP in the anterior-posterior direction were calculated. Prior to each trial, balance confidence was assessed. Perceived state anxiety, fear, conscious control of movement, and movement self-consciousness were assessed after each trial. RESULTS: Eight multiple linear regressions were conducted with individual characteristics included as the independent variables and changes in state perceptions, cognitions, and COP summary measures as the dependent variables. A combination of the individual characteristics accounted for a moderate, but significant amount of variance in all COP summary measures as well as perceived state anxiety and fear. MP-COP shifted further back in individuals who reported greater risk aversion and conscious control of movement. RMS-COP decreased more in individuals who reported greater risk aversion and movement self-consciousness but less conscious control of movement. MPF-COP and perceived fear increased more in individuals who reported greater risk aversion. Perceived anxiety increased more in individuals who reported greater risk aversion and less experience with height. CONCLUSIONS: Unique combinations of individual characteristics influence postural strategy and perceptions of anxiety and fear when threatened. Further work will explore the mediating role of state perceptual changes as potential mechanisms underlying the relationship between individual characteristics and postural control.
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P3-E-27 Effect of chronic low back pain in spatio-temporal gait parameters during walking combined with hand prehension movements

Priscila Abbári Rossi[1], Natalia Rinaldi[1], Renato Moraes[1]

[1]Medicine School of Ribeirao Preto, University of São Paulo

BACKGROUND AND AIM: Chronic low back pain (CLBP) is one of the most common musculoskeletal problems in modern society and interferes with motor performance of automatic activities such as walking. The addition of upper limb movements can affect walking differently in individuals with CLBP, since muscular response is modified in these individuals when they elevate their arm while standing still. Therefore, the aim of this study was to compare spatio-temporal gait parameters in individuals with and without CLBP when walking combined with hand prehension movement of an object positioned at three different heights. METHODS: Thirty individuals participated in this study: fifteen in the CLBP group and fifteen in the control group (CG). Participants performed two distinct tasks: free walking and walking combined with hand prehension of an object positioned over an adjustable support surface in three different heights (80%, 100% and 120% of greater trochanter's height). RESULTS: Step length, duration, speed and width were assessed using an analysis of variance (ANOVA) for three factors (2 groups [with and without CLBP] X 4 conditions [free walking and walking combined with hand prehension movement in three different heights: 80, 100 and 120%] X 3 steps [N, N-1 and N-2]) with repeated measures on the last two factors. Statistical analysis revealed main effect of group for both step duration and speed, showing that the CLBP group had longer step duration and lower speed than the CG. In addition, there was an interaction effect between condition and step for all dependent variables, showing an increase in step duration and width as the participant approached the object for the conditions with walking and prehension, a decrease in step speed mainly in the step corresponding to object prehension for the 80% height condition and a decrease in step length mainly in the step that preceded the act of grasping the object. Furthermore, ANOVA identified an interaction effect between group and condition for step width, showing that the GC decreased step width as the height of the object decreased, differing from the CLBP group that maintained constant step width in all conditions that combined the prehension of the object. CONCLUSIONS: These results suggest that the addition of movement changes gait pattern, especially for the lowest height of the object. Furthermore, individuals with CLBP presented slower movements and wider base of support for performing the combined task than GC, possibly as a strategy to improve gait stability due to the increased movement of the trunk with the addition of the grasping task.

P3-E-28 The stepping threshold with an upper body pull postural perturbation paradigm

Dmitry Verniba[1], Ravi Chaudhari[1], William Gage[1]

[1]York University

BACKGROUND AND AIM: Balance correcting responses range between feet-in-place ankle strategies and stepping responses; the individual response is predicated on the characteristics of the perturbation. The nature of the response is largely determined by the magnitude of the applied acceleration and the distance over which the perturbation is applied. To date, the investigation of the relationship between perturbation parameters which determine the type of correcting response is generally limited to platform and waist pull studies. No studies have examined such relationship following an upper body acceleration. The objective of the current study was to investigate the relationship between the pull force and pull distance required to elicit a stepping response. METHODS: Seven young healthy males (age=26.4±2.7yrs, height=181±5.7cm, foot length=27.6±1.1cm) volunteered. The length of the base of support (BOS) was defined as the participant's foot length. Participants wore a shoulder harness, which was attached to a custom-made pull perturbation device. Unexpected forward perturbations were

induced by release of an electromagnet, which allowed free weights to fall a controlled distance exerting a pull on the participant. The pull distance and force, expressed as %BOS and %BW, respectively, were iteratively increased from 50%BOS - 150%BOS (10%BOS increments) and 2.5%BW - 14%BW (0.5%BW increments) to identify two stepping thresholds: partial-step (defined as an anteriorly directed foot movement that was <100%BOS) and complete-step (foot movement distance that was >100%BOS). Feet-in-place, partial-step, and complete-step responses were coded as 0, 0.5, and 1.0, respectively, and recorded for each combination of force and distance. Ensemble averages were calculated for each force-distance dyad. The threshold for complete-step was determined for each pull distance as the force that elicited a complete-step response for every participant. RESULTS: The linear regression function showed significant fit to the partial-step threshold data (R^2=0.959, df =12, P<0.0001). The quadratic function showed significant fit to the complete-step threshold data (R^2=0.951, df =10, P<0.0001). Moreover, the complete-step data shows a strong significant linear inverse relationship between required force and distance below 100%BOS (R^2=0.939, df =4, P=0.0014). Above 100%BOS a minimum force of approximately 7%BW is required to elicit a complete-step response. CONCLUSIONS: The current study identified a linear and quadratic pull force-distance relationship required to elicit a partial-step and complete-step, respectively. The meaning of the shape of these relationships remains open to interpretation. Our immediate concern to establish key parameters to reliably elicit a stepping response using this novel perturbation device has been satisfied. Next steps may include examination of special populations to explore factors that may alter the shape and parameters of these relationships.

P3-F-29 Obstacle avoidance strategies in the developing child

Sharissa Corporaal[1], Sjoerd Bruijn[2], Jacques Duysens[1], Stephan Swinnen[1]

[1]KU Leuven, [2]MOVE Amsterdam

BACKGROUND AND AIM: When negotiating obstacles in their walkway, children respond in a more cautious way than adults, which suggests different anticipatory strategies [1]. Children seem to prefer step width adjustments in the last steps prior to obstacle crossing [2]. Children under 8y make more errors in obstacle avoidance and they tend to take larger than necessary steps over obstacles [3]. Few studies investigated obstacle avoidance in slightly older children (9 years, [4]; 10 years, [2]), or compared young children and adults [1,2]. However, as far as we know, there have been no systematic studies for the full development between 8 and 18 years of age. We aimed to investigate these age-related changes in obstacle avoidance.METHODS: Preliminary data of 13 healthy children (8-18y) were analyzed. Subjects walked at their preferred speed along a 6m walkway on which an obstacle (150% step length) was projected with a beamer. Subjects were instructed not to step on this projection. Lower body kinematics were recorded during preferred walking and the obstacle avoidance condition. To assess gait adjustments in more detail, the last 2 steps prior to obstacle crossing were analyzed separately. Furthermore, the take-off distance and the Horizontal toe Displacement at Apex (HDA [1]) were assessed. HDA was defined as the relative horizontal distance between the starting rim of the obstacle and the toe of the leading leg when it reached its maximal clearance.RESULTS: Young children showed more variation in step length in the 2 steps prior to obstacle crossing (corr = -0.792, p=0.001), where the last step was larger than the penultimate step prior to the obstacle. In addition, younger children showed larger take off distances (corr = -0.584, p<0.05) and a trend towards a smaller HDA (corr=0.551, p=0.051) than older children. Compared with free walking, step width and length increased in the obstacle condition at all ages (p<0.01), while step velocity remained the same (p=0.623). In

addition, step width decreased steeply till age 14 (corr =-0.605, p<0.05) in free walking.CONCLUSIONS: Children of all ages adjusted their step pattern by increasing their base of support and lengthening their steps in anticipation to an upcoming obstacle. However, younger children showed more pronounced stepping adjustments in the 2 steps prior to obstacle crossing compared to older children, who showed a more constant walking pattern. In addition, younger children had larger take off distances and smaller HDA, indicating that they are less successful in fine-tuning their foot placements when crossing the obstacle. These preliminary results may indicate that young children possibly adjust their gait in a more reactive pattern, compared to the more proactive strategy in older children.REFERENCES:1.Berard JR, Vallis LA. Exp Brain Res. 2006 2.Vallis LA, McFadyen BJ. Exp Brain Res. 2005 3.Pryde KM, Roy EA, Patla AE. 1997 4.McFadyen BJ, Malouin F, Dumas, F. Gait&Posture. 2001

P3-F-30 Development of gait in children revealed by principal component model of lower-limb kinematics and kinetics

Akira Sawatome[1], Mitsunori Tada[2], Hiroshi Takemura[1], Makiko Kouchi[2], Masaaki Mochimaru[2]

[1]TUS, [2]AIST

1) Background and Aim Development of gait in children was extensively studied in the past, and there is general agreement that the walking skill is established in accordance with their growth. The main concerns in the past studies were solely on the joint angles, step length, cadence, walking velocity or duration of single-limb stance representing the partial aspect of gait. In this research we conducted principal component analysis for kinematics and kinetics data of lower-limb to take entire gait pattern into consideration, and evaluate intra-subject variability of gait within the principal component space to quantify the development of gait. 2) Methods For this purpose, 4 years longitudinal gait data from 4 to 7 years old collected from 10 children were pre-processed by Visual3D (C-Motion, Inc.) to obtain angles and torques of hip, knee and ankle joints. The torques was then normalized by height and weight of the corresponding subject before extracting one gait cycle (from heel strike to subsequent heel strike of the same foot) and discretizing them into 101 points to represent single gait data by 606 variables. All the data were then analyzed by principal component analysis to map the gait data to lower dimensional space. We calculated product of standard deviation of 1st and 2nd principal component scores for quantifying annual change in intra-subject variability of gait. 3) Results The reconstructed gait data from the principal component space clearly demonstrated that major difference of gait pattern lies in joint torque rather than joint angle. The 1st principal component contributes to change the hip and ankle joint torque, while the 2nd principal component contributes to change the knee and ankle joint torque especially at the instance of heel contact. The average of the principal component score for all trials and subjects in each year moves linearly within the 2-dimensional principal component space as the subjects grew up. This movement in the lower dimensional space corresponds to the change in the strategy of stabilization. Younger children tend to use the ankle torque for stabilization and hip torque for propulsion, while elder children tend to use the ankle torque for deceleration and hip torque for stabilization. Also the result of t-test revealed that there was significant difference in the variability of gait between the ages of 5 to 6 years ($p < 0.05$), although there were no significant differences between the ages of 4 to 5 and 6 to 7 years. These findings are consistent with the result of previous gait researches. 4) Conclusions We conducted principal component analysis for kinematics and kinetics data of lower-limb, and evaluate intra-subject variability of gait within the lower dimensional space. The

results of this analysis suggest that the walking skill is established in the age of 5, and the gait pattern continues to change as the subjects grew up even after the walking skill is established.

P3-H-31 Effects of Levodopa and Severity of Parkinson?s Disease on Postural Sway and Gait

Carolin Curtze[1], Martina Mancini[1], Patricia Carlson-Kuhta[1], John Nutt[1], Fay Horak[1]

[1]Oregon Health & Science University

BACKGROUND AND AIM: Parkinson's disease (PD) is a chronic neurodegenerative condition resulting in progressive loss of motor function. The most common treatment for PD involves dopaminergic replacement therapy. Postural instability and gait impairments became increasingly severe as the disease progresses, despite treatment with Levodopa. It is still not known if neural control of postural sway in stance or responsiveness to levodopa changes with the progression of PD. We studied the effect of Levodopa treatment and severity of disease on postural sway and gait using objective measures from inertial sensors. METHODS: We recruited 105 participants with a diagnosis of idiopathic PD and a group of 64 age-matched healthy control subjects. The PD subjects were tested in the morning in their practical OFF state, i.e. at least 12h after last medication intake of their dopamine replacement therapy. Subsequently, they were retested in the ON state, i.e. 1h after taking their medication. The severity of PD was clinically assessed with the Motor UPDRS both OFF and ON state. Participants performed 3 trials of the Instrumented Stand and Walk test (ISAW), consisting of standing quietly for 30 seconds, followed by a verbal instruction to initiate gait with the most involved leg, walk 7 meters, turn 180 degree after crossing a line on the ground, and walk back to the initial starting position. The subjects wore 6 inertial sensors (MTX Xsens or Opals, APDM) at the wrists, ankles, sternum and lumbar area and 35 reliable and valid measures of sway, gait initiation, gait and turning, were computed directly with Mobility Lab. The sensitivity of the different postural control and gait measures to Levodopa was investigated by comparing the standardized response means (SRM). RESULTS: Levodopa induced the strongest improvements on bradykinesia-related gait metrics (Upper and Lower Body, SRM>0.5, Figure). More moderate effects of levodopa were observed for the anticipatory postural adjustments of gait initiation, sway jerk and frequency, and temporal measures. Moderate worsening were seen on sway RMS and sway velocity; indicating that subjects with PD were less stable ON than OFF medication. Furthermore, Levodopa did not change dynamic stability during gait. In addition, Pearson correlation analysis revealed turning and bradykinesia-related gait metrics were most related to severity of disease ($r>0.4$, $p<0.01$), whereas postural sway and dynamic stability measures were moderately to poorly related to severity of disease ($r<0.35$, $p>0.01$). CONCLUSIONS: Knowledge of Levodopa and disease severity-induced changes in balance and gait function could be used to optimize management of PD. The outcomes of this study could be used for the evaluation of alternative, non-dopaminergic therapies to treat motor symptoms of PD. ACKNOWLEDGEMENTS: Supported by NIH grants: # 1 RC1 NS068678 and # UL1 RR024140 FIGURE: Effect of Levodopa on postural sway and gait

P3-H-32 Influence of levodopa on stepping threshold to pulls in Parkinson's disease.

Irene Di Giulio[1], Rebecca St George[1], Eirini Kalliolia[1], Daniel Voyce[1], Amy Peters[1], Brian Day[1]

[1]University College London

BACKGROUND AND AIM: Postural instability is a common symptom of Parkinson's disease (PD) that leaves patients vulnerable to a higher risk of falling. Assessing the relative merits of different treatments for this problem is crucial. However, clinical assessments of postural stability seem relatively coarse, while the procedure is uncontrolled and likely to be variable between clinicians. It is assessed by evaluating the response to a posterior pull at the shoulder level with scores between 0 (normal) and 4 (unable to stand without assistance). In this study we investigate the usefulness of a novel technique that replicates this test, but in a controlled and repeatable way using two computer-controlled motors (forward and backward pulls). With this, we measure individuals' threshold force for taking a step and ask: 1) whether thresholds differ for pulls in the two directions; 2) whether levodopa alters these stepping thresholds in PD; 3) whether the method is more sensitive than the clinical test. METHODS: Nine PD patients (68±3 y) and 8 healthy participants (62±13 y) stood symmetrically on two force plates (Kistler) whilst pulls were delivered at the shoulder. Pulls of unpredictable and variable force were applied for 1s, either forwards or backwards randomly, via strings connected to two motors positioned in front and behind the participant. Whole-body kinematics was recorded in 3D (Coda). Participants were instructed to resist the pull unless a step became necessary to avoid a fall. All participants performed two sessions with about 64 pulls in each. The PD group were studied OFF and ON medication (levodopa) in sessions 1 and 2 respectively. Each patient was clinically assessed using UPDRS in both sessions. Stepping thresholds were calculated for the two directions in each session and differences were tested using ANOVA. RESULTS: On average, the overall UPDRS score improved by 11.78 points between session 1 and 2 ($p<0.001$). However, only 2 of 9 patients showed an improvement in the clinical pull-test. In contrast, motor-evoked stepping thresholds were more sensitive to conditions. In general, stepping thresholds were larger in session 2 than session 1 ($p=0.016$) and were higher for forward than backward pulls ($p=0.003$). Importantly, the thresholds showed a significant effect of session that was different for the patients and which depended on the direction of pull (group x session x direction interaction: $p=0.007$). That is, for backward pulls the threshold in session 2 was higher than for session 1 in PD patients (23.53±5.11N; 26.89±4.49 N), but not in healthy controls (29.70±5.59N; 28.39±5.65N), suggesting an effect of levodopa. CONCLUSIONS: The direction-specific benefits of levodopa found in this small study should be extended to a larger sample and compared with other forms of treatment. This novel motor-controlled pull test is likely to provide a useful and sensitive means of assessing balance deficits and the effects of treatment in PD.

P3-H-33 N-acetyl-L-leucine accelerates vestibular compensation after unilateral labrinthectomy by action in the cerebellum and thalamus

Andreas Zwergal[1], Lisa Günther[1], Guoming Xiong[1], Klaus Jahn[1], Michael Strupp[1], Marianne Dieterich[1], Christian la Fougere[2], Roswitha Beck[1]

[1]University of Munich, [2]University of Tübingen

Background and aim: An acute unilateral vestibular lesion leads to a vestibular tone imbalance with nystagmus, head roll tilt and postural imbalance. These deficits gradually decrease over days to weeks due to central vestibular compensation (VC). In this study, the effects of i.v. N-acetyl-DL-leucine, N-acetyl-L-leucine and N-acetyl-D-leucine on VC were investigated by behavioural testing and serial [18F]-Fluoro-desoxyglucose ([18F]-FDG)-µPET in a rat model of acute unilateral chemical labyrinthectomy (UL). Methods: Vestibular behavioural testing included measurements of nystagmus, head roll tilt and postural imbalance before and on days 1, 2, 3, 5, 7, 9, and 15 after UL. In addition, sequential whole-

brain [18F]-FDG-µPET was performed before and on days 1, 3, 7, 15 after UL. Results: Compared to the control group, a significant reduction of postural imbalance scores was identified on day 7 in the N-acetyl-DL-leucine ($p < 0.03$) and the N-acetyl-L-leucine groups ($p < 0.01$), but not in the N-acetyl-D-leucine group (comparison for 24 mg per rat i.v. in each group). The course of postural compensation in the DL- and L-group was accelerated by about 6 days relative to controls (for instance, postural imbalance scores of DL-group 3.5 ± 0.5 on day 9, L-group 3.8 ± 0.5 on day 9 and control group 3.6 ± 1.5 on day 15). The effect of N-acetyl-L-leucine on postural compensation at day 7 depended on the dose: in contrast to 60 mg/kg, 15 mg/kg and 3.75 mg/kg had no significant effect. µPET showed that as compared to controls and N-acetyl-D-leucine (24 mg), N-acetyl-L-leucine (24 mg) caused a significant increase of the regional cerebral metabolic rate for glucose in the vestibulocerebellum and a decrease in the posterolateral thalamus and subthalamic region at days 3 and 7. Conclusions: N-acetyl-DL-leucine at a dose of 24 mg per rat and N-acetyl-L-leucine at a dose of 24 mg per rat or 60 mg/kg i.v. improves compensation of postural symptoms after UL likely by activation of the vestibulocerebellum and deactivation of the posterolateral thalamus.

P3-J-34 Exergaming (Xbox Kinect®) versus mirror matched gym based exercise for postural control in healthy adults: a Randomised Controlled Trial.

Gillian Barry[1], Alasdair MacSween[2], John Dixon[2], Paul van-Schaik[2], Denis Martin[2]

[1]Newcastle University, [2]Teesside University

BACKGROUND AND AIM: Exergaming (exercise with the use of an interactive computer-generated environment) is increasingly used in physical rehabilitation and may be more effective than traditional balance based exercise for healthy adults [1] to improve postural control. To date, no research has analysed the effects of exergaming on postural control and physiological cost with respect to a control group given mirror-matched exercise. The aim of the research is to investigate the effect of exergaming (Xbox Kinect®) versus mirror-matched exercise (MME) on postural control, physiological cost and perceived exertion. METHODS: A convenience sample of 50 young healthy active adults was recruited with 44 completing both pre and post exercise testing. Participants were single blind randomised into either the exergaming training group (n=23) or the MME group (n=21). Training was performed three times per week over a four week period (12 x 30 minute sessions). Postural control was measured with a Kistler force platform during unipedal quiet standing with eyes open. Outcome measures consisted of: Centre of pressure displacements in the anterior-posterior (CoPAP) and medio-lateral (CoPML) directions and the CoP velocity (CoPV). Physiological measures were mean HR (measured in beats per minute, BPM) and rate of perceived exertion (RPE). Analysis of covariance (ANCOVA) compared the post-test differences between the groups controlling for baseline performance. Within-subject differences of exercise over time for each measurement were investigated with a mixed analysis of variance (ANOVA). RESULTS: Greater improvements were observed in the exergaming group for CoPML displacement in unipedal standing between the groups after intervention ($p< 0.01$), and significant within group changes for CoPML range and standard deviation and CoPV ($p<0.05$) with lower values in the exergaming group, indicating better postural stability. Mean HR was similar between groups at moderate levels of physical activity with HR reaching an average of 150.2± (13.7) BPM for the exergaming group compared to 149.5 (6.4) BPM for the MME group. RPE was significantly decreased ($p<0.05$) in the exergaming group, 13.3 (1.4) compared to 14.2 (0.9). CONCLUSION: Our findings show that exergaming can be more beneficial than MME without a virtual background to improve postural

control.Lower levels of RPE in the exergaming group compared to the MME group would tentatively suggest that people are more immersed into the activity. Reference:1.Brumels, K.A., Blasius, T., Cortright, T., Oumedian, D. and Solberg, B. (2008). Comparison of efficacy between traditional and video game based balance programs. Journal of Clinical Kinesiology, 62, (4): 26-31.

P3-J-35 On the Move: Feasibility of a Group-based Motor Learning Exercise Program in Community-Dwelling Older Adults with Impaired Mobility

Jennifer Brach[1], Sara Francois[2], Subashan Perera[1], Jessie VanSwearingen[1], Stephanie Studenski[1]

[1]University of Pittsburgh, [2]Washington University

BACKGROUND AND AIM: Walking difficulty is a common, costly problem in older adults. Exercise can be used to improve walking; however, many group-based exercise programs are impairment-based and do not target the underlying motor control of walking. Impairment-based programs aim to increase physiologic capacity in body systems that contribute to walking, but do not include task specific exercise necessary to make use of the capacities. A motor learning intervention aims to improve the motor skill of walking by re-aligning biomechanical and neuromotor control, reinforcing motor programs, and improving feedback for adjusting movements. We developed a group-based motor learning program specifically for walking and implemented the program in the community. We describe the acceptability, risks, and mobility outcomes of the "On the Move (OTM)" program in older adults with impaired mobility. METHODS: Participants included 31 older adults (mean age 82.3±5.6) with a gait speed of 0.73±0.21 m/s. The physical therapist led program met 2 times per week for 12 weeks. The 1 hour group class consisted of a warm-up, motor learning through walking and stepping patterns to facilitate the timing and coordination of walking, strengthening exercises, and stretching. Acceptability of the program was determined by retention and adherence rates and a satisfaction survey. Risk was measured by adverse events and questions on perceived challenge and safety. Mobility (gait speed, figure of eight walk test [F8WT], and six minute walk test [6MWT]) was compared pre- to post-intervention by paired t-tests. RESULTS: Of the 31 participants, 24 (77%) completed the program (mean age=82.2±4.7, range 69-90 years; mean gait speed=0.76±.21, range 0.41-1.12m/s). Six participants were unable to complete the program secondary to medical problems unrelated to the study and one was unsatisfied with the program. The program had high adherence with participants attending on average 83% (479/576) of the exercise classes. Most participants (96%) were satisfied or extremely satisfied with the program. The program had an excellent safety profile with only one subject experiencing a controlled non-injurious fall. Participants felt challenged but safe with 96% reporting that the program was at least somewhat challenging and 96% reporting that they felt safe or very safe. There was preliminary evidence for improved mobility after the intervention: gait speed improved from 0.76±.21 to 0.81±.22 m/s, p=0.06; F8WT from 13.0±3.9 to 12.0±3.9 s, p=0.07; and 6MWT from 246±75 to 281±67 meters, p=0.02. The mean change in gait speed, 0.05m/s, and 6MWT, 35m, met or exceeded a level of meaningful change. CONCLUSIONS: A group-based motor learning exercise program that specifically targets walking was safe and acceptable to the older adult with impaired mobility and resulted in clinically meaningful improvements in gait speed and 6MWT.

P3-J-36 Objectively measured training progression in Parkinson´s disease - is dual-tasking an interfering factor?

David Conradsson[1], Håkan Nero[1], Niklas Löfgren[1], Maria Hagströmer[1], Erika Franzén [1]

[1]Karolinska Institutet

BACKGROUND AND AIM: Balance training is a promising intervention to address locomotion and prevent falls in Parkinson's disease (PD). To appropriately challenge the physiological systems causing balance impairments, it is essential to gradually increase the level of challenge for all training elements. However, this is problematic since balance training contains many active components and information concerning its progression is unclear and lacks scientific validation. Therefore, our aim was to explore training progression throughout a new 10-week balance training program (1), aiming to progress single-task (ST) as well as cognitive challenging dual-task exercises (DT). METHODS: Ten individuals with idiopathic PD (Hoehn & Yahr 2 to 3), mean age 72 years (range 63 - 83) performed 10 weeks (3 x 60 minutes/week) of group training supervised by two physiotherapists. The program, emphasizing highly challenging balance exercises, was divided into three phases (A, B and C) to promote training progression. Phase A (week 1-2) introduced ST-exercises, phase B (week 3-6) introduced basic DT-exercises (i.e. performance of a secondary cognitive or motor task) and increased the level of challenge for ST-exercises, and phase C (week 7-10) aimed to further progress ST- as well as DT-exercises. The amount of time spent on DT-exercises was approximately 30% and 60% in phase B and C, respectively. As a measure of progression for dynamic and overall activity, accelerometers (Actigraph GT3X+) were used for each training session (n=30) to capture the number of steps taken and the summation of the total vector magnitude counts. Activity data was averaged for the three phases, presented as median and analyzed with Wilcoxon matched pairs test (p=0.05). RESULTS: The results revealed that no progression occurred between phase A and B, regarding the amount of steps (A: 802, B: 891, p=0.093), whereas the vector magnitude counts showed significant increase (A: 65624, B: 70369, p=0.013). In phase C results showed a significant progression compared to phase B, both regarding the amount of steps (C: 1174, p=0.005) and the vector magnitude counts (C: 86695, p=0.005). CONCLUSIONS: This study represents a novel approach to address validity aspects of training interventions and the findings support the overall progression for this program. Interestingly, the progression declined when DT-exercises first were introduced (phase B), and increased subsequently after familiarization to DT-exercises (phase C). We believe that this result illustrates the interfering effect of cognitive demanding elements for motor performance, and this likely conflict needs to be considered when designing a program targeting both elements. REREFENCES: 1) Conradsson D, Löfgren N, Ståhle A, Hagstromer M, Franzen E. A novel conceptual framework for balance training in Parkinson's disease-study protocol for a randomised controlled trial. BMC Neurol 2012;12:111.

P3-J-38 Changes in characteristics of physical activity after stroke

Niruthikha Mahendran[1], Suzanne Kuys[2], Sandra Brauer[1]

[1]University of Queensland, [2]Allied Health Research Collaborative, The Prince Charles Hospital

BACKGROUND AND AIMS: After stroke, the volume of physical activity, often measured as activity duration and steps taken per day, is lower than recommended guidelines (1). Other characteristics of physical activity such as frequency of bouts (2), activity intensity (3) and sedentary behaviours (4) may also be different after stroke, and changes over time following discharge from hospital require further investigation (5). The aim of this study was to characterise physical activity in stroke at one and three months post discharge from hospital. METHODS: 35 stroke survivors (aged 71±14 years, 65% male) were recruited and assessed at one and three months following discharge from hospital. Activity was

measured over four days using the ActivPALTM accelerometer. Volume of activity recorded included time spent sitting/lying, standing and walking and steps taken per day. Frequency of sedentary and activity bouts and intensity of activity bouts were calculated. Averages per day over each four-day period were calculated for all measures. Paired sample t-tests were used to determine differences over time. RESULTS: All participant volume data were analysed. A subset of 10 participants (aged 74+ 12 years, 60% male) were analysed for frequency and intensity data. At one month, participants spent an average of 20.0±1.8 hours sitting/lying, 2.9±1.1 hour standing and 1.0±0.6 hours walking per day. Participants averaged 4754±3641 steps per day at one month. There were no changes in volume of activity (duration and step count) between one and three month time points. Average frequency of activity bouts per day was 61+40 and 43+25 at one and three months respectively, with most bouts (74%) being <5minutes in duration at both time points. Average frequency of sedentary bouts per day was 52+26 at one and 42+25 at three months, with most bouts being <30minutes in duration. Participants demonstrated decreased frequency of both activity (p=0.037) and sedentary bouts per day (p=0.042) at three months after discharge. Most activity bouts at were low in intensity (83% at one month and 76% at 3 months), and only one participant engaged in high intensity activity at both time points. Participants engaged less frequently in low intensity activity at three months (p =0.03). CONCLUSIONS: Stroke survivors demonstrate low volume of activity at 1 and 3 months following hospital discharge. While overall steps and duration of activity per day remains unchanged, frequency of bouts appears to decrease over time. Also, the majority of activity bouts are short in duration and of low intensity after stroke. 1 Michael K et al. Arch Phys Med Rehabil. 86:1552-6, 2005 2 Alzahrani MA et al. JOP. 57(1):47-51, 2011 3 Manns PJ et al. Stroke. 40:864-7, 2009 4 English C. Phys Ther. Epub, 2013. 5 Askim T et al. J Rehabil Med. 45:423-8, 2013

P3-J-39 Effects of Low Intensity Functional Electrical Stimulation Assisted Cycling Training in Stroke Patients on Brain Plasticity and Electromyography

Chih-Wei Peng[1], Shih-Ching Chen[1], Chao-Chen Lo[2], Pei-Yu Huang[2], Cheng-Yen Huang[2], Chien-Hung Lai[1], Jia-Jin Chen[2]

[1]Taipei Medical University and Hospital, [2]National Cheng Kung University

1) Background and aim Symmetric gait pattern is a key issue in the rehabilitation for stroke patients. Low intensity of electrical stimulation was proposed to be beneficial in better facilitation of volitional muscle contraction. Thus the aim of this study is to investigate the effect of low intensity functional electrical stimulation assisted cycling (FES cycling) training by using near infrared spectroscopy (NIRS) and electromyography (EMG). 2) Methods Subjects were asked to have the evaluation with EMG and NIRS before and after FES training. The FES cycling trainings were performed 30 minutes a time, three times a week for one month. 10 mA electrical current was applied on the quadriceps of affected side during each FES cycling training. EMG was used to measure the muscle activities. Linear envelops and circular cross correlations were used to obtain the shape symmetry index (SSI) and area symmetry index (ASI) to compare the level of symmetry cycling pattern. A continuous wave NIRS system with 8 sources and 16 detectors was used to record the hemodynamic signal in sensorimotor cortex (SMC), supplement motor area (SMA), primary motor cortex (PMC), and secondary sensory cortex (S2). 3) Results In most of training subjects, the EMG linear envelops after circular cross correlation in pre- and post-training showed an improvement in SSI, and their quantitative NIRS values that shows an increase in the changes of oxyhemoglobin in most regions. However, in some subjects the EMG amplitude of sound side

increases largely but there is no increase in the affected side, indicating that after one-month training, the subject mainly used sound side to complete the movement. Same finding can be seen in changes of oxyhemoblobin, that there is an increase in unaffected brain side and a decrease in affected brain side. 4) Conclusions Some training cases showed an improvement in both cortical activation and muscular symmetry pattern after one-month FES cycling training, but others showed no effective progress. This may be due to 10 mA of electrical currents is too small to be sensed by subjects. Further study can be performed by using higher intensity up to sensory threshold for better feedback facilitation.

P3-J-40 Virtual reality-based balance training using body-worn sensors: Results of a pilot study in older adults

Michael Schwenk[1], Gurtej Grewal[1], Bahareh Honarvararaghi[1], Stefanie Schwenk[1], Jane Mohler[1], Dharma S. Khalsa[2], Bijan Najafi[1]

[1]University of Arizona, [2]Alzheimer's Research and Prevention Foundation

BACKGROUND AND AIM: Virtual environments provide feedback about the movement performance, thus assisting the user during training. To be able to implement virtual reality training to geriatric practice, studies should focus on systems that can be applied in the every-day clinical setting and allow for practicing of tasks that resemble everyday life challenges. Recent progress in technology for wearable systems to monitor human motion can facilitate development of such virtual reality-based exercise systems. The aim of the present study was to evaluate the effectiveness of a virtual-reality-based balance training technology using body-worn sensor-based real time feedback for improving balance in older adults. METHODS: Ten older adults (mean age 84.0 years) living in a residential care home were randomized to an intervention group (IG, n=5) or control group (CG, n=5). The IG performed virtual reality-based game like balance training including postural balance tasks (point-to-point ankle reaching task) and dynamic balance tasks (crossing virtual obstacles) while receiving real-time feedback from lower extremity motion on a screen. Balance training was conducted twice per week over four weeks. Each session lasted 45 minutes and was supervised by a qualified instructor. The CG received usual care. Improvements in postural control were quantified by reduction in sway of ankle joint, hip joint and center of mass (COM) measured by validated body worn sensor-based assessment. Improvements in dynamic postural balance were measured by the Alternate-Step-Test. RESULTS: Our findings revealed a significant reduction in anterior-posterior COM sway (change: IG: -35% vs CG: +9%, p=.033) and in ankle sway (change: IG: -42% vs CG: +46%, p=.01) in the IG compared to the CG. Changes in hip sway and medio-lateral COM sway did not reach level of significance (p=.062-.086). Significant improvements were found for dynamic postural balance (change: Alternate-Step-Test time, IG: -24%, CG: +6%, p=.019) in the IG compared to the CG. CONCLUSIONS: The current research evaluated a novel easy-to-use exercise training technology that provides real-time visual feedback from lower extremity motion in order to assist and motivate older adults during balance training. Our finding support that the proposed exercise training paradigm is effective in improving postural and dynamic balance among older adults. We anticipate significant improvements in all parameters from a study with larger sample size.

P3-J-41 Promoting Functional Plasticity to Promote Mobility: Preliminary Data from a 6-Month Randomized Controlled Trial

Teresa Liu-Ambrose[1], Shirley Wang[1], Chun Liang Hsu[1], Michelle Voss[2], Niousha Bolandzadeh[1], Elizabeth Dao[1], Ging-Yuek Hsiung[1], Teresa Liu-Ambrose[1]

[1]University of British Columiba, [2]University of Iowa

BACKGROUND AND AIM: The widely accepted dogma is that improved physical function underlies the effectiveness of exercise interventions in reducing falls risk. However, evidence from our randomized controlled trials suggests that exercise may reduce falls risk via mechanisms other than improved physical function. Specifically, improved functional plasticity of neural networks that contribute to both cognitive function and motor planning/control may be an important yet under-appreciated mechanism by which exercise reduces falls risk in older adults. Thus, we conducted an exploratory analysis to assess whether change in the functional connectivity (i.e., temporal coherence of brain activation) of the frontal-parietal network (FPN) is associated with change in general balance and mobility among older adults with vascular cognitive impairment. METHODS: Participants were a subset of 70 community-dwelling adults with mild vascular cognitive impairment, who were otherwise cognitively intact (Mini-Mental State Examination [MMSE] ≥24/30). All participants were enrolled in a 6-month randomized controlled trial (RCT) designed to primarily assess the effect of thrice-weekly aerobic training (AT) on cognitive function. Participants were randomly assigned to either: 1) thrice-weekly resistance training (AT); or 2) monthly nutrition counselling (CON; control group). Assessments of cognitive function, mobility, and functional magnetic resonance imaging (fMRI) were conducted at baseline and 6 months. A battery of standard neuropsychological tests was administered to assess executive functions and processing speed. The Short Physical Performance Battery (SPPB) was used to assess general mobility and balance (maximum score = 12). During fMRI scanning, participants were asked to perform a simple finger tapping task that included periods of rest (i.e., resting state). Seed-based functional connectivity analysis was performed to establish brain connectivity maps of four aging-related neural networks: default mode network (DMN), fronto-parietal network (FPN), fronto-executive network (FEN), and the motor network (MotN). For our analysis, we specifically focused on the FPN. Pearson correlations were calculated between change in FPN connectivity and change in the 3 subcomponents of the SPPB as well as the SPPB total score. RESULTS: Ten participants completed fMRI scanning at baseline and trial completion. At the end of the 6-month RCT, the AT group demonstrated a reduction in functional connectivity in the FPN during rest compared with the CON group. Furthermore, reduced functional connectivity in the FPN during rest was significantly associated with improved standing balance performance ($p = 0.022$; $r = -0.709$). CONCLUSIONS: These preliminary results suggest that targeted exercise training may improve mobility and balance via changes in functional plasticity. Our results support the proposed central benefit model for falls prevention.

P3-K-42 Influence of a dual-task on foot clearance during gait in people with incident Parkinson's disease

Lisa Alcock[1], Brook Galna[2], Sue Lord[2], Lynn Rochester[2]

[1]Faculty of Medical Sciences, Newcastle University, [2]Institute for Ageing and Health, Newcastle University

BACKGROUND AND AIM: Reduced foot clearance (FC) has been reported in established Parkinson's disease (PD) and may reflect hypokinetic gait, however it is unknown whether it is present in incident PD. FC deficits in PD may also be exacerbated when distracted by a concurrent cognitive task (dual-task),

although this has not yet been quantified. The aims of this study were to evaluate whether: i) FC is reduced in incident PD; ii) dual-task influences FC; and iii) there is a relationship between FC and step length. METHODS: Participants walked around a 25m circuit at a comfortable pace for two minutes under single- and dual-task (maximum digit-span recall) conditions. Spatiotemporal gait characteristics were collected with an instrumented walkway (GAITRite). Trajectories of bilateral calcaneous (heel) and the dorsal aspect of the hallux (toe) were measured with a VICON system (100Hz). Maximum heel and toe clearance, and minimum toe clearance during mid-swing were extracted from filtered (Woltering, MSE:20mm) data, adjusting for minimum marker height and normalising to stride time. The effect of pathology and dual-task were tested using a mixed ANOVA. Pearson's correlations (r) quantified the relationship between step length and FC. RESULTS: Preliminary data was analysed for 12 people with incident PD (Mean[SD] Age: 67.8[7.8] years; UPDRSIII: 22.8[7.2]; 9 males) and 10 controls (Age: 65.9[5.4] years, 4 males) from a large longitudinal study (ICICLE-Gait). Age and sex was similar between groups ($p>.05$). Significant group main effects showed that PD participants walked with a lower maximum (Control: 131[17]mm PD: 102[31]mm; $p=.016$) and minimum (Control:24[9]mm PD:16[8]mm; $p=.040$) toe clearance compared to controls, although maximum heel clearance was not different between groups. Maximum toe clearance was lower under dual-task conditions for both groups ($p=.021$). There were no other significant effects for condition or condition x group interactions. Within the PD group, reduced step length was significantly related to a lower maximum heel ($r=.813$, $p=.001$) and toe ($r=.902$, $p<.001$) clearance but not related to minimum toe clearance ($r=.348$, $p=.268$). For controls, step length was related to maximum toe clearance only ($r=.767$, $p=.010$). CONCLUSIONS: People with incident PD walked with a lower toe clearance than controls, and although dual-task resulted in further reductions, FC was not disproportionately affected by pathology. Associations between step length and FC support earlier work and hypokinesia may contribute to reductions in foot clearance in PD. Analysis on a larger sample (n = ~75 controls and ~75 PD) will be presented to include a comprehensive model of foot trajectories as well as examine the clinical implications with longitudinal assessment of falls.

P3-K-43 Incidence, Type, and Control of Medio-Lateral Protective Stepping in Older Fallers and Non-Fallers

Woei-Nan Bair[1], Michelle Prettyman [1], Brock Beamer[1], Mark Rogers[1]

[1]University of Maryland, Baltimore

Background and aim. Stepping responses to externally applied balance perturbations, especially in the lateral direction, can effectively reveal balance deficits underlying falls. However, few studies have directly compared different types of medio-lateral protective stepping limiting our understanding of balance control related to fall status. Protective stepping also may vary with different perturbation magnitudes, but detailed characterization of stepping responses in relation to magnitudes is lacking. The aim of this study was to compare the control characteristics of four protective stepping strategy types evoked by different magnitudes of lateral perturbations in older adult non-fallers and fallers. Methods. Fifty-two community-dwelling older adults were tested: 36 non-fallers and 16 fallers (Mean±SD: 74.6±7.6 and 73.4±4.6 years old, 17 and 10 females, respectively). Participants reacted naturally to maintain their balance in response to 60 randomly applied lateral waist-pulls at five different magnitudes. We identified the number of trials with steps (incidence of stepping), and for each stepping trial we recorded step count and type of 1st step used. Spatio-temporal characteristics of 1st step were determined by kinematic recordings. Perturbation magnitude effects were analyzed with reference to

Balance Tolerance Limit (BTL, defined as the lowest perturbation magnitude at which the mean step count was greater than one) as below, at, and above BTL. For incidence of stepping, conditional independence was tested for group and step type. Mean step count and 1st step spatio-temporal parameters were each analyzed by a separate mixed ANOVA model. Results. Fallers used medial steps most frequently whereas non-fallers predominantly took crossover-back-steps. Fallers took more recovery steps than non-fallers, who also modified their number of steps for different step types. Group differences in 1st step spatio-temporal characteristics were significant only at step initiation (step onset time) and termination (trunk angle at landing) but not for step execution (single stance duration and step length). Group differences mainly resided in fallers' inability to modulate step spatio-temporal characteristics between different step types. Group differences were more clearly demonstrated with above-BTL than at-BTL perturbations. Conclusions. These results indicated that fallers used a biomechanically less effective stepping strategy in response to lateral perturbations. They also lacked the ability to modulate stepping at the critical time points of step initiation and termination. Perturbation magnitudes likely to induce more than one step (above BTL) can better differentiate protective stepping performance differences between fallers and non-fallers. [Supported by NIH R01AG029510]

P3-K-44 Age-related differences in CoM downward acceleration and velocity profiles during stair descent: effects of high risers

John Buckley[1], Richard Foster[1], Bill Baltzopoulos[2], Costis Maganaris[3], Neil Reeves[4]

[1]University of Bradford, [2]Brunel University , [3]Liverpool John Moores University, [4]Manchester Metropolitan University

BACKGROUND / AIMS: With an increase in riser height, the high levels of torque demand observed in older adults during stair descent would have to be produced/maintained over a greater range of motion with added impairment of reduced ranges of motion at the involved joints(1) and/or a reduced ability to generate sufficient torque at the extremes of joint range of motion(2). Such changes in joint kinematics/kinetics will likely affect how whole body CoM is controlled downwards(3). Here we investigate age-differences in how downward CoM acceleration and velocity are controlled during stair descent when riser height was increased by 150%. METHODS: 15 older (mean 75 yrs) and 17 young (mean 25 yrs) adults descended ('step-over-step' gait) an instrumented 4-step staircase, whose riser height was varied between 170 and 255 mm. Analysis focussed on determining age differences in CoM downward acceleration and velocity profiles during the single limb lowering phase, and in the joint kinetics at the ankle and knee of the lowering and landing limb. RESULTS: Lowering phase: CoM downward velocity and acceleration peaks ($p<0.007$) and the moment and power peaks at the support-limb ankle (moment, $p=0.006$, power, $p=0.005$) and knee (moment, $p=0.16$, power = 0.004) were of lower magnitude, and the duration of lowering was longer ($p<0.001$), in older adults. All measures were seen to increase in both groups at the higher riser height ($p<0.001$), but such increases were less pronounced in older adults ($p<0.05$). Landing limb: ankle moment peaks were smaller in older adults ($p=0.004$) and became increased in both groups at the higher riser height ($p<0.001$). Ankle eccentric power peaks were smaller in older adults ($p=0.009$) and the increases with riser height increase were less pronounced ($p=0.035$). Moment and power peaks at the knee increased with increased riser height ($p<0.001$) but there were no differences between groups. CONCLUSIONS: The increase in CoM downward acceleration and velocity peaks, and in ankle and knee moment and power peaks, with

increase in riser height indicates that stair descent was more challenging in both groups at the higher riser height. As CoM acceleration and velocity peaks were reduced in older adults at both heights and particularly so at the higher riser height, this suggest they adopted a more conservative stair descent strategy; as evidenced by their longer duration of lowering. The reduced eccentric moment and power peaks during both the lowering and landing phases, particular at the ankle, suggests older adults were not capable of developing similarly high moments to the young. This reduced capacity explains why the older adults displayed a more 'cautious strategy' in controlling their CoM downwards especially so at the more challenging high riser height. REFS: 1. Lark et al. Eur J Applied Physiol, 91: 287-295, 2004. 2. Reeves et al. J Electromyo Kinesiol 18:218-27, 2008. 3. Buckley et al. Exp Gerontol, 48: 283-289, 2013.

P3-K-45 Motor and cognitive correlates of gait slowing in a challenging environment in people with Parkinson's disease

Maria Joana Caetano[1], Jasmine Menant[1], Colleen Canning[2], Daniel Schoene[1], Jooeun Song[2], Serene Paul[2], Stephen Lord[1]

[1]Neuroscience Research Australia, [2]University of Sydney

BACKGROUND AND AIMS: The ability to walk through challenging environments requires integrity of motor and cognitive functions in order to maintain stability and avoid falling. These functions are limited in people with Parkinson's disease (PD) and contribute to the increased occurrence of falls in this population. The aims of this study were to identify: a) the extent to which people with PD slow down when faced with a challenging environment requiring stepping adaptability and b) motor and cognitive correlates of gait slowing within this group. METHODS: Nineteen people with idiopathic PD (H&Y 1 to 3; aged 68.3±6.5 years old) were tested "on" medication. Gait adaptability was measured by a new test which involved making a rapid voluntary change in the stepping path in response to light stimuli presented on a 4 m long electronic walkway. As the participants walked at their self-selected speed, a coloured light stimulus was projected on the pathway two steps a head (figure 1). According to the colour of the light stimulus, participants had to avoid or step onto it and continue walking. Participants performed three free walking (control) trials followed by nine virtual obstacle trials. Outcome measures were gait speed in obstacle and control trials, percentage reduction in gait speed between the obstacle and control trials, standard measures of motor (UPDRS-III, finger reaction time), cognitive function (Trail Making Tests A and B, Clock Drawing Test, Copy Design) and fear of falling (Falls Efficacy Scale-International). RESULTS: Compared to control trials, participants walked significantly slower during the obstacle trials (mean difference=14.4 cm/s, t=5.91, df=18, p<.001). Percentage of gait slowing significantly correlated with fear of falling (r=.618, p<.005), UPDRS-III scores (r=.551, p<.014), and reduced performances in the Trail Making A (r=.535, p<.018), Trail Making B (r=.448, p<.054) and Clock Drawing (r=-.394, p<.095) tests. Further, in participants with poor visuospatial/executive function (Clock Drawing Test score <3), the percentage of gait slowing was twice that of participants with good visuospatial/executive function (mean difference=10.2%, t=2.00, df=17, p=.06). CONCLUSIONS: Gait slowing when faced with a challenging environment was associated with impaired performance in complementary domains; motor performance, processing speed, visuospatial/executive function and concern about falling. These preliminary findings suggest that a gait slowing measure may represent a composite measure of motor and cognitive impairment in people with PD.

P3-K-46 Reduced ability to discriminate shadows from surface undulations contributes towards increased falls risk in older adults

Mark Hollands[1], Benjamin Curzon-Jones[2], Andrew Schofield[1]

[1]Liverpool John Moores University, [2]University of Birmingham

Background and Aims: Vision is the only sensory modality that informs us in advance about the properties of our walking environment and is therefore essential to planning adjustments to walking direction and guidance of the feet to avoid obstacles and hazards and to accommodate surface undulations. Discrimination between surface undulations and shadows relies on the ability to perceive changes in visual contrast in reflected light from textured surfaces. However, the ability to perceive these texture contrast modulations declines with age. We propose that age-related decline in visual perception of contrast modulations might represent a previously unconsidered mechanism contributing to older adults' increased susceptibility to trips and falls. The aim of the present study was to test whether age-related reduction in the ability to perceive texture modulations affects limb trajectories during an obstacle avoidance task. Methods: We covered a 150 mm high curved step with printed textures and illuminated the step with a spotlight. We used two textures a uniform contrast texture which appeared as a normally shaded undulating surface (control condition) and a low-contrast texture which had a region of reduced contrast on the riser so as to mimic a subtle material change i.e. we created an optical illusion of a surface undulation reliant on sensitivity to contrast modulations. On each trial participants were asked to first estimate the step height by raising one foot and then mount the step. Each participant completed 10 trials for each texture in counter balanced order. Eight younger (mean age 28 years) and eight older (mean age 70 years) adults took part, all wearing their normal optical correction. Toe positions trajectories were measured using a 13 camera Vicon MX motion capture system and minimum toe clearances between the step surface and toe were calculated. Results: There was a significant main effect of age group on estimated step height but no effect of texture type. There was a significant interaction between age group and texture ($F(1,14) = 7.12$, $p = 0.018$). When climbing the step younger adults allowed an additional 9.6 mm clearance for the low contrast step compared to the uniform step. Older adults did not make any significant adjustment to toe trajectory. Conclusions: Although the texture manipulation did not affect perceptual estimates of step height it did alter stepping behaviour in the younger, but not older, adults. This result suggests that subtle visual cues describing texture and surface undulations are normally used to modulate stepping but that these cues are not available to older adults. We believe these results have important practical implications for identifying, and reducing falls, risk in older adults.

P3-K-47 Do cognitive and motor impairments predict balance control post-stroke

Ashleigh Kennedy[1], William McIlroy[1]

[1]Toronto Rehabilitation Institute

BACKGROUND AND AIM: Stroke impairs control of balance which places individuals at a higher risk for falling, as well as limiting mobility and activities of daily living. There is evidence of the link between balance control challenges and physical impairment, however; more recently the influence of cognitive impairment on balance control has become more apparent. An investigation into the relationship between both physical and cognitive impairment and balance control after stroke would provide information about determinants of post-stroke instability that may help facilitate the design of more

effective rehabilitation programs. Therefore, this study focused on revealing possible links between clinical indices of motor and cognitive impairment and balance 1 year post-stroke. METHODS: A cross-sectional retrospective chart review of the Rehab Affiliate database was performed for 159 participants one year post-stroke. A linear regression analysis determined the predictive capacity of basic demographics (age, body mass index), overall stroke severity (National Institutes of Health stroke scale (NIHSS)), motor impairment (Chedoke-McMaster Stroke assessment (CMSA) scores for the leg) and cognitive measures (Montreal cognitive assessment (MoCA) and trail making tests A & B time to completion and missed connections) on balance control (Berg Balance Scale (BBS)). The BBS is a measure of functional balance and is a good predictor of future falls. RESULTS: The BBS scores ranged from 4 - 56 with a mean of 43 (SD 15). The univariate linear correlations between BBS and measure variables were: r = - 0.55 (age); r = 0.48 (BMI); r = - 0.49 (NIHSS), r = -0.88 (SCP), r = 0.65 (CMSA leg), r = 0.21 (MoCA); r = -0.37 (Trails A time); r = - 0.18 (Trails B time); r = - 0.195 (Trails B missed connections). The multivariate analysis (F9,19) = 70.85, p < 0.0005, adjusted R2 = 0.97) suggested that a significant proportion of the total variation in the Berg Balance Score was predicted by age (p = 0.001), NIHSS (p = 0.0001), SCP (p = 0.0001), MoCA (p = 0.0001), trails making test B time to completion (p = 0.021) and missed connections (p = 0.001). CONCLUSIONS: The results from this study highlight the relationship between cognitive function and balance control. Specifically, the data revealed links between the Montreal Cognitive Assessment and the Trail Making Test B and the Berg Balance Scale. The MoCA assesses several cognitive domains including visuospatial abilities and executive function. Trails B test is commonly related to speed of processing and executive function including task switching. The cognitive abilities measured in both of these assessments are likely very important in functional balance. Overall, this data may be used to guide the development of stroke rehabilitation programs, particularly regarding the importance of cognitive rehabilitation in recovery of mobility among stoke survivors.

P3-K-48 Maori and nonMaori in advanced age, a contrast of frailty measures and falls: LILACS NZ

Ngaire Kerse[1], Ruth Teh[1], Simon Moyes[1], Lorna Dyall[1], Tim Wilkinson[2], Martin Connolly[1]

[1]University of Auckland, [2]University of Otago

Background: The utility of the frailty concept in indigenous people and in very old people is not known. Falls and frailty may predict mortality in different ways. Methods: A cohort study of Mâori 80-90 years and non-Mâori 85 years at inception in 2010 were used to construct and compare the Fried and Rockwood Frailty Indices in predicting mortality over three years follow up. Falls were ascertained by self report. Rockwood was constructed from 34 deficits on the complete sample, 410 Mâori and 512 non-Maori. The Fried was constructed from community dwellers that completed the full interview (206 Mâori and 344 non-Mâori) using gait speed; PASE activity score; grip strength; and poor energy, and weight loss. Mortality was from National mortality data. Rockwood was examined in the full sample and prediction of mortality of both Rockwood and Fried compared using regression techniques adjusting for deprivation, education and age. Falls were used to predict mortality, then controlled for both frailty indices. Results: Over three years 100 Mâori(24%) and 109 non-Mâori(21%) died(ns). 43% of non-Mâori fell in year of enrolment and 36% of Mâori (ns when adjusted). According to Fried, Mâori were less frail than non-Mâori. Mâori: 34% notfrail, 59% prefrail, 7% frail; non-Mâori 20% notfrail, 65% prefrail and 15% frail(p <0.001) with no gender variation. Scores on the Rockwood Index did not differ by ethnicity. The lowest and highest Rockwood quartile had 10% and 47% mortality (p<0.001) for Mâori and 6% and

38% mortality (p<0.001) for non-Mâori. Fried showed 40% and 20% (p 0.016) mortality for the frail and prefrail group respectively for Mâori and 28% and 16% (p 0.004) for non-Mâori. Using regression the Rockwood and Fried both predicated mortality (p<0.002). Falls significantly predicated mortality and was completely confounded by the Fried scale, but not the Rockwood. Conclusions: Frailty and falls both predict mortality. The Fried scale, not Rockwood, explained all the variance in mortality predicted by falls. Falls maintained prediction of mortality independent of Rockwoods scale for both Mâori and non-Mâori. The two frailty concepts measure different things

P3-K-49 ERP Measures Reveal Dual-Task Interference in Postural Performance in Young Adults

Carrie Elaine Little[1], Marjorie Woollacott[1]

[1]University of Oregon

BACKGROUND AND AIM: Competition for attentional resources during concurrent execution of a postural and cognitive task (dual-task) has been shown to alter one or both tasks. The aim of the current study was to examine interference between performance of a visual working memory (VWM) task and postural recovery following perturbation. We hypothesized that 1) VWM capacity would decline, 2) Postural response Electroencephalographic (EEG) Event Related Potential (ERP) amplitude would decline, and 3) ERP latency would be shortened in DT versus ST conditions in YAs. METHODS: Fourteen YAs (20.8±1.7 years) participated in the study. Standing Postural Perturbations (10 cm @ 30 cm/s) occurred in ST and DT conditions. The VWM task was a change-detection task (colored squares) projected on a screen in front of subjects and VWM capacity was determined; the VWM single task condition was performance of the task while sitting. ERP amplitude and timing associated with postural perturbation were recorded using a 256 electrode EEG system. RESULTS: One-way repeated measures ANOVA identified a significant main effect of postural condition on K-Score ($F(2,12) = 4.02$, $p<0.05$, $r=0.50$). Contrasts revealed that VWM capacity in the perturbation condition was significantly decreased ($F(1,13) = 6.18$, $r=0.57$) compared to sitting. Two-way repeated measures ANOVA identified a significant decline in ERP amplitudes ($F(1,13) =20.77$, $p<0.001$, $r=0.78$) in DT versus ST conditions (Figure 1). There was a significant main effect of cortical region on level of activation ($F(3,11) = 4.29$, $p<0.05$, $r=0.53$). Contrasts revealed ERP amplitude in the R Sensory was significantly greater than in the L Sensory cortical region ($F(1,13) = 6.86$, $r=0.58$). ERP latency was significantly shorter ($F(1,13) = 35.95$, $p<0.001$, $r=0.86$) during the DT versus ST conditions. CONCLUSIONS: The reduction in VWM capacity and both Perturbation induced ERP amplitude and latency during the DT condition highlights an interference pattern that supports the sharing of attentional resources between the two modalities in young adults.

P3-K-50 Presynaptic control of balance in healthy subjects

Zoé Miranda[1], Dorothy Barthélemy [1]

[1]Université de Montréal

Background: When subjected to unexpected perturbations, sensory inputs- notably from peripheral afferents- are modulated and integrated in the central nervous system to generate appropriate postural responses. Previous research has shown that presynaptic inhibition is a mechanism which plays an important role in modulating sensory transmission and the goal of this study is to assess presynaptic inhibition during perturbations of balance. Methods: Perturbations were induced by randomly tilting the platform on which subjects stood, at a speed of 20°/s for 400 ms in a forward or backward direction.

Soleus (SOL) EMG activity was recorded. 1) Modulation of SOL H reflex was first assessed (n=9, 27±7 yrs) by electrical stimulation of the tibial nerve at the popliteal fossa. Single-pulses were applied randomly prior to and 0, 25, 50, 75, 100, 200, 500 or 800 ms after tilt onset. 2) To further estimate presynaptic inhibition, we quantified in 5 subjects: A) the facilitation of SOL H-reflex induced by femoral nerve (FN) stimulation and B) the depression of SOL H-reflex (D2 inhibition) by common peroneal nerve (CPN) stimulation. The tibial nerve was stimulated alone (control) or conditioned by FN or CPN at different delays (same as for H-reflex). A decrease in presynaptic inhibition was determined if both an increase in FN-induced facilitation and a decrease in CPN-induced inhibition occurred. Results: 1) A decrease in H-reflex amplitude was observed during backward tilt at latencies of 75 to 800 ms (maximal inhibition occurred at 200 ms; 15% of control). Inhibition of H reflex was first observed at 75 ms which preceded a decrease in the SOL EMG (latency: 149 ±20 ms). During forward tilt, facilitation was observed from 100 to 800 ms (maximal facilitation occurred at 200 ms; 188% of control). Onset of this facilitation preceded an increase in SOL EMG (latency of 162±18 ms). 2) During quiet standing, SOL H-reflex depression from CPN was 81+/-9% of control and the SOL H reflex facilitation from FN was 105+/-8%. During forward tilt, presynaptic inhibition decreased, as manifested by a decrease in H-reflex depression from CPN stimulation (103±6%) and by an increase in SOL H-reflex facilitation from FN stimulation (118±8%) at a latency of 100 ms. Similar changes were observed during backward tilt (120±16% for CPN and 196±37% for FEM conditioning). Conclusions: Preliminary results suggest that presynaptic inhibition is modulated during postural reactions. Decreased presynaptic inhibition could explain the increase in H reflex amplitude during forward tilt, but can't explain the substantial decrease in H reflex during backward tilt. Thus, presynaptic inhibition may not be directly involved in SOL activation/suppression, but might rather be decreased during tasks relying on unpredictable sensory feedback to increase influence of proprioceptive input on spinal networks, as suggested in previous studies. Supported by NSERC, REPAR.

P3-K-51 FFRAT, a Web-based Assessment Tool for Evaluating Fall Risk in the Elderly

Lorenzo Chiari[1], Luca Cattelani[1], Pierpaolo Palumbo[1], Luca Palmerini[1], Stefania Bandinelli[2], Federico Chesani[1]

[1]Universita' di Bologna, [2]Azienda Sanitaria di Firenze

BACKGROUND AND AIM: It has been estimated that about 30% of the population aged 65+ fall at least once in a year. Falls can result in physical injuries, in loss of self-confidence and/or in increase of frailty. Fall prevention can diminish the number of falls; however, to be cost-effective, it should be applied to subjects with the higher risk of fall. The FARSEEING Fall Risk Assessment Tool (FFRAT) is a web-based software tool that estimates the fall risk of a subject. FFRAT computes the probability of a fall within a year as a consequence of the subject being (not) exposed to known Risk Factors (RF). Whenever the exposure to a specific RF is unknown, FFRAT takes into account also the prevalence of the RF over the population. METHODS: FFRAT exploits the findings of epidemiological studies about fall risk factors. We defined an ontology containing RF, Odds Ratios, factor prevalence over the population, settings (community dwelling, acute care context, etc.), and estimators (clinical/personal data indicating exposure to a risk factor). Currently FFRAT focuses on the community dwelling and uses the results of [1]. A software based on LPADs [2] is automatically generated from the ontology: it takes in input the subject profile (the list of known estimators), and computes the probability. Estimators can have boolean or scalar values; the "unknown" value is also supported. Inputting of the profile is made through a simple web interface: together with the ontology and the software, they make up FFRAT.

RESULTS: We have assessed FFRAT using InCHIANTI [3], an epidemiological study where 1453 people have been enrolled at baseline and underwent three subsequent visits covering globally a 9-year follow-up. At each follow-up subjects were asked about falls occurrence in the previous 12 months, and received an extensive clinical evaluation. A total of 2319 observations from 977 subjects aged 65+ have been extracted, and submitted to FFRAT to predict fall probability. When compared with observation, FFRAT performance showed an area under the ROC curve (AUC) of 0.62, and a Brier score of 0.166. CONCLUSIONS: The discrimination achieved by FFRAT in terms of AUC is comparable to other traditional tools (Tinetti Balance, AUC 0.62 [4], Timed-Up-and-Go test, AUC 0.61-0.62 [5,6]). Future work will focus on supporting other settings, and on supporting more risk factors. 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. REFERENCES: [1] Deandrea, S. et al. Epidemiology 21, 658-668 (2010). [2] Riguzzi, F. et al. Th. and Prac. of Log. Prog., 13, 279-302 (2013). [3] Ferrucci, L. et al. J. Am. Geriatr. Soc. 48, 1618-25 (2000). [4] Raîche, et al. Lancet 356, 1001-2 (2000). [5] Lin, M.-R. et al.. J. Am. Geriatr. Soc. 52, 1343-8 (2004). [6] Morris, R. et al. Age Ageing 36, 78-83 (2007).

P3-K-52 Acute Effect of an Adapted Racquetball Training on Motor Symptoms and Balance in PD

Shaun Porter[1], Chris Dalton[1], Julie Nantel[1]

[1]University of Ottawa

BACKGROUND: Parkinson's disease (PD) affects balance and postural stability. The Functional reach test (FRT) is a validated tool to identify PD patients with fall history (Behrman et al., 2002) and at high risk of falling again. AIM: Our objective was to assess motor function, range of motion (RoM) and postural stability before (pre) and immediately after (post) a 45 min training session of racquetball (RB) adapted for individuals with PD. METHODS: Eight PD participants, (Dx: 6.4 ± 4.4 years; Hoehn and Yahr stages 1-3) took part in this study. Prior to the motor task, participants filled out a 1-year self-reported fall questionnaire. The FRT consisted of standing quietly for 5 seconds, lifting the least affected arm to 90º and holding for 3 seconds (T1), reaching as far as possible while maintaining heel contact with the ground and holding for 3s (T2), returning back to standing with arm up, and resuming quiet standing for 10 seconds (T3). FRT was performed on two-force platforms (Kistler, Switzerland) pre- and post-exercise. Kinetics was captured at 200Hz and filtered with a zero-lag fourth-order Butterworth filter, 10Hz cutoff frequency. Center of pressure velocity (VCoP) in the medial-lateral (ML) and anterior-posterior (AP) directions were derived from the ground reaction forces to assess postural control. FRT epochs T1 to T3 were compared pre and post exercise. Motor function and stability were assessed using independent sample and paired t-tests and correlations were used to assess relationship between the questionnaires and VCoPs. RESULTS: We found significant differences in VCoPml/ap between T1 and T2, T1 and T3 (AP pre/post, ML post: $p<0.01$, ML pre: $p<0.05$), and T2 and T3 (AP pre, ML post: $p<0.05$, AP post: $p<0.01$). No significant differences were found for FRT score and ROM, although there was a group average increase (1.3% and 1.4%). There were no significant differences on VCoP measures pre- versus post-exercise. Number of falls showed a correlation in T3 AP after (VCoP) (post: $r = 0.7$, $p=0.05$). DISCUSSION: Contrary to our hypothesis RB did not decrease stability. Furthermore, the participants as a group increased their reach, ROM as well as reported feeling better post RB. However, participants needed more than 10s to re-stabilize after a self-initiated perturbation. Postural balance during this period of re-stabilization (T3) showed a strong correlation with the number of falls in the previous 12 months.

Although participants reported feeling better after training, they should be made aware that after exercising they could be at a higher risk of postural instability and falls.

P3-K-53 Association between spasticity and balance impairments in persons post-stroke

Reza Rahimzadeh Khiabani[1], George Mochizuki[2], Farooq Ismail[3], Chris Boulias[3], William Gage[1], Chetan Phadke[3]

[1]York University, [2]University of Toronto, [3]West Park Health Care Centre

Background and aim: Although balance impairment and spasticity are common problems in persons post-stroke, the relationship between spasticity and balance impairment is not clearly understood. In this study, we investigated the association between spasticity and balance impairment to understand if spasticity can contribute to physical and psychosocial aspects of balance control in persons post-stroke. Methods: Fifteen patients with stroke and spasticity completed the Activities Balance Confidence Scale (ABC) as a measure of patients' balance self-efficacy, and the Berg Balance Scale (BBS) to assess functional balance performance. Total spasticity levels in the upper limbs (UL) and lower limbs (LL), and number of muscle groups with spasticity in the UL and LL were gathered from Modified Ashworth Scale (MAS) scores from patient charts. Spearman's rho was used to study the correlation between spasticity and balance measures. Results: Significant negative correlations between total upper limb MAS Score and ABC (rho=-0.50; $p<0.05$) and BBS (rho = -0.52; $p<0.05$) were found. Similarly, significant negative correlations between number of muscle groups with spasticity in the upper limbs and ABC (rho=-0.58; $p<0.05$) and BBS (rho= -0.51; $p<0.05$) were found. Total lower limb MAS scores and number of muscle groups with spasticity in the lower limbs both showed non-significant positive correlations with the ABC (rho = 0.31; p = 0.13) and (rho= 0.29; p = 0.15), and with the BBS (rho=0.15; p = 0.29) and (rho= 0.17; p = 0.27) respectively. Conclusion: The results suggest that upper limb spasticity in patients post-stroke, in terms of total spasticity level and number of muscle groups with spasticity, contributes to balance impairment and balance confidence. Upper limb spasticity should be considered when clinically evaluating falls risk for patients post-stroke.

P3-K-54 The Effects of Added Body Mass on Spatiotemporal Gait Measures and Gait Variability during Treadmill Walking

Brian Street[1], Andrew Sweetnam[1], William Gage[1]

[1]York University

Background: Obesity has been associated with increased postural sway during quiet standing [1] and an increase in the number of falls [2]. Modeling approaches have linked extra body weight to the increased postural sway observed during quiet standing in obese individuals [3,4]. Spatiotemporal gait variability has been shown to reliably identify those who have fallen and is predictive of future falls [5], and is associated with elevated postural sway during quiet standing [6]. The purpose of this study was to investigate the effect of added body mass on spatiotemporal gait measures and gait variability. Methods: 14 healthy young adults (age = 23.1 ± 2.5 years) provided informed consent and took part in this study. 3D lower-limb kinematic data was recorded during three 20-second trials of treadmill walking under two conditions; 1) normal walking (NO LOAD), and 2) walking with a weighted vest equivalent to 30% of participant body mass (LOAD). Percent double limb support (%DS) and stride length were determined. Spatiotemporal gait variability was assessed using the coefficient of variation of stride

length (COVSL) and stride time (COVST). Paired t-tests were used to assess differences between the NO LOAD and LOAD conditions. Results: Participants were significantly heavier (BMI = 28.8 ± 1.8 kg/m2) during the LOAD condition compared to the NO LOAD condition (BMI = 22.4 ± 2.4 kg/m2; t13 = 17.15, p<0.001). It was observed during the LOAD condition that participants demonstrated reduced stride length (t13 = 4.19, p<0.001) and the proportion of time spent in double support was significantly larger, compared to the NO LOAD condition (t13 = 6.01, p<0.001). Both spatial (t13 = 2.98, p=0.005) and temporal (t13 = 2.74, p=0.008) variability were greater in the LOAD condition. Conclusions: This study investigated how additional body weight can affect gait cycle parameters and gait variability. Additional body mass was related to increased spatial and temporal gait variability measures. Increased gait variability can be indicative of gait instability, and has been linked to elevated fall risk. Increased variability was perhaps countered by a shift towards a more conservative gait pattern, marked by greater time in the more stable double limb support phase of gait, and reduced stride length. The findings of this study suggest increased body mass may increase the risk of falling, and help explain why obese individuals are at greater risk of falling.

P3-K-55 Investigating the Relationship between Sarcopenia and Functional Measures of Gait and Posture in Community-Dwelling and Assisted-Living Older Adults

Lori Ann Vallis[1], Emily McIntosh[1], Taylor Campbell[1], K. Brent Smale[1]

[1]University of Guelph

BACKGROUND AND AIM: Sarcopenia has been linked to functional deficits and increased falls risk [1]. This risk is of concern due to high disability and mortality rates associated with falling in older adults [2]. Our lab estimated the prevalence of sarcopenia in community-dwelling (Study 1) and assisted-living older adults (Study 2) using the European Working Group on Sarcopenia in Older People (EWGSOP) diagnostic criterion [3]. Prediction models were developed for fat-free mass (FFMI) measurements and sarcopenia using measures of gait and posture. METHODS: Eighty-five community-dwelling (42 male; 75.2±5.7 years; Study 1) and 36 assisted-living older adult participants (10 male; 86.7±5.7 years; Study 2) completed assessments for grip strength, balance, mobility, and gait. Quiet standing balance was assessed using a force plate (AMTI Inc., MA, USA) and a GAITRite mat (CIR Systems Inc., PA, USA) recorded measures of gait. Body composition was measured using bioelectrical impedance analysis (BIA; Bodystat Ltd., Isle of Man, UK) and FFMI values were calculated. Using the EWGSOP algorithm (FFMI with grip strength and gait speed) sarcopenic individuals were identified. RESULTS: Based on EWGSOP criterion [3], 12 of 85 community-dwelling individuals (14%) were classified sarcopenic; all demonstrating reduced muscle mass [1,4] and decreased grip strength but no reduction in gait speed. Seven other individuals were pre-sarcopenic (muscle loss without function or strength declines). Among the assisted-living population, eight (22%) of 36 individuals were classified sarcopenic (reduced muscle mass and grip strength). All 36 had grip strength deficits and 15 (43%) participants had gait impairments (all non-sarcopenic individuals). The equation predicting the most variability of FFMI for Study 1 included: sex, step time, Body Mass Index (BMI), and time outside a 95% confidence ellipse (adjusted R^2=0.9272). When applied to the assisted-living population, the predictability was reduced (adjusted R^2=0.6744). Instead, the best prediction of FFMI included: forearm circumference, BMI, handgrip strength, and variability of double support time (adjusted R^2=0.7950). CONCLUSIONS: Our work suggests that the EWGSOP model is not sensitive enough for all older adults; the reduced effectiveness of our previous prediction model indicates an abundance of differences between community-dwelling and

assisted-living older adults. If early intervention is the ultimate goal, more sensitive models for each population is needed to identify at-risk individuals prior to the onset of functional deficits, to facilitate early implementation of intervention strategies to attenuate muscle loss and decrease falls risk. REFERENCES: [1] Roubenoff (2000). Eur J Clin Nutr 54 (Suppl 3): S40-7. [2] Lord et al. (2007). Cambridge University Press, p: 93-4. [3] Cruz-Jentoft et al (2010). Age and Ageing, 39(4), 412-423. [4] Janssen et al. (2002). J Am Geriatr Soc, 50, 889-99.

P3-K-56 Cognitive neural network modulation in relation to balance impairments

Kelly Westlake[1], Elizabeth Woytowicz[1], Chandler Sours[1], Joseph Rosenberg[1], Rao Gullapalli[1]

[1]University of Maryland, Baltimore

BACKGROUND: Traumatic brain injury (TBI) results in both cognitive and physical impairments, with approximately 30% of patients reporting impaired balance, even in mild TBI. Investigations of the effect of divided attention on balance have revealed important links between delayed postural responses, risk of falling, and cognitive function. To date, no observations have been made regarding the relationship between neural changes in cognitive network function and impaired balance following TBI. AIM: We aimed to investigate the neural shift from a resting to an attentionally demanding state in relation to balance performance in subjects with mild TBI. METHODS: Using functional magnetic resonance imaging (fMRI), we used a general linear analysis to compare default mode network (DMN) suppression and fronto-parietal activation during a 2-back working memory task in subjects with mild TBI and balance impairments (BI) (n = 7, age 47±15yrs) or no balance impairments (NB) (n=7, age 47±15yrs). RESULTS: BI subjects showed a decreased ability to suppress the DMN compared to NB subjects during the working memory task. In contrast, an increased activation of the fronto-parietal executive regions was found in BI compared to NB subjects. Results were cluster corrected at $p<0.05$. CONCLUSIONS: Our results provide the first evidence of a direct relationship between altered neural network suppression and impaired balance. This mechanism may underlie an ineffective attention shifting ability towards important sensory information related to balance. Ongoing research using data-driven fMRI analysis will extend our findings to the role of anticorrelated whole brain functional networks in balance control and executive cognitive function.

P3-K-57 Anxiety-related changes in the conscious control of gait

William Young[1], Mark Williams[1]

[1]Brunel University

BACKGROUND AND AIM: Every year, 30-60% of older adults fall. Most display anxiety about falling again. Fall-related anxiety causes profound changes in control of posture and gait (e.g., postural stiffening, less efficient gaze behaviours (Young et al., 2012; Young & Hollands, 2013)). Fearful of falling again, older adults may consciously control their movements (Huffman et al., 2009). Consequently, cognitive resources are diverted away from external factors and the automaticity of well-practiced movements, such as walking, can be disrupted, which raises fall risk. There are various theories describing the manner in which conscious control of movement can be achieved. The most prominent theory suggests that anxious individuals will 'reinvest' cognitive effort towards controlling their actions by reverting to explicit (declarative) cues used at the onset of skill learning (Masters & Maxwell, 2008). However, the literature surrounding the theory of reinvestment is built on evaluating performance of ontogenetic

skills (skills learned using explicit performance cues). Gait, however, is a largely implicit and phylogenetic skill, learned in the relative absence of declarative, verbal rules. Therefore, it is inappropriate to conceptualise anxiety-related tendencies to consciously control posture and gait as 'reinvestment'. Instead, it is likely that older adults with falls-related anxiety will start to 'over-think' their movements, and new explicit cues for movement are formed. METHODS: The purpose of the current project was to examine explicit cues for movement in 40 older adults and to identify whether relationships exist between such self-generated explicit cues, state anxiety, and self-reported reinvestment. We also asked each participant to perform an adaptive gait task; stepping over a series of obstacles along a 7 meter walkway. Each participant performed the walking task 20 times. Gait parameters (gait velocity and double support time) were measured using a GaitRite walkway. RESULTS: Results show clear evidence for a relationship between self-reported state anxiety, reinvestment, and the reporting of declarative movement cues. The declaration of movement cues corresponded to gait parameters that might be considered 'stiffening', such as increased double support time. CONCLUSIONS: The presence of emergent movement cues leads us to conclude that the increased conscious control of movement cannot be described as 'reinvestment', but rather 'investment' in to newly generated movement rules that predicate exclusively conservative movement strategies. With respect to developing therapeutic tool to reduce fall-risk and promote automatic/implicit movement control processes in older adults, these result are very encouraging as it is likely that recently formed cognitive strategies are more susceptible to intervention compared to explicit rules leaned in the early stages of skill acquisition.

P3-L-58 Influence of proprioceptive vibrations on postural strategies for stroke patients: a hemispheric dependence

Noémie DUCLOS[1], Luc MAYNARD[2], Djawad ABBAS[2], Serge MESURE[1]

[1]Institut of Movement Sciences, [2]CRF Valmante

Background and Aim: Postural control is one of the most difficult tasks for stroke patients. It's the result of the perturbed elaboration of their spatial referential and a difficult to correctly interpret and use the sensory sources of information. These troubles should be exacerbated depending on the affected hemisphere. These observations lead to talk about a right "postural" hemisphere. Our main hypothesis was that this predominance is mostly based on a particular sensorial sensitivity. Studies have showed a specific recruitment of right brain areas in response to Ia fibers activation. Our objective was to determine the proprioceptive weight in the postural control, depending on the right hemisphere is affected or not. Methods: We applied bilateral Achilles or Peroneus tendon vibration (20 seconds, 80Hz) to stroke patients with a right cerebral hemispheric lesion (RCH lesion, n=8) or a left one (LCH lesion, n=11) and to a control group (n=15). They were asked to staying as stable as possible, in standing position, without vision. Standard posturographic parameters were computed (Y [antero-post.] and X [medio-lat.] positions of the Center Of Pressure; covered length; and their evolution along time). Statistic analyze was realized through a repeated measures ANOVA Results: All groups showed similar amplitudes in the resulting Y displacement, in both Achilles and Peroneus condition, in backward position. The bilateral application induced no X displacement, except for the group with LCH lesion in Achilles condition. Its displacement was similar to what we could expect after vibration of the non-affected limb only. All vibrations resulted in an increased covered length. Patients with RCH lesion was always the most instable group (initially, during and after vibration). We noted that their instability increased during a more important time during vibration and was longer to decrease, particularly along

the X axis. However, when we calculated the percentage of increase, patients with LCH lesion showed the most important increase of instability induced by vibration. Conclusions: When the left hemisphere is affected (LCH lesion), the postural reaction along X axis is built as if only the right hemisphere integrated the proprioceptive inputs. Here, with the right hemisphere non-affected, it is the most sensitive situation to the proprioceptive perturbation (through percentage of increased length). In the other side, when the right hemisphere is affected (RCH lesion), the proprioceptive inputs are still integrated but resulting in a maladjusted stability. The left hemisphere can't compensate this instability. We concluded to a proprioceptive sensitivity of the right hemisphere in postural situation. Organizational strategies of postural reaction differ, considering the stimulated hemisphere as well as the adaptive responses related to the disturbance (effects and post-efects).

P3-L-59 Complex muscle vibration patterns to induce gait-like lower limb movements: A proof of concept in healthy and neurologically affected participants

Cyril Duclos[1], Claire Kemlin[2], Dany Gagnon[1], Joseph-Omer Dyer[1]

[1]Université de Montréal, School of rehabilitation, [2]Centre for Interdisciplinary Research in Rehabilitation (CRIR-IRGLM)

Background and aim: Muscle vibrations induce illusions of movement, motor responses and cerebral activity similar to voluntary contraction. It could therefore be possible to induce complex gait-like illusions and movements by applying vibrations appropriately. However, it requires the application of multiple fast alternating vibrations to lower limb muscles. Our objectives were to test the feasibility to deliver complex vibrations in a time-organized manner and to determine whether the application of such a vibration pattern can induce gait-like movements among healthy and neurologically affected participants in a relaxed standing position. Methods: Patterns of vibration, produced by twelve vibrators applied bilaterally on the flexor and extensor muscle groups of the lower limbs, were based on normal gait kinematics. One-second- and 2-second-cycle patterns of vibration were tested. Vibrator responses were assessed using auto- and cross-correlations and frequency analyses based on accelerometry measurements, and compared between patterns. These complex vibrations were then tested in four healthy participants, three persons with subacute hemiparesis due to stroke (Chedoke McMaster Stroke assessment (/7): leg [3-6], foot [2-4]), and one with chronic spinal cord injured (AIS B, T12). The subjects were supported by a body weight support system. Lower-limb kinematic data were recorded using a NDI Certus motion capture system. The amplitude and period of cyclic movements induced by the vibrations were analyzed at the knees and hips with descriptive statistics. Results: High auto- (>.8) and cross-correlation (>.6) coefficients demonstrated a good response of the vibrators to the control signal. Alternated movements of flexion and extension at the knees and hips were measured in response to the applied vibrations, with small amplitude (1.2±1.5° to 4.9±8.8°) and periods corresponding to 1- and 2-seconds gait cycles for more than 80% of cycles recorded, with some variability between participants, that did not seem link to sensorimotor deficits. Conclusion: Electromechanical vibrators can deliver complex cyclical vibrations and trigger gait-like lower limb movements. The application of a complex pattern of vibration can trigger rhythmic movements of small amplitude in the absence of voluntary command in healthy and neurologically impaired subjects. It could provide a means of early and intensive rehabilitation training in this population.

P3-L-60 Immediate effects of anterior weight shift training on muscle coactivation during gait in adults with hemiplegia after stroke

Ryosuke Kitatani[1], Koji Ohata[1], Kaoru Sakuma[1], Yumi Aga[1], Natsuki Yamakami[1], Yu Hashiguchi[1], Sayuri Osako[1], Shigehito Yamada[1]

[1]Kyoto University

BACKGROUND AND AIM: Postural control ability is strongly related to gait function, and then balance training is found to improve gait function in adults after stroke. For these adults, muscle coactivation during gait is a compensation strategy to enhance postural stability. Therefore, decrease in muscle coactivation after balance training might efficiently improve postural control ability. However, the effects of balance training on muscle coactivation in adults after stroke remains unclear. This study aimed to investigate the immediate effects of balance training on muscle coactivation during gait in adults with hemiplegia after stroke. METHODS: Seventeen community-dwelling subjects with chronic hemiplegia after stroke participated in this study. Adults after stroke have reported that shifting weight was more challenging in the forward direction than in the lateral direction on the paretic side. Therefore, balance training was performed with anterior weight shifting while standing bilaterally. The subjects stood quietly for 5-sec, and were then encouraged to shift as much weight anteriorly as possible and maintain this forced position for 5-sec. This protocol was repeated 5 times with 1-min resting periods for each training session. Four sessions were conducted, for a total of 20 weight shifts. The subjects performed the 10-m walking test before and after training. Electromyography signals were bilaterally recorded at the tibialis anterior (TA) and lateral gastrocnemius (LG) muscles during gait. The coactivation index (CoI) was calculated on the paretic and non-paretic sides for the following sub-phases of the stance phase: first and second double support (DS1 and DS2) and single support (SS). Before and after training gait speed, muscle activities, and CoI in each sub-phase on both sides were compared. RESULTS: Gait speed was found to be significantly increased after training ($p < 0.05$). On the paretic side, the TA muscle activity after training was found to be significantly decreased during all sub-phases (DS1, $p < 0.05$; SS and DS2, $p < 0.01$), whereas the LG muscle activity was not significantly different. The CoI during the SS phase on the paretic side after training was found to be significantly decreased ($p < 0.05$). On the non-paretic side, there were no significant differences in the muscle activities and CoI before and after training. CONCLUSIONS: The anterior weight shift and SS phase during gait involve a forward movement of the center of pressure, which requires increased plantarflexor torque at the ankle joint to stabilize posture. In this phase, the TA muscle activity does not generally occur because it acts as an antagonist muscle. Therefore, the results of the present study indicated that anterior weight shift training could decrease the antagonist muscle coactivity, thereby improving gait in adults after stroke.

P3-L-61 Acute and short-term changes in serum BDNF concentration following treadmill-based exercise in people with motor-incomplete SCI

Tania Lam[1], Zhen Chen[1], Mohamed Sayed-Ahmed[2], Abdulaziz Al-Yahya[2]

[1]University of British Columbia, [2]King Saud University

Background and Aim: Body-weight supported treadmill training (BWSTT) is a rehabilitation exercise intervention for improving walking in people with spinal cord injury (SCI). There is evidence from animal studies that intensive physical training, such as that found during BWSTT, can enhance the endogenous expression of biomarkers of neuroplasticity, such as brain-derived neurotrophic factor (BDNF). In

humans, BDNF concentration in the peripheral circulation provides an estimate of its expression in the brain. Previous studies have shown that serum BDNF concentration is modulated with exercise in humans, but we know very little about how exercise-based rehabilitation approaches affect BDNF levels in people with SCI. Thus, the aim of this study was to evaluate how rehabilitation training parameters affect serum BDNF concentration in people with SCI. Methods: Twenty individuals with motor-incomplete SCI (>12 months post-injury) and 20 age- and gender-matched able-bodied control subjects participated in this study. All subjects underwent a 1-week training protocol. Subjects were stratified according to their self-reported level of physical activity, and categorized as sedentary or active. They were then randomized to perform 30-min BWSTT sessions either every day (5X/week) or every other day (3X/week). Training was implemented on a treadmill, with SCI subjects using the Lokomat. During training, we monitored the subjects' rating of perceived exertion (RPE) using the Borg CR10 Scale. This was used to control for the intensity of exercise across subjects and to increase or decrease the treadmill speed as needed. The target RPE was 2-3 after 10 min; 4-5 at the 20-min mark; and finally an RPE of 6 by the end of training. (Subjects were not informed of these criteria for monitoring their training intensity.) Blood samples were taken from the ante-cubital vein immediately before and after the training on Day 1 and Day 5. Plasma levels of BDNF were estimated using commercially available kits. Results: There were no differences in RPE during training across subjects, indicating that we were able to control for exercise intensity. Resting concentrations of BDNF measured on Day 1 tended to be higher in the control subjects (M=13.5 ng/mL, SD: 12.6) compared to the SCI subjects (M=9.4 ng/mL, SD: 6.2), but this difference was not significant. Both groups tended to show increased BDNF concentration immediately after training. There was no significant effect of training frequency (3X/week vs. 5X/week) on the change in BDNF concentration by Day 5 in either subject group. Conclusion: The results of this study indicate treadmill-based gait training may lead to increases in serum BDNF concentration in some individuals. Further work is planned to understand the changes in BDNF concentration over the longer-term course of rehabilitation programs. These results will help in determining the optimal parameters of rehabilitation training protocols.

P3-L-62 Anticipatory postural adjustments and step execution during gait initiation in water: A pilot study

Andresa Marinho-Buzelli[1], Ana Barela[2], Jose Angelo Barela[2], Melissa Celestino[2], Milos Popovic[1], Mary Verrier[1]

[1]University of Toronto, [2]Cruzeiro do Sul University

BACKGROUND AND AIM: Adequate postural responses during step initiation are a primary goal during steady-state gait training. Aquatic physical therapy is often used to facilitate step initiation and walking in individuals with insufficient postural control. It has been reported that the aquatic medium seems promising to stimulate more continuous activity of postural muscles due to water resistance. Buoyant force may assist weight-transfer during step initiation while water resistance may promote a slower execution of movement potentially facilitating the control of the initial step. The aim of the present study was to investigate how immersion in water changes anticipatory postural adjustments (APAs) and the execution of the initial step when able-bodied subjects walk in water in comparison to their performance on dry land. METHODS: Seven female able-bodied individuals were requested to stand on an AMTI waterproof force plate in water and on dry land. Initial foot position was self-selected and maintained in all trials. Arm position was maintained at approximately 90 degrees of elbow flexion

during trials in both conditions. Percentage of body mass (BM) offloading in water was calculated during quiet standing. Step initiation was triggered by an auditory cue for both conditions and participants were asked to start gait at a self-selected speed and to continue walking for 4 steps focusing on a target at a 3-m distance. Five trials of gait initiation were utilized for analyses. Center of pressure (COP) trajectory during APAs was divided into three sections: S1, S2, and S3 (Hass et al., 2008). To capture spatio-temporal parameters and joint angles of the first step in the sagittal plane, markers were placed on the bony landmarks of the initial swing limb. RESULTS: Age, height, BM and percentage of BM offloading of all participants ranged from 22 to 54 years, 151 to 167 cm, 55 to 70 kg, and 55% to 69%, respectively. Percentage of BM offloading was negatively correlated with height ($r= -0.84$, $P<0.05$). In S1, displacement and velocity of COP in the ML direction were significantly increased in water compared to dry land ($P<0.05$). Displacement in ML direction and duration of S2, when COP moved laterally towards the stance limb, increased during performance in water in comparison to on dry land ($P<0.05$). S3, the anterior shift of the COP, was significantly slower ($P<0.05$) and longer ($P<0.05$) in water compared to dry land. Step duration increased by 37.7% ($P<0.001$) while step velocity decreased by 42% ($P<0.01$) in water. Ankle range of motion (ROM) of the swing limb increased by 45% ($P<0.05$) while knee ROM did not change in water. CONCLUSIONS: The aquatic medium significantly increased ML COP displacement, step duration and ankle ROM during initial step. Future studies to replicate the findings in a larger sample are warranted to determine if they are consistent in individuals with sensorimotor deficits and applicable for rehabilitation.

P3-L-63 The effect of restricting arm movements on walking speed in children with Cerebral Palsy and Typically Developing children

Pieter Meyns[1], Wouter Hoogkamer[1], Sjoerd Bruijn[2], Kaat Desloovere[1], Jacques Duysens[1]

[1]KU Leuven, [2]VU University Amsterdam

BACKGROUND AND AIM: In children with Cerebral Palsy (CP) abnormal motor behavior is a core feature [1]. Persistent motor impairments, such as abnormal limb strength, control, and/or muscle tone, result in pathological gait in many children with CP. Previous descriptive studies have indicated the possible compensatory role of the altered arm movements in CP gait [2-4]. One function of arm swing during gait is to assist gait balance [5]. To assess whether arm movements have a functional role during CP gait, the effect of having the arms free or restricted to swing on walking speed is evaluated in hemiplegic (HEc) and diplegic (DIc) children with CP, and compared to typically developing children (TDc). It was hypothesized that arm restriction would decrease walking speed in CP, in particular in the most unstable CP group. METHODS: Participants included 11 spastic HEc, 14 spastic DIc and 24 TDc (4-12yr). Participants were asked to walk either with the arms free or with the arms crossed over the abdomen. Total body kinematics were recorded during preferred and fast walking. A repeated measures ANOVA was used with Group as a factor, and Arm condition as a repeated measures factor. Tukey's post hoc comparisons were systematically applied ($\alpha=0.05$). RESULTS: Crossing the arms significantly decreased walking speed (main effect of Arm; free 1.41±0.43m/s vs crossed 1.37±0.37, $p<0.001$). DIc walked significantly slower compared to TDc (1.13±0.44 vs 1.58±0.43, $p<0.001$), while HEc did not (1.34±0.33, $p=0.08$; main effect of Group, $p=0.002$). The interaction effect of Arm*Group ($p=0.024$) indicated that both DIc (free 1.17±0.41 vs crossed 1.09±0.48, $p=0.008$) and HEc (1.38±0.33 vs 1.30±0.33, $p=0.05$) showed a higher decrease in walking speed when they crossed the arms over the abdomen compared to TDc (1.58±0.43 vs 1.58±0.43). CONCLUSIONS: When during gait the arms are unable to move freely,

children with CP significantly reduced their walking speed, while TDc did not. These results clearly show that children with CP (especially DIc) experience adverse effects on the gait pattern when arm movements are restricted, indicating that the arms play a functional role in the gait pattern of both DIc and HEc. The relation between arm movements and step width and angular momentum during unperturbed walking in children with CP described in previous research [2-5], indicate that altered arm movements in CP are related to balance. This suggestion is supported by the current results since DIc experienced a higher adverse effect of arm restriction, and they are expected to have more involved balance problems due to bilateral lower limb impairment (while this is less the case in HEc). Acknowledgements: PM was supported by BOF (PDMK/12/180) and FWO (G.0901.11). References: 1. Bax M et al. Dev Med Child Neurol 2005 2. Meyns P et al. Res Dev Disabil 2011 3. Bruijn et al. Res Dev Disabil 2011 4. Meyns P et al. Eur J Paediatr Neurol 2012 5. Meyns P et al. Gait Posture 2013

P3-L-64 Aftereffect of a new robot-assisted gait training on kinematics and kinetics during walking in individuals after stroke

Koji Ohata[1], Aki Watanabe[2], Hideaki Takahashi[3], Noriaki Ichihashi[1]

[1]Graduate school of Medicine, Kyoto University, [2]Yufuin Kosenenkin Hp., [3]Honda R&D

Background and aim: To facilitate gait training for patients after stroke, many robot-assisted gait devise have been developed. In previous study, patients who receive robot -assisted gait training in combination with physiotherapy after stroke are more likely to achieve independent walking than patients receiving gait training without these devices. However, there were few studies reported whether robotic-assisted gait training improved kinematic and kinetic gait parameters in hemiparetic patients. The aim of this study was to identify the effects of the new robot -assisted device named "Stride Management Assist Device" (SMA, Honda R & D Co. Ltd, Japan) on kinematic and kinetic gait parameters during walking in individuals after stroke. 2) Methods: Twenty-four individuals (18male, 6 female, mean age: 61.1±11.5 years) with hemiplegia after stroke were participated in this study. SMA is an automated stride assistance system which applied robotic engineering to controlling walk ratios (stride length/cadence) and adding supporting power to the thigh during walking. The SMA assists both flexion and extension of the hip joints in a ballistic manner by means of electrical actuators. All participants were assessed using 3D gait analysis system (VICOM) before (baseline trial), during (SMA trial), and immediately after (aftereffect trial) walking with the SMA on a 5m walkway at a self-selected comfortable speed. Peak values of hip kinematics and kinetics on paretic side were measured during gait in three conditions. The difference of hip peak angles and peak moments during gait cycle were assessed using repeated measures ANOVA. Then, the amounts of difference between baseline and SMA or aftereffect trials were calculated and the relationships estimated using Pearson's correlation coefficient. A significance level of $p < 0.05$ was used. 3) Results: The peak hip extension angle during terminal stance phase was significantly increased in aftereffect trial than in other trials ($p<0.01$). The peak hip extension moment during loading response phase was also increased in aftereffect trial than in other trials ($p=0.05$). Significant relationships between the change induced by using SMA and the change as aftereffect were shown in the peak hip extension, flexion angle and peak hip flexion moment during gait cycle. Conclusion: The SMA can increase the peak hip extension angle that impaired in individuals after stroke. The hip kinematic and kinetic changes induced by using SMA were remained as aftereffect.

P3-L-65 Changes in gait in adults with chronic hemiparesis after balance training on a mobile mechanized surface while gaming

M Ann Reinthal[1], Debbie Espy[1]

[1]Cleveland State University

Background and Aims: Balance deficits are common post central nervous system insult, limiting the ability to regain normal function, and especially adversely affecting gait. Improving balance has a positive impact on gait, but requires a large number of practice repetitions. This pilot study examined the impact on gait speed and sagittal plane kinetics of using a mechanized balance system concurrently with video gaming to provide large quantities of repetitive task practice to train balance among people with chronic hemiplegia and a history of falls. Methods: Five adults with chronic hemiplegia secondary to stroke and traumatic brain injury participated in this repeated measures case series. Pre- and post-assessment included three-dimensional kinetic and kinematic gait analyses. Participants trained from 10 to 12 sessions for a total of six to 10 hours on a round, mechanized tilting balance platform (Proprio 5000, Perry Dynamics, Decatur, IL) while concurrently playing Wii video games that further challenged their balance. The platform moved at a predictable velocity, direction, and magnitude of motion for four-minute increments after which the training parameters were varied. Participants trained from 22,000 to 36,000 repetitions of platform tilt. Data were analyzed with SPSS using paired t-tests and a Pearson product moment correlation. Results: Overall, gait speed did not change significantly pre- to post-intervention. Hip extension power generation (H1) in early stance phase immediately after foot contact was the only significant change ($P = 0.047$) in lower extremity sagittal plane kinetics. Changes in H1 hip power correlated ($r = 0.945$) with pre-intervention gait speed. H1 hip power did not change in the one individual who was not an independent ambulator and who walked using an assistive gait device. The only individual whose gait speed increased post-intervention (from 76 to 92 cm/sec) was also the only individual whose A2 ankle power at push-off increased (from 0.4 to 0.8 W/kg). Conclusions: While gait speed did not change, H1 hip power improved during walking after the balance intervention in this group of individuals with chronic hemiplegia. The balance training protocol is unique in several ways. It is very challenging because of the simultaneous demands of playing active video games while concurrently staying upright on the externally paced mechanized mobile surface. Also, the surface tilts require use of both ankle and hip strategies. Finally, the surface provides a large amount of repetitive practice during the engaging gaming activity. The task parameters for the gaming particularly necessitate control of the head and trunk segments for accurate arm motion. The improvements in H1 hip power during gait may be due to both increased practice with use of hip extension during balance tasks as well as substantial head arm and trunk (HAT) control practice during dynamic lower extremity activities.

P3-L-66 Low-level laser therapy as a possible resource to improve muscle regeneration in aged rats

Natalia Rodrigues[1], Fatma Vatansever[1], Livia Assis[2], Sabrina Peviani[3], Joao Durigan[4], Fernando Moreira[3], Michael Hamblin[5], Nivaldo Parizotto[3]

[1]University of Sao Paulo, [2]Federal University of Sao Paulo, [3]Federal University of Sao Carlos, [4]University of Brasilia, [5]HAVARD University

Background and aim: With increasing age, there is a decline of skeletal muscle system, what can interfere on daily activity and quality of life of elderly. Sarcopenia, changes in central and peripheral nervous system, blood hypoperfusion, regenerative changes contributing to atrophy, and muscle weakness are some of the skeletal muscle problems during aging. Determination, proliferation and differentiation of satellite cells in the regenerative process and/or skeletal muscle hypertrophy are essential to form new muscle fibers and it is regulated by specific transcription factors, known as myogenic regulatory factors (MRFs). In the elderly, the activation of MRFs is inefficient which impair the muscle regenerative process. Recent studies found that low-level laser therapy (LLLT) has a stimulatory effect in the muscle regeneration process. However, the effects of this therapy when associated with aging are still unknown. There with, the aim of this study was to evaluate the effects of LLLT (830 nm) on the tibialis anterior (TA) muscle of aged rats. Methods: 42 male Wistar rats was used to form two groups: old rats group (n=21; 10 months of age) and young rats group (n=21; 3 month of age). Each of group was randomly divided into three groups of young rats (n=7) and three groups of aged rats (n=7). These groups were submitted to cryoinjury laser irradiation, cryoinjury only and control group (no cryoinjury/no laser irradiation). The laser treatment was performed for 5 consecutive days. The first laser application was done 24 h after the injury (on day 2) and on the seventh day, the TA muscle was dissected and removed under anesthesia. After this the animals were euthanized. Histological analyses with toluidine blue as well as hematoxylin-eosin staining (for counting the blood capillaries) were performed for the lesion areas. In addition, MyoD and VEGF mRNA was assessed by quantitative polymerase chain reaction. Results: The results showed significant elevation ($p<0.05$) in MyoD and VEGF genes expression levels. Moreover, capillary blood count had an improvement in elderly laser group when compared to young animals. Conclusion: In conclusion, LLLT increased the maturation of satellite cells into myoblasts and myotubes, enhancing the regenerative process of aged rats irradiated with laser.

P3-M-67 Adaptations to Reduced Ankle Motion during Level & Obstacle Walking

Jonathan Singer[1], Eoghan Landy[2], Stephen Prentice[2]

[1]Sunnybrook Research Institute, [2]University of Waterloo

BACKGROUND AND AIM: A great deal of research exists on the adaptive strategies of individuals affected by neuromuscular disorders, which alter gait. Such strategies, however, are often difficult to interpret because of associated pathologies. The role of the ankle in healthy gait is to generate a "push-off" force to create forward propulsion of the body (Winter, 2009). The purpose of this work was to identify adaptation patterns and compensation strategies in healthy individuals, while wearing a device that reduces ankle motion and "push-off" power (Ankle Motion Minimizer-AMM).
METHODS:Participants performed two walking conditions: level walking trials and obstacle avoidance trials, in which a 30cm obstacle was placed midway in the swing phase of the ipsilateral limb. Walking trials were divided amonst 4 AMM conditions: NORM (free ankle motion), IPSI (AMM on right limb), CONTRA (AMM on left limb) & BI (AMM on both limbs). Motion capture and force plate data were collected to determine the lower body kinematics, joint moments and joint powers. Walking velocity, kinematic and kinetic discrete measures were identified. Each variable for each condition was analysed with a single factor Repeated Measures ANOVA with an alpha level of 0.05. RESULTS: Firstly there were no significant differences in walking velocity across the AMM conditions. Participants did exhibit a decreased range of motion and power production at the ipsilateral ankle, which was also apparent in

the bilateral condition in both the level and obstructed conditions. The joint moment of the ipsilateral ankle was strikingly similar in phasing and magnitue to normal. The notable significant changes were witnessed in the work performed during the prominent power burst of the knee and hip joint. The knee action is primarily absorptive - significant increases in both Level and Obstructed conditions in Uni- & Billiateral trials were observed. The lost ankle propulsion with AMM may have been compensated with increases in the pull-off work performed at the hip (H3) during Uni- & Billiateral conditions. Strikingly the work during the knee burst responsible for the added knee flexion that appeared only during Obstructed trials (K5) was unchanged by the AMM conditions. There may also be some contribution from the contralateral limb to compensate for AMM conditions. CONCLUSION: When individuals were unable to produce power through the ankle joint, they acted to increase power propulsion via contributions from both ipsi- and contralateral limbs. Specifically, hip actions during pull off (H3 power); although increases in knee action were also seen. Much of this was absorptive, dependent on segmental dynamics and specific intersubject variations. It was clear that the control of these tasks exhibits exceptional plasticity and accomplishment when contributions of an individual joint was comprimized and limited its function. Winter, D.A. (2009) Biomechanics and Motor Control of Human Movement 4th Ed

P3-M-68 Mechanisms of Motor Adaptation in Reactive Balance Control

Lena Ting[1], Torrence Welch[2]

[1]Emory University and Georgia Tech, [2]Rimkus Consulting

BACKGROUND AND AIM: Reactive balance control must be rapidly modified to provide stability in the face of environmental challenges. However, only anticipatory postural adjustments preceding voluntary movements have been studied in the framework of motor adaptation and learning theory. In motor adaptation experiments, changes in motor control are observed over repeated trials of the same movement in a training set, an experimental set where a novel environmental perturbation such as a visuomotor rotation is introduced, and then a washout set identical to the training set. Adaptation is characterized by a change in a motor variable from the beginning to the end of each set, large errors in the novel environment, the presence of aftereffects at the beginning of washout when the novel perturbation is removed, and a return at the end of washout to a level comparable to the end of training. Here, we examined whether motor adaptation occurs in task-level balance control. We hypothesized that adaptation occurs in task-level balance control during responses to perturbations due to central changes in the control of both anticipatory and reactive components of balance. METHODS: Our adaptation paradigm consisted of a Training set of 30 forward support-surface perturbations, a Reversal set of 60 novel countermanding perturbations that reversed direction, and a Washout set identical to the Training set. Electromyographic (EMG) and kinematic data were collected on 15 healthy subjects (8M, 7F; 22.5 ± 3.2 years). We examined modifications to task-level balance by computing peak CoM displacement and velocity in each trial. We examined anticipatory postural control by measuring initial postural lean and background EMG. Reactive balance was evaluated using EMG latencies and amplitudes. In addition, we identified changes in the sensorimotor transformation between the induced CoM kinematics and the subsequent EMG response. The parameters of the sensorimotor transformation identify the central sensitivity to perturbation independent of the stimulus magnitude. RESULTS: Task-level balance performance showed adaptive changes with repetitive trials. All subjects took reactive steps at the beginning of both Reversal and Washout, with CoM displacement and velocity then decreasing as subjects transitioned to hip and ankle strategies. Only small changes in anticipatory

postural control, characterized by body lean and background muscle activity, were observed. Adaptation was found in the evoked long-latency muscular response and also in the sensorimotor transformation mediating that response. Finally, in each set, temporal patterns of muscle activity converged towards an optimum predicted by a trade-off between maximizing motor performance and minimizing muscle activity. CONCLUSIONS: Our results suggest that adaptation in balance, as well as other motor tasks, is mediated by altering central sensitivity to perturbations and may be driven by energetic considerations.

P3-N-69 The Effect of Robot-Assisted Gait Training on Chronic Stroke Survivor - A Case Report

Chien-Hung Lai[1], Chih-Chao Hsu[2], Shih-Ching Chen[1], Jiunn-Horng Kang[1], Chih-Wei Peng[1], Su-Hsien Lin[2]

[1]Taipei Medical University and Hospital, [2]Taipei Medical University Hospital

BACKGROUND AND AIM: Stroke is one of the most common cause of walking disability. Although several rehabilitation centers have begun to incorporate robot-assisted gait training (RAGT) into daily treatment schedule, the effect of RAGT has remained controversial. We examined the effect of RAGT on a chronic stroke survivor with severe motor impairment of lower limbs. METHODS: A 48-year-old male has suffered from stroke 31 months ago and has undergone intensively traditional rehabilitation for more than 30 months before RAGT. This patient underwent RAGT and traditional rehabilitation 30 min/time each, 3 times a week for 3 months. The Short Form 36 (SF36), Mini-Mental Status Examination (MMSE), Brunnstrom stage, Berg Balance Test (BBT), Functional Ambulation Classification (FAC), Motricity Index (MI), Modified Ashworth Scale (MAS), Barthel Index and Resting Metabolic Rate (RMR) were assessed before and after 3-month training. RESULTS: The SF36, MMSE, Brunnstrom stage, BBT, FAC, MAS, Barthel index and RMR showed improvement after 3-month training. CONCLUSIONS: The findings show that RAGT cooperated into traditional rehabilitation may enhance the clinical outcome in locomotion ability in chronic stroke survivor with severe impairment of lower limbs. However, a large and randomized study is necessary to verify our results.

P3-N-70 Effect of auditory cues on the fractal dynamics of human gait during treadmill walking

Kei Masani[1], Hossein Rouhani[2], Masaki Abe[3], Kimitaka Nakazawa[3], Daichi Nozaki[3]

[1]Toronto Rehabilitation Institute - UHN, [2]Toronto Rehabilitation Institute, [3]University of Tokyo

BACKGROUND AND AIM: Stride interval fluctuation during walking has unique dynamics called long-range correlation or fractal dynamics. With rhythmic auditory cues, such as metronome sounds, the fractal dynamics disappear. However, the effect of auditory cue on fractal dynamics of human gait is not conclusive and has been intensively studied, especially on the standpoint of integration of auditory sensory cues with motor control. The purpose of this study was to quantitatively investigate the dynamics of the stride interval fluctuation during treadmill walking with auditory cues, and to propose a model that would account for its dynamics. METHODS: Ten healthy subjects (18 - 24 yrs) participated in this study. Each subject was requested to walk on a treadmill with his/her natural cadence and speed (natural walking). The average cadence was calculated in the first trial, and then the subject was asked to walk with the same speed while a metronome sound with average cadence was added (metronome walking). Detrended fluctuation analysis (DFA) was performed to examine the fractal dynamics of each gait condition. Agreeing with previous studies, the DFA plot for metronome walking showed a curve at

around a window period of 30 steps. Thus, we calculated the slope of DFA plot before (1st period) and after (2nd period) the window period of 30 steps, separately. Further, we performed a simulation study based on the assumption that stride interval fluctuation during metronome walking is a summation of innate fractal rhythm and an error of the current rhythm from the metronome sound. RESULTS: The alpha value for natural walking was 0.96±0.09, suggesting that natural walking has fractal dynamics even with a constrained speed (i.e., walking on a treadmill), which agrees with previous studies. In contrast, metronome walking showed alpha value of 0.37±0.16 for the entire range, suggesting that long-range correlation disappeared. For metronome walking, the alpha value was 0.56±0.08 and 0.21±0.21 for the 1st and the 2nd periods, respectively. These alpha values were different from each other, indicating that the DFA plot for the metronome walking was curved with a convex shape. In the simulation study, we found that the simulated stride interval fluctuation showed a curved DFA plot very similar to the one in the experiment. This result suggests that fractal dynamics were preserved even during metronome walking while an error correction based on the previous step modifies the stride interval. CONCLUSIONS: We quantified the curved DFA plot for the metronome walking, and we also proposed a model that accounted for the dynamics of metronome walking, which successfully simulated the dynamics of stride interval fluctuation during metronome walking. Further investigation on the model would reveal how the fractal dynamics of human gait occurs and how the auditory cue is integrated in the sensory-motor coordination of human gait.

P3-N-71 Role of muscle coactivation and reaction time in postural perturbation in the elderly

Shinya Ogaya[1], Koutatsu Nagai[2], Yusuke Okita[3], Koji Nonaka[1], Akira Iwata[1], Yumi Higuchi[1], Satoshi Fuchioka[1]

[1]Osaka Prefecture University, [2]Kyoto Tachibana University, [3]Kyoto University

BACKGROUND AND AIM: Muscle coactivation to increase joint stiffness has an advantage to decrease postural perturbation during the time between the onset of postural perturbation and the onset of force generated by the muscles, which is termed as the muscle reaction time. Therefore, coactivation is thought to act effectively when the muscle reaction time is extended. There is no study has investigated the contribution of muscle coactivation and reaction time to postural perturbation. This study aimed to reveal the effect of muscle coactivation and reaction time on postural perturbation by using simulation analysis. METHODS: The study involved 1 healthy elderly woman, aged 65 years, old for capturing an experiment motion data. Two markers were attached on the skin above the greater trochanter and lateral malleolus. The subject stood on a computer-controlled moving platform and was instructed to maintain balance without stepping. The ankle angle was monitored during anterior platform translation (velocity 15 cm/s, amplitude 6 cm). For the simulation part of the study, a simple inverted sagittal pendulum model included with one limb segment and center of mass, the ankle joint, and two muscles (plantar and dorsal flexor) was applied. The model parameters were decided based on data in preceding studies. The dorsal flexor activation level before perturbation (pre-DF activation level) was set to 0%, 20% and 40% of maximum activation and the plantar flexor was activated for maintaining the static standing posture. The postural change after the platform translation was simulated. The muscle reaction time was set to 100 ms, 140 ms, and 180 ms. Muscle activation against perturbation was calculated by using a differential equation based on ankle angle, velocity, and acceleration for muscle activation-excitation dynamics. Optimization was used to determine the formula constant, to calculation the

muscle activation against perturbation, to minimize the square difference between the experimental and the simulation angle trajectories. The effect of pre-DF-activation and reaction time on the postural perturbation was investigated by using the simulation analysis. The perturbation angle, difference between the pre-perturbation and post-perturbation angle, was calculated. RESULTS: The maximum perturbation angles increased with long reaction time and high pre-DF activation level. When the pre-DF activation level increased, the postural perturbation became smaller. The postural perturbation decreased in longer reaction time when the pre-DF activation level was high, however the postural perturbation did not show marked changes during the shorter reaction times when the pre-DF activation level was high. CONCLUSIONS: Muscle coactivation contributes to decreasing the magnitude of postural perturbation. In the case of long reaction time, muscle coactivation is an effective strategy to decrease postural perturbation.

P3-N-72 Comparing two approaches for predicting the balance recovery performances by stepping

Thomas Robert[1], Pascal Vallee[2]

[1]Université de Lyon, [2]Université de Lyon, IFSTTAR/UCBL

BACKGROUND AND AIM: Falls are currently one of the first cause of death among elderly and a major public health issue. Recently, more and more attention has been put on the balance recovery following a perturbation of the equilibrium. In particular several studies suggested that balance recovery performances following a perturbation are good predictors of the risk of falls. Such recovery is a complex process involving various types of actions - or strategies - such as displacement of the centre of pressure within the foot, use of upper body inertia through trunk rotation and stepping. However, despite recent advances, numerical tools able to predict the outcome of a balance perturbation and including these different strategies are still rare and only partially validated. Two recent studies (Koolen et al, Int. J. Robot. Res. 2012 and Aftab et al., Humanoids 2012) seem particularly promising. They both included the three types of reactions but using two different approaches. However, there results were not validated against human experimental data for Koolen et al. and not compared against each other. Thus, the present study proposes to compare prediction results from these two models to the same experimental data from the literature (Hsiao-Wecksler and Robinovitch, Clin. Biomech., 2007). METHODS: Koolen et al. extended the previous "Capture point" or "extended CoM", including multiple steps and non-instantaneous stepping. Assuming that the body behave like an inverted pendulum, their model allow predicting, given an instantaneous state (position and velocity of the center of mass relative to the base of support) and the landing time of the future steps, if the balance can be recovered in n steps. An alternative version is proposed in this study where the step landing time does not need to be specified. Aftab et al. proposed another approach: a mechanical model of the human body is driven by a controller which decides the optimal recovery strategy over a time horizon to bring the model back to its reference state. Both models were used to simulate tether-release experiments of young subjects (Hsiao-Wecksler and Robinovitch, 2007). RESULTS: Model from Aftab et al. was able to accurately predict both the landing time and position of the recovery steps (mean error < 50 ms and 6 cm respectively). Step length and duration predicted using Koolen's et al. model (with impose or free step duration) were systematically shorter. Both models were less efficient in predicting the highest recoverable perturbation. CONCLUSIONS: Results were very encouraging, in particular for the model from Aftab et al. Lower accuracy using model from Koolen et al. may be explained by a strong

dependence of the results to hypothesis that the body behave like a linear inverted pendulum, which is typically not appropriate in tether-release experiment. This would reinforce the interest for the controller approach proposed by Aftab et al.

P3-O-73 Concurrent Reduction in Plantar Cutaneous Sensation and Complexity of Postural Control in People with Multiple Sclerosis

Michael Busa[1], Stephanie Jones[1], Richard Van Emmerik[1]

[1]University of Massachusetts Amherst

BACKGROUND AND AIM: Multiple Sclerosis (MS) is an auto-immune disorder which affects both motor and sensory function via reduced neural conductivity. Poor balance has been reported to impact 90% of those with MS and may result from MS related sensory-motor dysfunction. Entropy analysis allows for the identification of fluctuations in postural control patterns that reflect adaptability of the balance system. In particular, multiscale entropy (MSE) is a measure that examines point-to-point fluctuations in a time series at different temporal scales. The aim of this study was to examine differences in the MSE of the postural Center of Pressure (CoP) between those with and without MS and relate these changes to potential differences in sensory function. We hypothesized that the MS group would exhibit reduced entropy (complexity) as well as reduced plantar sensation, in response to a vibrating stimulus. METHODS: Twelve females with MS and 12 age, height, weight and sex-matched controls completed testing procedures. MS patients exhibited mild-to-moderate physical impairment, as characterized by an Expanded Disability Status Scale score of 4.0 (±1.4). Participants completed sensory assessment under each foot and performed three postural tasks: quiet stance and maximum forward, and backward lean. Sensory function was assessed by measuring the amount of time each subject could feel a vibrating stimulus (128 Hz). All postures were performed with feet parallel, a stance width of 33 cm and eyes open for a duration of 25 s. The net CoP was calculated from data collected from two AMTI force platforms. MSE of the anterior-posterior and medial-lateral CoP positions was obtained over 20 time scales (0.03-0.6s) with an overall complexity index (CI) calculated as the numerical integral across these time scales. Student's t-tests were used to detect significant differences in CI between groups (α=.05) for each timed vibration and postural task. RESULTS: MS patients exhibited a significant reduction the timed vibration under each foot ($P<.05$). The CI in medial-lateral direction of the CoP was also significantly reduced during quiet stance and both postural lean perturbations ($P<.001$). No differences were observed in the CI of anterior-posterior CoP. CONCLUSIONS: MSE analysis revealed decreased complexity in the medial-lateral time series of the CoP in people with MS compared to age- and gender-matched controls during quiet standing and perturbed postures (leans). These results indicate that the concurrent reductions in plantar cutaneous sensation and the complexity of postural control may be related among those with MS. However, the nature of this relationship remains to be explored.

P3-O-74 Impact of a gait-specific feedback strategies during a single session of fast walking training after stroke.

Vincent DePaul[1], Adam Jongsma[1], Gena Matta[1], Avril Mansfield[1], William McIlroy[1]

[1]Toronto Rehabilitation Institute - UHN

BACKGROUND and AIM: Following stroke many individuals demonstrate a decreased ability to walk at fast speeds. Reduced gait velocity is associated with limited community mobility, increased risk for falls,

and disability. The combination of step length and cadence determines one's walking velocity. In healthy adults, velocity increases are proportionally driven by increased step length. Following stroke, step length is reduced and increased velocity is frequently achieved by increasing cadence. This strategy can be inefficient and may reduce the maximal gait speed achieved. Increased velocity and a more typical gait pattern are common therapeutic targets in stroke rehabilitation. During gait training, therapists frequently encourage, instruct and give patients feedback (FB). Despite the liberal use of verbal input, there has been little research on the impact of the different FB strategies on recovery of gait following stroke. The purpose of this study is to evaluate the impact of a single session of fast walking training, and to compare the impact of two types of FB on gait velocity, and cadence-to-step length ratio in individuals with history of stroke. METHODS: Randomized controlled study with blinded outcome assessment. Participants: 20 community dwelling individuals with chronic unilateral stroke. All participants underwent a single session of fast walking training. During training each participant performed approximately 30 short (9 m) walks at their maximal self-selected velocity over the GAITRite mat. Practice was distributed over 5 blocks of approximately 3 walks. Prior to beginning each block of walking, participants in the control group received FB regarding their gait speed while those in the experimental group received FB regarding their step length. Outcomes: Impact of FB conditions on gait velocity, step length, cadence, and cadence-to-step length ratio were assessed during immediate retention (day 1), and delayed retention testing (1-3 days post-training) using the GAITRite system. Measures were taken at maximal pace, comfortable pace, and maximal pace with a concurrent cognitive task. RESULTS: On initial analysis (n=3), all participants increased maximal gait velocity (+17.6%) following training. Gait velocity remained increased at delayed retention testing (+10%). Participants who received gait speed FB increased velocity through increased cadence and increased (+ 7.3%) their cadence-to-step length ratio. Participants who received step length FB reduced their cadence-to-step length ratio at immediate (-34%) and delayed retention (-7.4 %). CONCLUSIONS: In this group of individuals with chronic stroke, a single session of repetitive, fast walking training with FB was associated with substantial increases in maximal gait velocity. In addition, early evidence indicates that individuals receiving step-length FB learn to increase velocity with increased step-length rather than cadence.

P3-O-75 Electroencephalography in Parkinson's Disease Patients with Freezing of Gait while Stepping in Place

Conor Fearon[1], Saskia Wachter[2], Niamh McDevitt[2], Elaine Harrington[1], John Butler[2], Timothy Lynch[1], Richard Reilly[2]

[1]Dublin Neurological Institute, [2]Trinity Centre for Bioengineering

BACKGROUND AND AIM: Freezing of gait, the inability to produce effective stepping, affects up to 60% of patients with advanced parkinsonism and is associated with falls, injury and death. Freezing of gait is difficult to reproduce experimentally because of its unpredictability. Virtual reality environments are useful in precipitating freezing experimentally and are a promising model for study of this paroxysmal phenomenon. Few studies investigating electroencephalography in freezing of gait exist. We aim to use a virtual reality paradigm in patients with freezing of gait to explore P300 event-related potentials using an oddball task while stepping in place. METHODS: We recruited a cohort of patients with Parkinson's Disease with and without freezing of gait from the Movement Disorder clinic at the Dublin Neurological Institute at the Mater Misericordiae University Hospital. Participants navigated through a virtual reality

environment by stepping in place on a Nintendo Wii balance board while performing a two-stimulus oddball dual task. Synchronous sixty-four channel EEG was captured using a Biosemi Active Two data acquisition system and P300 event related potentials were recorded. Temporal gait parameters, including freezing episodes were collected and number of dual task errors was also recorded. RESULTS: We present results of ambulatory EEG data collected during a virtual reality dual task while participants step in place on a balance board. 85 discrete motor arrests occurred during the virtual reality task. Using this system, it was possible to automatically detect freezing episodes and collect temporal gait parameters. There was no significant difference in stride time or gait asymmetry between freezers and non-freezers (0.98 v 1.09 and 0.40 v 0.36, respectively). There was a significant difference between groups in gait rhythmicity (24.85 v 16.87). The ability to detect P300 was not influenced by whether the patient was sitting, standing or stepping in place. P300. Differences in P300 amplitude and latency between groups as well as differences in dual task performance are presented. Although there was no significant difference between groups in P300 amplitude and latency, the FOG group made more errors on the dual task and had a significantly longer reaction time. CONCLUSION: We have constructed a virtual reality paradigm that reliably provokes freezing of gait episodes while patients step in place. This system allows automatic detection of freezing episodes as well as collection of temporal gait parameters. By combining this paradigm with an oddball dual task we can investigate P300 event related potentials, allowing us to probe attentional responses and context updating as well as detecting cortical responses during episodes of freezing of gait.

P3-O-76 Progression of gait dysfunction in incident Parkinson's disease over 18 months

Brook Galna[1], Sue Lord[1], David Burn[1], Lynn Rochester[1]

[1]Newcastle University

Background and aim: Gait disturbance is a cardinal feature of Parkinson's disease (PD) and a significant cause of disability. Our earlier analysis of a large incident cohort of PD (ICICLE-PD) showed impairments across multiple domains of gait. Measurement of gait has potential utility for understanding the evolution of PD from the prodromal state through to advanced disease, however there have been no detailed longitudinal studies describing the progression of gait dysfunction in early PD. This study takes a systematic and comprehensive approach to describe changes to gait over the first 18 months in incident PD. Methods: 121 people with idiopathic PD were tested within four months of diagnosis and 18 months later. We measured 16 gait variables categorised into five independent domains: Pace (step velocity and step length); Variability (standard deviation (SD) of step, swing and stance time), Rhythm (step time, swing time, stance time); Asymmetry (step, swing and stance time asymmetry); and Postural Control (Step width, SD of step width, step length asymmetry) over 2 minutes of continuous walking using an instrumented walkway (GAITRite). Participants were tested at the peak dose of their medication. Change scores were calculated as: 18 month assessment minus baseline assessment. ANOVA was used to test whether gait changed significantly over the 18 months. Change in medication (levodopa equivalent daily dosage, LEDD) was included as a covariate. A $p<.05$ was used to guide interpretation. Results: Preliminary data are presented for 96 people with PD (Mean (SD); Age: 68.2 (9.8) years; 33 females; baseline MDS UPDRS III: 24.9 (10)). LEDD increased from 179mg at baseline to 384mg at 18 months. When not controlling for changes to medication, there were no significant changes in gait apart from a small decrease in step and swing time. Controlling for change in LEDD revealed subtle yet significant shortening of step length and quickening of step and swing time over the 18 months. No

significant changes in asymmetry, gait variability or postural control variables were observed. Conclusions: Our findings indicate that gait does not change considerably over the first 18 months in incident PD, which may be associated with increased LEDD. This is in line with longitudinal clinical evaluation that shows initial improvements in PD motor symptoms due to pharmacological management [1]. After accounting for changes in medication, we detected a more hypometric step length along with a quicker step time. These changes are likely due to further deterioration of the basal ganglia and reflect primary pathology. Future analysis will consider the influence of motor phenotype and disease severity on predicting progression of gait impairment in individuals with PD. References: TC Vu, JG Nutt & NHG Holford (2012) Progression of motor and nonmotor features of Parkinson's disease and their response to treatment. Br J Clin Pharmocol, 74(2), p.267-283

P3-O-77 The disruption of postural responses and arm reach in standing from a loud acoustic stimulus can be modified by training in persons post-stroke

Vicki Gray[1], Mark Rogers[1], Sandy McCombe Waller[1]

[1]University of Maryland Baltimore

Background and Aim: A loud acoustic stimulus (LAS) is known to elicit a classical startle reaction as well as a StartReact response which is the release of a prepared posture movement sequence by the startling stimulus. When the LAS is applied with an imperative signal in a simple reaction time task, the StartReact response normally speeds up the movement execution. After a stroke there is evidence that the classical startle reaction is enhanced, however there is little known about the StartReact response on voluntary reaching when the LAS is applied at the imperative signal. Therefore, the purpose of this study was to examine the effects of a LAS at the imperative signal on the motor preparation of paretic limb reaching movements while standing and whether the motor preparation can be modified with training. Methods: Seven individuals > 6 months post stroke and 2 control subjects were tested using a simple reaction time reaching task with either the paretic (stroke) or right (control) performed in standing. A warning light cue preceded the imperative light signal (IS) by 2 seconds. In 25% of the trials subjects were randomly presented with LAS at the IS and at 100 ms after the IS. We recorded the center of pressure (COP) from two force platforms to assess anticipatory postural adjustments (APA), hand kinematic variables and electromyographic (EMG) activity of the paretic tibialis anterior, soleus, medial and anterior deltoids and biceps brachii muscles. Testing was performed before and after 6 weeks of upper extremity reach training in standing. Results: At baseline, the LAS applied at the IS resulted in an earlier and larger EMG area of the lower extremity muscles which was accompanied by an earlier shift in the COP displacement. In the upper extremity, the EMG burst was initiated earlier with a larger EMG area, though the initiation of the hand AP displacement was delayed. The LAS disrupted the coordination of the postural response and hand reach with a greater time between the onset of the COP displacement and the hand reach possibly due to interference by the presence of a classical startle response. After training, there was an increase in EMG area with an earlier onset time of the lower extremity muscles generating an increase in the COP velocity. In the hand reach, the EMG burst onset time increased, and the execution speed and maximum hand displacement increased. The coordination of the onset of the APA and the reach movement was reduced, approaching control values. Conclusions: The disruption of the reaching movement by the classical startle reaction was reduced after training. The effects of training also improved the temporal coordination sequence between the postural response and reaching movement. Thus, in a standing reach task, the StartReact response for the

paretic upper extremity is altered indicating a potential deficit in motor preparation in persons with chronic stroke but that can be improved by training the arm in standing.

P3-O-78 Objective assessment of gait in Parkinson's disease: The effects of motor subtypes and medication

Talia Herman[1], Aner Weiss[2], Marina Brozgol[2], Shirley Shema[2], Ziv Sberlo[2], Nir Giladi[3], Jeffrey Hausdorff[4]

[1]TLVMC, [2]Laboratory for Gait and Neurodynamics, Movement Disorders Unit, Tel-Aviv Sourasky Medical Center, [3]Dept of Physical Therapy, Sackler Faculty of Medicine, and Sagol School of Neuroscience, Tel-Aviv Un, [4]Sackler Faculty of Medicine and Sagol School

INTRODUCTION AND AIM: Patients with the Postural Instability Gait Difficulty (PIGD) subtype of Parkinson's disease (PD) exhibit, by definition, more deficits in balance and gait, compared to the Tremor Dominant (TD) subtype. However, objective gait features have not yet been fully described in the literature. The aim of the present study was to quantitatively characterize differences in gait features between the PIGD and TD subtypes both OFF and ON anti-parkinsonian medications. METHODS: Patients with PD were classified at the OFF state into predominant PIGD subtype (p-PIGD, n=31) or predominant TD subtype (p-TD, n=32) based on their score on the Unified Parkinson Disease Rating Scale. Participants walked under single (usual walking) and dual task (DT) condition (walking while serially subtracting 3's from a predefined number). About two hours after taking their usual medication, gait was reassessed. The McRoberts DynaPort Hybrid system was used to acquire 3D acceleration signals. Measures included number of strides, stride variability and regularity, and frequency based measures. Harmonic ratio (HR) was used to describe gait smoothness. Gait speed was determined using a stopwatch. In addition DT cost, defined as the difference between the measures of the DT condition and the basic usual walking was calculated. RESULTS: Off medications, gait speed was significantly lower in the p-PIGD compared to the p-TD group both under usual walking (p-PIGD: 1.06±0.19 m/sec; p-TD: 1.22±0.18 m/sec; p= 0.002) and in the DT condition (p-PIGD: 0.90±0.27 m/sec; p-TD: 1.07±0.21 m/sec; p= 0.009). The p-PIGD group walked with higher gait variability in usual walking compared to the TD group as reflected by the higher vertical width (p=0.005), higher AP width (p=0.006) and lower vertical stride regularity in usual walking (p=0.003). They also exhibited decreased gait smoothness in usual walking as reflected by the lower vertical harmonic ratio (p=0.011). The p-TD group walked with significantly lower number of strides (p<0.036) in both conditions, representing a longer stride length. In the ON medication state, several gait features were no longer different between the p-PIGD and p-TD, however, stride length and stride regularity still differed in the two groups (p<0.032). The DT cost did not differ between groups with and without the effect of treatment. CONCLUSIONS: As expected, the p-PIGD and the p-TD groups differ in several locomotor constructs under single and DT conditions, representing slower gait, shorter strides, less smoothness and excessive instability. These objective markers may shed light into different PD aspects such as rhythmicity, regularity and bradykinesia that may be difficult to quantitatively evaluate using only visual gait analysis or clinical rating scales like UPDRS. Acknowledgement: this work was funded in part by the MJFF

P3-O-79 Split-belt adaptation in cerebellar patients with focal lesions

Wouter Hoogkamer[1], Sjoerd Bruijn[2], Stephan Swinnen[3], Frank Van Calenbergh[4], Jacques Duysens[3]

[1]KULeuven, [2]VU University Amsterdam, [3]KU Leuven, [4]University Hospitals Leuven

BACKGROUND AND AIM: Patients with diffuse degenerative cerebellar damage are deficient in adaptations to split-belt walking [1]. It was speculated that this was due mostly to the cerebellar regions most important for control of posture and locomotion, namely the midline vermis and fastigial nuclei [1]. To substantiate this proposal one needs to examine patients with focal lesions in these areas, for example due to cerebellar tumor resection. It was hypothesized that such patients would show similar deficits in adaptation. METHODS: Nine patients with focal cerebellar lesions (lesion sizes: 2.1-60.1cc; 6 with vermal lesions) were examined along with nine healthy controls. All subjects executed a split-belt protocol consisting of 3 minutes baseline walking (1.0 m/s), 10 minutes split-belt walking (one belt at 0.5 m/s and one at 1.0 m/s) and 5 minutes at baseline walking (1.0 m/s). RESULTS: Step length symmetry adapted similarly between patients and healthy controls, although the patient group's slow leg swing speed was less reduced. Furthermore, the initial overshoot in step length symmetry (the aftereffect that commonly is observed when belts are reset to equal speeds) was smaller in patients (mean=0.108%, SD=0.043%) than in controls (mean=0.141%, SD=0.019%; $p<0.05$). Also, while in the healthy control group the de-adaptation of this aftereffect in step length symmetry was driven by increasing the step length of the slow leg, the patients reduced step length on the fast leg. CONCLUSIONS: These results suggest that mildly ataxic patients with focal cerebellar damage (ICARS: mean=5.4, SD=5.5) are able to adapt their step lengths during split-belt walking. This is in contrast to severely ataxic patients, but in line with a mildly ataxic subgroup with diffuse cerebellar damage in the Morton & Bastian study [1]. Noteworthy, several gait features such as leg swing speed and each leg's step length (de-)adapt differently between cerebellar patients and healthy controls. This might be related to deficits in somatosensory perception in the cerebellar patient group [2], which have been observed to be related to the early rate of split-belt adaptation [3]. In future work we aim to evaluate this relation in cerebellar patients and to identify which cerebellar regions are important in gait adaptation using lesion-symptom mapping in a larger patient group. ACKNOWLEDGEMENTS: This work was supported by FWO (G.0756.10). REFERENCES: 1 Morton SM, Bastian AJ. J Neurosci 26: 9107-16, 2006. 2 Bhanpuri NH, et al. J Neurosci 33(36):14301-6, 2013. 3 Hoogkamer W, et al. 2nd joint world congress of ISPGR and Gait & Mental Function, P4-B-66, 2013.

P3-O-80 Effects of anti-parkinson medications on dual-task walking in people with Parkinson's disease

Valerie Kelly[1], Rebecca Archer[1], Anne Shumway-Cook[1]

[1]University of Washington

BACKGROUND AND AIM: Gait impairments are common in people with Parkinson's disease (PD) and are exacerbated under dual-task conditions requiring performance of a concurrent cognitive or motor task. Although anti-parkinson medications are commonly used in PD, their effects of medications on dual-task walking performance are not well understood. Specifically, it is unknown whether instructions remain an effective way to modify dual-task walking in the off-medication state, despite the fact that medication fluctuations become increasingly common with PD progression. The purpose of this study was to compare the ability to modify dual-task walking in response to instructions in the off-medication and on-medication states. We hypothesized that the effect of instructions on walking would be greater in the on-medication compared to off-medication state. METHODS: We tested 8 people with PD in the off-medication and on-medication states. Participants walked as quickly as they safely could while

performing a concurrent cognitive task (auditory Stroop). Participants were given two different sets of instructions: 1) focus on walking, and 2) focus on the cognitive task. Primary outcome for walking were gait speed and biomechanical stability, assessed as the frontal plane inclination angle. Primary outcomes for the cognitive task were response latency and accuracy. RESULTS: Mean (standard deviation [SD]) age was 72 (5) years and disease duration was 6 (4) years. Dual-task gait speed was faster in the on-medication compared to the off-medication state (P=.02) and was faster with instructions to focus on walking compared to focus on the cognitive task (P=.04), with no interaction between medications and instructions (P=.47). Biomechanical stability was comparable in both medication states (P=.59) and with both sets of instructions (P=.21), with no interaction (P=.53). Cognitive task response latency and accuracy were comparable in both medication states (both P>.37) and in response to both sets of instructions (both P>.07), with no interactions (both P>.34). CONCLUSIONS: Contrary to our hypothesis, people with PD were able to modify dual-task walking in response to instructions to a comparable degree in off-medication and on-medication states, with no change in biomechanical stability during walking. Medications did not impact dual-task cognitive performance. People with PD report the need for increased concentration to monitor and improve walking, and physical therapists often incorporate a cognitive strategy, in which attention is focused on specific gait parameters, into gait rehabilitation for people with PD. These data suggest that such a cognitive strategy is effective in both off-medication and on-medications in people with PD, suggesting that instructions to focus on walking can effectively improve dual-task walking even in people with PD whose response to medication fluctuates.

P3-O-81 The integration of vision and proprioception on obstacle crossing strategies in people with motor-incomplete spinal cord injury.

Raza Malik[1], Tania Lam [1]

[1]University of British Columbia

Background and Aim: In people with motor-incomplete spinal cord injury (m-iSCI), functional ambulation is an important goal. The ability to perform skilled walking tasks (such as obstacle crossing) is an essential component of functional mobility. Important components of obstacle crossing include accurate foot placement, adequate toe-obstacle clearance and appropriate coordination across multiple segments. Sensorimotor integration of visual and proprioceptive inputs are important in mediating these strategies. In people with m-iSCI, proprioceptive information could be compromised because the axons carrying proprioceptive information pass through the spinal cord. Thus, the overall objective of this study is to understand how motor and sensory deficits in people with m-iSCI affect obstacle-crossing strategies. Methods: Individuals with m-iSCI and able-bodied controls performed an obstacle-crossing task. Obstacle height was scaled to 10% of each participant's leg length. Three conditions were presented: 1: Full vision, no instructions; 2: Full vision, instructed to look straight; 3: Lower visual field obstruction (using dribble goggles), instructed to look straight. An eye tracker device was used to determine gaze behavior (gaze duration and number of glances to the obstacle), and motion capture analysis was used to determine lead and trail limb horizontal distance from the obstacle and lead toe clearance height over the obstacle. In subjects with SCI, lower extremity motor score was used to measure strength, the Spinal Cord Injury- Functional Ambulation Profile (SCI-FAP) was used to assess ambulatory capacity, and lower limb proprioceptive sense was assessed using a hip and knee joint position-matching task using the Lokomat and customized software controls. Results: Lower limb proprioceptive sense was varied across subjects with m-iSCI. In general, m-iSCI participants tended to

glance at the obstacle more frequently with longer gaze durations compared to controls. As the lower visual field became more obstructed, able-bodied controls exhibited increasing lead and trail limb horizontal distance and toe-obstacle clearance (consistent with previous studies). In subjects with m-iSCI, lead and trail limb horizontal distance and toe-obstacle clearance height tended to be smaller and was modulated to a lesser extent with visual field occlusion compared to that measured in controls. Subjects with m-iSCI also showed more trial-to-trial variability in these gait parameters compared to controls. Conclusion: The results of this study indicate that people with SCI rely more heavily on vision to cross obstacles and show limited ability to modulate the key gait parameters required for successful obstacle crossing. Our data suggest that proprioceptive deficits also need to be considered in rehabilitation programs aimed at improving functional mobility in individuals with m-iSCI.

P3-O-82 Predicting factors of dual task gait velocity in Parkinsons disease

Esther Molenaar[1], Carolien Strouwen[2], Liesbeth Münks[2], Samyra Keus[1], Bastiaan Bloem[1], Alice Nieuwboer[3]

[1]Radboud University Medical Centre, [2]KU Leuven-University of Leuven, [3]KU Leuven-University Leuven

ABSTRACT SUMMARY: Dual tasking is limited in people with Parkinson's disease. By using a forward linear regression analysis we identified a model with the most important predicting factors of gait velocity during dual tasking. The model, in which single task gait velocity was the most important factor, explained 68% of the variation. BACKGROUND AND AIM: People with Parkinson's disease have difficulties performing two or more tasks simultaneously. Generally, gait velocity decreases and fall risk increases. In the DUALITY study, a randomized controlled trial, we evaluate the efficacy of two physiotherapy treatment strategies. However, we are also interested to determine factors predicting gait velocity of patients with Parkinson's disease on a functional dual task. METHODS: In 69 patients participating in the DUALITY study (Hoehn & Yahr II-III; able to walk independent; MMSE>24), we assessed gait velocity during single task and dual task walking. Patients were asked to walk at a comfortable speed and in a safe manner over a 9m GaitRite mat. For the dual walking task, the "Mobile Phone-task" was developed. Patients had to type 10 digits on a cell phone while walking. In this complex dual task attention and vision is used for typing instead of walking. Each patient performed single task (ST) and dual task (DT) walking in a randomized order. Pearson's correlation (for data with normal distribution) was carried out, containing patient characteristics (age, education level, H&Y, disease duration, disease severity UPDRS), patient-reported problems in dual task situations (DT questionnaire), cognitive tests (ScopaCog, MoCA,MMSE,ANT,AIT,FAB), ST gait velocity, and freezing of gait (FOGQ). The factors which were significantly correlating ($p<0.05$) with performance on the dual task were used in a forward linear regression model. An additional t-test was used to compare groups: freezers and non-freezers (n=31/n=38). RESULTS: The best model predicting DT gait velocity (R2 =0.679; p=0.00), included ST gait velocity (B=-6.27); educational level (B=-15.96); age (B=18.14); and DT questionnaire (B =33.47). Differences between performance of freezers (M=80.48, SD=20.83) and non-freezers (M=77.87, SD=21.49) on DT gait velocity were not significant (t=-0.508, p=0.613). CONCLUSION: We have identified a model explaining 68% of variation of DT gait velocity. The strongest predicting factor in this model is ST gait velocity. This may have implications for physiotherapy treatment strategies in clinical practice.

P3-O-83 Gait cycle timing parameters and their correlation with functional and subjective gait assessments among persons with multiple sclerosis

Meir Plotnik[1], Robert Naismith[2], Joanne Wagner[3]

[1]Sheba Medical Center, [2]Washington University School of Medicine, [3]Saint Louis University

Background and Aim: The majority of persons with multiple sclerosis (pwMS) have walking limitations. These are usually assessed by functional gait tests and by subjective questionnaires. The aim of the present work is to study the relation between these 'traditional' assessments and bilateral coordination of gait (BCG), gait asymmetry (GA) and gait variability as assessed by a gait analysis system that provides timing of the gait cycles over relatively long walking paths. Methods: Sixty nine subjects with MS (55 women) performed the 6 minute walk test (6MWT) in a 50 foot long corridor. Stride time variability (Stride CV), GA as measured by comparing left and right leg swing times, and BCG as quantified by the phase coordination index (PCI - higher values mean worse coordination), were calculated based on heel strike and toe offs timing obtained from ambulatory gait analysis system (APDM®, Portland, Oregon, USA) for the straight line walking segments. Functional gait assessments included the Timed 25-foot Walk Test (T25FWT), 6MWT distance score, the slope of the incremental change in the distance covered during each minute of the 6MWT (SLOPE; calculated by linear regression), the 12-item MS Walking Scale (MSWS-12) and the Activities-specific Balance Confidence Scale (ABC). Correlation analyses between stride CV, GA and PCI and the functional and subjective gait assessments were performed. Results: The mean values (±SD) of the age, body mass index (BMI) and the Expanded Disability Status Scale (EDSS), were 46.9 ± 10.4 y, 28.7 ± 7.3 (kg/m2) and 2.18 ± 0.91, respectively, with no gender effect. Values of the functional and subjective gait measures and of Stride CV, GA and PCI are depicted in Table 1, and so is the correlation matrix. Stride CV, GA and PCI were not correlated with age, gender or with BMI. Correlation analyses (Table 1) demonstrate that increased Stride CV, GA, and PCI, were associated with more pronounced functional gait limitations and greater self-perceived limitations in walking and balance. Conclusions: Comparing our results with the literature suggests that stride CV, GA, and PCI are increased in MS as compared to healthy cohorts. Gait cycle timing features are indicative of both functional gait performance and subjective assessment of gait and balance performance, and thus can be utilized for ambulatory monitoring of gait in pwMS.

P3-O-84 Anticipatory postural reactions and arousal state during external perturbations are altered in people with stroke

Courtney Pollock[1], Mark Carpenter[1], Alessio Gallina[1], Taian Vieira[2], Tanya Ivanova[1], S. Jayne Garland[1]

[1]University of British Columbia, [2]Universidade Federal do Rio de Janeiro

BACKGROUND AND AIM: While neuromuscular control of standing balance is known to be impaired after stroke, less is known about how fear of falling and decreased balance self-efficacy contributes to balance deficits post-stroke. Increased fear and arousal have been shown to influence balance control in healthy individuals; however, it is not known if people post-stroke demonstrate a similar response. The purpose of this study was to explore the influence of participant-controlled versus investigator-controlled timing of postural perturbations on anticipatory postural reactions and the level of physiological arousal post-stroke. METHODS: Eight participants with stroke, and 7 age-matched controls, stood with each foot on a separate force platform. External loads of 2% body weight were applied at the level of the hips to perturb the participant anteriorly. Ten loads were triggered either by the investigator or by the participant (total 20). Electrodermal activity (EDA; measurement of physiological arousal), high-density surface electromyography (EMG) of the calf muscles (multi-channel EMG arrays over

soleus, medial and lateral gastrocnemius) and center of pressure (CP) measurements were taken prior to perturbation (anticipatory) and post-perturbation. Exploratory t-tests were used to compare conditions (self-, investigator-triggered) and groups (stroke and control). RESULTS: Participants with stroke demonstrated significantly higher levels of anticipatory EDA levels during perturbations compared to controls ($p < 0.05$). There was no significant difference between anticipatory EDA levels during self- and investigator-triggered perturbations in people post-stroke or controls ($p > 0.05$). In people post-stroke, the plantarflexors demonstrated significantly larger anticipatory amplitude during self-triggered compared to investigator-triggered perturbations ($p < 0.05$) and demonstrated significantly greater activation than the plantarflexors of controls ($p < 0.05$). CP displacement and velocity was decreased post perturbation in people with stroke compared to controls during both conditions ($p < 0.05$). Muscle activation levels post-perturbation were not significantly different between groups. CONCLUSIONS: Higher levels of anticipatory physiological arousal demonstrated by participants post-stroke were accompanied by significantly more pre-perturbation muscle activation in the plantarflexors of both the paretic and non-paretic legs. This anticipatory activity was associated with decreased CP peak displacement and velocity in participants post-stroke compared to controls, suggesting a bracing strategy. The relationship between physiological arousal during challenges to standing balance warrants further examination in people post-stroke as it may influence postural control strategies.

P3-O-85 Gray matter loss mediates the association between functional connectivity of the salience network and PIGD symptoms

Jeffrey Hausdorff[1], keren Rosenberg-Katz[1], Talia Herman[1], Yael Jacob[1], Nir Giladi[1], Talma Hendler[1]

[1]Tel Aviv Sourasky Medical Center

BACKGROUND AND AIM: Gait disturbances in Parkinson's disease (PD) might be related to disrupted interaction between motor and cognitive functions. Indeed, PD patients of the Postural Instability and Gait Difficulties (PIGD) subtype, usually suffer from larger cognitive deterioration than the Tremor Dominant (TD) subtype, suggesting that their gait difficulties might be related to their cognitive decline. We aim to discover the neural correlates underlying the PIGD symptoms. METHODS: PD patients were classified as belonging to the predominantly-PIGD subtype (p-PIGD, n=31) or predominantly-TD subtype (p-TD, n=32) based on their score on the Unified Parkinson Disease Rating Scale as assessed in the OFF state. The level of functional connectivity of large scale brain networks, i.e., the central executive network, the default mode network and the salience network, was evaluated for each patient using resting state functional magnetic resonance imaging (rs-fMRI). The level of functional connectivity was compared between the two PD subtypes and correlations between the levels of connectivity and PIGD score, motor and cognitive measurements were computed. The influence of gray matter (GM) volume on these correlations was evaluated using a mediation analysis (Baron and Kenny, 1986; Preacher and Hayes, 2004). RESULTS: Stronger functional connectivity of the salience network was detected in the p-PIGD subtype compared to the p-TD subtype (Fisher's LSD; $P < 0.017$). Among all PD patients, the increased functional connectivity of the salience network was associated with higher PIGD scores ($n=103$, $r=0.342$, $p<0.0005$), lower gait speed while dual-tasking ($n=103$, $r=-0.236$, $p<0.017$) and lower scores on the catch game ($n=103$, $r=-0.211$, $p<0.036$). The association between functional connectivity of the salience network and PIGD scores was mediated by GM atrophy in the precentral gyrus (indirect effect = 2.239, 95% CI=0.143 to 1.375*), suggesting an attempt for a compensatory mechanism.

CONCLUSIONS: These results propose that increased functional connectivity of the salience network may be a result of gray matter atrophy. The increased connectivity however was positively correlated with symptoms severity and we therefore suggest that it play a role in the difficulties observed among patients with the PIGD subtype, especially in relation to those symptoms that combine motor and cognitive functions as required for gait. Baron R.M., Kenny D.A. (1986) The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol 51:1173-82. Preacher K.J., Hayes A.F. (2004) SPSS and SAS procedures for estimating indirect effects in simple mediation models. Behav Res Methods Instrum Comput 36:717-31. This research was supported by the Michael J. Fox Foundation for Parkinson's Research.

P3-O-86 Cortical mechanisms underlying the sensorimotor enhancement of locomotion post stroke induced by light haptic touch

Samir Sangani[1], Anouk Lamontagne[1], Joyce Fung[1]

[1]McGill University

BACKGROUND AND AIM: Light touch (haptic) cues have been shown to improve postural stability in healthy older adults and more recently during gait in post stroke individuals. Recent studies utilizing EEG demonstrate that both the motor cortex and the corticospinal tract contribute directly to muscle activation in lower limbs during steady-state treadmill walking. However, cortical hemodynamic activity associated with changes in locomotor function in response to light haptic touch while walking on a self-paced treadmill remains unclear. The primary objective of our study is to utilize near infrared spectroscopy (NIRS) to investigate and characterize cortical activity in terms of concentration of oxygenated hemoglobin (Oxy-Hb) in both the frontal and sensorimotor cortices as posture and gait control is enhanced by haptic touch during self-paced treadmill locomotion in post stroke participants and healthy subjects walking at matching slow speeds. METHODS: We have recruited 7 healthy control subjects and 1 stroke participant, and will target testing 10 post-stroke and 10 control subjects in all. NIRS measurement was performed using the Hitachi ETG-4000 system with a custom-built optode cap covering the frontal and sensorimotor cortices. The experimental protocol included repeated block trials consisting of two alternating blocks of standing and walking at the comfortable self-selected speed in stroke participants and slow speed in healthy controls. There were a total of three trials, where the haptic touch condition was randomly alternated with no haptic touch condition. The cortical hemodynamic response was quantified in four different phases termed as preparation, acceleration, steady-state walk, and deceleration. Primary outcome measures included gait speed and changes in Oxy-Hb concentrations at those four phases with respect to quiet standing. RESULTS: Light haptic touch during slow speed walking in healthy controls did not show any significant changes in gait speed as well as in cortical activity. In contrast, individuals with stroke had a significant increase in gait speed in the haptic touch condition compared to the no haptic touch condition. This increase was associated with an increase in the activation of the lateral sensorimotor cortex of the affected hemisphere (Figure 1). In addition, changes in laterality index with light haptic touch demonstrated improved cortical symmetry during walking. CONCLUSIONS: Improved symmetry of cortical activation of sensorimotor and frontal regions associated with enhanced locomotor ability post stroke provides preliminary evidence of promoting sensorimotor enhancement with haptic feedback during locomotion, as a novel intervention of gait rehabilitation post stroke.

P3-O-87 Is freezing of gait in Parkinson's disease associated with changes in gaze behaviour?

Carolina Silveira[1], Danielle Bell-Boucher[2], Frederico Pieruccini-Faria[2], Eric Roy[1], Quincy Almeida[2]

[1]University of Waterloo, [2]Sun Life Financial Movement Disorders Research and Rehabilitation Centre/Wilfrid Laurier University

BACKGROUND AND AIM: Previous research has argued that freezing of gait (FOG) in narrow spaces may result from disrupted visuomotor processing, although a direct relationship between gaze behaviour and the occurrence of FOG has never been evaluated. The first objective of this study was to investigate how individuals with PD who experience FOG (PD-FOG), those who do not experience FOG (PD non-FOG), and healthy age-matched controls extract visual information while walking through narrow spaces. Furthermore, we aimed to examine whether changes in gaze behaviour precede freezing episodes. METHODS: Nine PD-FOG, 11 PD non-FOG, and 11 age-matched control participants walked through a 10-meter corridor in two conditions: parallel walls (PW) and narrowing walls (NW). A wireless eye-tracking system recorded participants' gaze behaviour. Three areas of interest (AOI) were examined: pathway (ground), walls, and through the distal opening. Percentage of fixations (PF) and percentage of total fixation duration (PTFD) were compared between groups, corridor condition, trials and AOIs. The number of FOG episodes was assessed using video analysis as well as confirmed by a trained expert. RESULTS: A main effect of AOI for PF ($F(2,56)=38.4$ $p<0.001$) and PTFD ($F(2,56)=36.7$ $p<0.001$) showed that all participants looked more at the pathway than the walls or through the distal opening, but no overall differences between groups were found. Since FOG occurred in both PW and NW (relatively equally, 6 compared to 4 respectively), all trials with freezing episodes were pooled to address the second objective. Surprisingly, prior to freezing episodes, fixations were mainly focused on the pathway (PF and PTFD higher than 90% in both corridors). CONCLUSIONS: No differences in gaze strategies were identified between groups suggesting that freezing episodes may not be associated with a disrupted acquisition of visual information, or where attention is allocated during walking. Since fixations directed to the ground (i.e. travel path) have been associated with the extraction of self-motion information through optic flow, it would appear that a disruption to the integration of visual flow with other sensory feedback may lead to an inaccurate perception of self-motion, which may underlie this FOG phenomenon.

P3-O-88 Freezing beyond gait in Parkinson?s disease: an update on current neurobehavioral evidence

Sarah Vercruysse[1], Moran Gilat[2], James Shine[2], Elke Heremans[1], Simon Lewis[2], Alice Nieuwboer[1]

[1]K.U.Leuven, [2]The University of Sydney

Background and aim: Parkinson patients are frequently troubled by sudden paroxysmal arrests or brief episodes of movement breakdown, referred to as 'freezing'. Freezing of gait (FOG) is common in advanced PD and typically occurs in walking conditions that challenge dynamic motor-cognitive control. Mounting evidence suggests that episodic motor phenomena during repetitive upper limb, lower limb and speech sequences resemble FOG and may share some underlying neural mechanisms. However, the precise association between gait and non-gait freezing phenomena remains controversial. This review aimed to 1) clarify this association based on behavioral and neuroimaging studies on non-gait freezing published between 2000 and 2013 and 2) to explore their relevance to current conceptual models of

FOG (Nieuwboer and Giladi, 2013). Methods: We used PubMed to search for literature of which the title or abstract made mention of 'motor block(s)', 'motor arrest(s)', 'hesitation', 'freezing', 'freezing of gait', 'gait freezing', 'akinesia/akinetic', 'festination' or 'movement breakdown' in combination with one of the search terms covering the types of movement under investigation ('upper limb', 'lower limb', 'hand(s)', 'finger(s)', 'feet/ foot', 'stepping' or 'articulation/articulatory', 'oral', or 'speech'). After further screening for relevance, 33 articles on episodic motor phenomena were maintained. We then examined the clinical manifestation, the behavioral constraints that triggered the episode and the kinematic properties during the episode. In addition, we investigated the co-occurrence of non-gait freezing and FOG within patients. Results: We found converging evidence for the occurrence of freezing-like motor blocks during lower limb, upper limb and speech control, which present with a similar clinical manifestation as gait freezing (see Supplementary overview). These types of freezing seemed to be elicited by similar spatiotemporal motor constraints that fit well with the Threshold and Decoupling models of FOG. Cognitive features of upper and lower limb freezing are in line with the Cognitive and Interference models of FOG but merit further study in relation to speech freezing. The generic nature of the various types of freezing would imply partially overlapping neural circuitry. Neuroimaging studies of upper and lower limb freezing so far suggest that both FOG and non-gait freezing are related to profound alterations in the frontostriatal circuitry in keeping with the idea of competing neural resources that interfere with ongoing motor output. Conclusion: The review of the literature supports the existence of a close link between FOG and non-gait freezing phenomena even though these do not capture the full complexity of FOG. Motor-cognitive triggers of non-gait freezing fit well with conceptual models of FOG. Freezing is at least partially related to impairments in frontostriatal neural communication.

P3-O-89 Early differentiation in neural connectivity between PIGD and TD subtypes of Parkinson?s disease (PD): a preliminary resting state fMRI analysis

Griet Vervoort[1], Wim Vandenberghe[1], Alice Nieuwboer[1], Sarah Vercruysse[1]

[1]KU Leuven

Background and aim: Parkinson's disease (PD) is associated with altered frontostriatal connectivity during task performance as well as during rest. Though some network changes were shown to co-evolve with general disease progression, their relationship to the clinical subtypes of PD is currently unclear. The aim of this exploratory study was to compare the strength of functional brain connections between early patients with PD with the postural instability and gait disorder (PIGD) and tremor dominant (TD) subtype using resting state functional magnetic resonance imaging (rs-fMRI). Methods: Twenty-six patients with early Parkinson's disease (disease duration: 5.2±2.7 years) and 10 healthy age-matched control subjects were included. Patients with PD were classified as PIGD (n=13), TD (n=8) or indeterminate (n=5) based on subscores of the MDS-UPDRS while 'off' medication. The PIGD and TD group were matched for disease duration and MDS-UPDRS III score. Patients in the indeterminate group were excluded from the analysis. All patients underwent a resting-state fMRI scan while 'off' medication using a Philips 3T MRI scanner (FEEPI sequence, duration: 435s, TR: 1.7ms) in combination with a high-resolution anatomical T1 sequence. During the resting-state scan, participants were asked to focus on a white cross with black background. Standard temporal and spatial preprocessing steps were applied to the functional images using SPM8. The CONN toolbox (v.13) was used to compute functional connectivity as the temporal correlation in blood-oxygen level dependent (BOLD) signals of selected

cortical and subcortical regions of interest (ROIs) based on previous literature. Group differences in ROI-to-ROI connectivity were explored by means of t-tests with FDR correction for multiple comparisons (FDR-corrected p-value < 0.05). Results: Compared to TD and control subjects, PIGD patients showed reduced functional connectivity between somatosensory regions (BA1, BA5, BA7) and frontal cortical regions (superior frontal gyrus, dorsolateral prefrontal cortex). PIGD patients also displayed reduced functional connectivity between the left pallidum and left dorsal posterior cingulate cortex as well as between the right pallidum and a ROI of the left thalamus known to be connected to the primary motor cortex. Conclusion: These results give a preliminary indication of early changes in neural network connectivity associated with the PIGD subtype of Parkinson's disease. These alterations were found in frontostriatal and cortico-cortical connections that may be involved in locomotor but also in cognitive control. Further brain-behavior correlations are needed to solidify these results.

P3-P-90 Balance after Total Hip Arthroplasty (THA) and the Effect of Hip Abductor Strength

Fang Lin[1], Julie Ermoloff[2], Justin Moore[2], Brett Painter[2], Kimberly Pittenger[2]

[1]Dr. William M Scholl College of Podiatric Medicine/Rosalind Franklin University of Medicine and Science, [2]Northwestern University

INTRODUCTION Literature is controversial on balance impairments in people post THA[1-3] especially for the long-term effect. The aim of the study was to investigate possible balance deficit post THA and to initially explore if hip abductor strength of the surgical hip played a role. METHODS 6 healthy adults (3 M/3 F, 54.0±2.3 yr, 169.1±8.9 cm, 79.0±18.7 kg) and 2 subjects (2 M, 67.2±8.7 yr, 175.0±11.3 cm, 91.2±6.0 kg, 5+ years post THA) who underwent 1 or 2 primary THAs via posterior-lateral approach participated. Synchronized kinematics and kinetics were collected while the subject stood unassisted to maintain static standing for 30 seconds in 4 conditions: Double-Leg Standing with eyes open (DLSEO) and eyes closed (DLSEC), and Single-Leg Standing (SLS) on left and right leg. Hip abductor strength was measured as % of body weight. WOMAC Index and Harris Hip Score were collected before trials as outcome measures. COP was obtained from force platform data for all trials and was then transformed to the coordinate system defined by the origin of the geometry center. COP sway area (in mm2) and maximum sway translation in sagittal and frontal planes (in % of body height) were calculated. The differences in COP parameters and hip abductor strength were analyzed using t-test with alpha as 0.05. RESULTS Fig. 1 shows the average results of COP sway area. COP area of THA subjects was substantially greater than that of controls for all testing conditions. For SLS trials, THA subjects had COP area more than 5 times greater than those of the controls. COP area was greater in SLS than in DLS for controls (P<0.01). COP translation (in % of body height) was significantly greater in coronal plane than in sagittal for DLS trials (P<0.001). THA subjects had hip abductor strength of 60.6±1.8 %BW and 46.2±24.0 %BW for left and right, respectively, drastically lower than that of controls (112.3±17.9 and 128.2±17.4, for left and right sides). However, outcome measures were similar for both groups, in that THA subjects reported 'good' and 'excellent' compared to 'excellent' from controls. DISCUSSIONS Our data suggest that although the self-perception of functioning in individuals more than 5 years post THA surgery was good to excellent, apparent balance deficits in single-limb stance on the surgical limb existed. Weakness of hip abductors of the surgical hip was also evident and may contribute to the balance deficits. Further evaluation with a greater sample size should help clarify this correlation. THA patients that present with balance deficits may believe that they have no functional impairments putting their safety at a greater risk. Hip abductor strengthening may have the potential to improve balance deficits evident in this

patient population. REFERENCES: [1]Rougier, P., et al. Motor Control 12, 136 (2008); [2] Lugade, V., et al. Clin Orthop Relat Res 466, 3051 (2008); [3]Majewski, M., et al. J Bone Joint Surg Br 87-B, 1337 (2005)

P3-P-91 The Impact of a Concurrent Task on Simple and Complex Walking Performance in Persons with Transfemoral Amputation

Sara Morgan[1], Brian Hafner[1], Valerie Kelly[1]

[1]University of Washington

BACKGROUND AND AIM: Limb amputation is a major life event that has a profound and negative impact on physical function in those affected. Loss of limb structures and disruption in the neural substrates that control limb movement contribute to mobility limitations in persons with lower limb loss (LLL) including impaired postural stability, activity limitations, and increased incidence of falls. These limitations are often pronounced in persons with more proximal LLL such as transfemoral amputation (TFA). Even state-of-the-art prosthetic technologies, such as microprocessor-controlled prosthetic knees (MPKs), are unable to exchange motor and sensory information directly with a user and therefore often require compensatory actions to operate effectively. This disconnect between the sensorimotor system and the prosthesis may contribute to the reported increased need for cognitive control of walking among persons with LLL. We currently lack fundamental knowledge about the impact of limb loss on the cognitive resources required for locomotor control under simple and complex walking conditions. Thus, the goals of this research are to: (1) quantify the impact of cognitive load on walking in people with TFA compared to non-amputee peers, and (2) assess the impact of cognitive load on walking over simple and complex terrains. METHODS: Fourteen MPK users with unilateral TFA and fourteen age/gender-matched controls were recruited. Participants walked at a self-selected speed under single-task (walking only) and dual-task (walking while performing an auditory analogue of the Stroop test) conditions over both a simple (flat, level) and a complex (compliant, foam) surface. Three-dimensional marker position data was collected in order to assess speed and stride-to-stride variability for walking tasks. Response latency and accuracy for the cognitive task were measured under single-task (seated) and dual-task (while walking) conditions. The dual-task effect (DTE) was calculated for all parameters. RESULTS: Preliminary findings reveal that people with TFA walked slower and with greater variability than controls ($p<0.05$ for five matched pairs). DTE for people with TFA did not significantly differ from that of controls ($p>0.05$) in simple walking conditions. In the complex walking conditions, preliminary analysis of one matched pair indicates greater walking DTEs for the person with TFA. CONCLUSIONS: Consistent with previous research, people with TFA walked more slowly and with greater variability than controls, even in simple walking conditions (single-task walking over flat, level surfaces). People with TFA had similar dual-task performance declines to controls on simple surfaces but preliminary analysis suggests greater declines on complex surfaces. This finding may be the result of an increased need for cognitive control by people with TFA when walking over complex terrains compared to those without amputation.

P3-P-92 Adaptation strategies in starting and stopping gait and the additional value of a self adapting microprocessor controlled knee.

Marc Nederhand[1], Erik Prinsen[2], Johan Rietman[2]

[1]Roessingh, Research and Development, [2]Roessingh, Centre for Rehabilitation

Background and aim: Ambulation in small indoor spaces is a continuous process of starting and stopping gait. Transfemoral amputees (TA) need to adapt for the necessary propulsive and braking forces for initiating and terminating gait. During steady state walking Microprocessor controlled knees (MPK) perform better on biomechanical variables than conventional knees (CK), but optimal use of stance flexion damping (yielding) for weight acceptance during gait is limited. We were interested in 1) the adaptation strategies of TA in starting and stopping gait and 2) the additional value of a self adapting MPK (Rheo knee,Ossur) for stance flexion during starting and stopping gait. Methods: Subjects: Unilateral TA, > 1yr postamputation, K2 to K4. Design: Case control, cross over. Outcomes: spatiotemporal, kinematic and kinetic parameters during 3 steps after gait initiation and 3 steps prior to gait termination. Experiment: 5 trials with initiation and 5 trials with termination of gait. Prosthetic foot and knee alignment were similar in both prosthetic conditions. Results: There were no differences between the MPK and CK in spatiotemporal, kinematic and kinetic parameters during the first 3 steps of starting gait. During stopping gait most of the adaptation comes from the intact leg. When the prosthetic leg is the final step (before the closing step), the MPK showed higher stance knee flexion movement (yielding) in part of the subjects. When the prosthetic leg is the second last step there were no differences in stance between the two prosthetic knees. Discussion: The preliminary results show that during deceleration of gait, just before termination, stance flexion damping of the MPK enables a gradual weight loading on the prosthetic leg. This is in contrast to steady state walking where the yielding function in both MPK and CK seems minimal. Not all subjects benefit from this damping function. The additional value of an adaptive MPK during starting gait is questionable, probably because initiation is predominantly controlled by ankle mechanics. Conclusion: The damping forces of a self adapting MPK may contribute to gradual weight acceptance during decelerating gait when ambulating in small indoor spaces.

P3-P-93 A novel evaluation of knee proprioception ability based on the analysis of Multiscale Entropy

Hui Zhang[1], Long Jiang[2], Diange Zhou[2], Jianhao Lin[2], Jue Zhang[1], Jing Fang[1]

[1]Peking University, [2]Peking University People's Hospital

Background And Aim : Osteoarthritis (OA) of knee is a common disease that can decrease muscular strength and proprioception, two essential components of postural control.[1] Two methods are used for the knee proprioception, that is, position sense test (measure the ability of kinaesthesia) and threshold detection test (test for joint position sense). However, the results from these two approaches vary much.[2] In this study, a complexity analysis, multiscale entropy (MSE) [3], is introduced to quantify the proprioception function with a novel experimental method recording the micro fractal patterns of the physiological fluctuation. Subjects and Methods: Twenty four knee OA patients and twelve healthy subjects were enrolled and confirmed an informed content. The OA subjects were comparable with Kellgren/Lawrence grade of 3 or higher. Each subject underwent traditional and MSE tests and both legs were tested. Traditional tests consist of kinaesthesia (KT) and joint position sense (JPS) measurements. In the KT test, the knee of each subject was moved passively towards a criterion angle (30°and 60°). In the JPS test, the subject was required to detect the start from an initial angle (30°and 60°) and stopped the movement as soon as possible. MSE test used a laser pointer fixed on the lower limb which was adjusted to the angle of 30° or 60° (Fig.1B). A target sheet is 5 meters away from the subject. The subjects aimed at the sheet (Fig.1A) in sitting posture for 60 seconds and the light spot locations were

recorded by the camera (Fig.1C). The data sampling rate of the camera is 100 frames/s. We could get the temporal series of the light spot from each subject. (Fig.2) Then we utilized multiscale entropy to get the complexity of the light spot locations, which was used to evaluate proprioception. In the data process, thirty scales were computed using Matlab. Results: Compared with the OA patients, controls have higher complexity, especially, between the scale 9 to the scale 15. (Fig.3) A significant difference ($p<0.05$) was found between the patients and healthy subjects in the results of MSE test. (Fig.4) Meanwhile, the correlation between the test of MSE and JPS was significant. Especially, the results of OA patients at the angle of 60° in the right leg ($r=-0.629$). (Fig.5) Conclusion: Our preliminary results suggest that based on the complexity analysis, a significant difference is identified between the patients and healthy persons which demonstrates that this multiscale dynamical indexes as well as the novel experimental approach can be used to evaluate the proprioception in knee osteoarthritis. Further studies will validate the replicability of this method.

P3-Q-94 Developmental changes in the neural network of proprioceptive processing from adolescence to adulthood

Christine Assaiante[1], Fabien Cignetti[1], Bruno Nazarian[1], Muriel Roth[1], Jean-Luc Anton[1], Marianne Vaugoyeau[1]

[1]CNRS - Aix-Marseille Université

Background and aim: Behavioural studies have evidenced age-related changes in proprioceptive ability from adolescence to adulthood and have linked proprioception to performance on activities of daily living related to mobility and balance. However, little is known about the development of the neural network underlying proprioceptive processing. In particular, this network might be importantly restructured at the time of puberty, driven by hormonal changes. Accordingly, the aim of the present study was to examine changes occurring in the proprioceptive-based network during adolescence up to adulthood. Methods: 54 subjects took part into the experiment, subdivided into three age groups (early adolescence: n = 18, age = 11-14 years; late adolescence: n = 18, age = 14-18 years; adulthood: n = 21, age = 25-40 years). The subjects 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 so selected as 30 Hz stimulation drives weak discharges of the primary endings and 100 Hz frequency optimally activates primary endings. Accordingly, contrasting the two vibration conditions would reveal the base network of proprioception-related activity. fMRI time series were analyzed using general linear models and region of interest analyses. Results: We found that adults, older adolescents and younger adolescents activated a similar, distributed network of primary sensorimotor regions and higher-order association (i.e., frontoparietal) regions. For each region of the network, there was no difference between the adults and the older adolescents both in terms of amount of activity and spatial extent of activation. In contrast, the network of the younger adolescents was characterized by a greater spatial extent of activation of the sensorimotor regions and a smaller spatial extent of activation of the frontoparietal regions as compared to older adolescents and adults networks. Conclusions: Our findings reveal plasticity (i.e., refinement) of the proprioceptive network during adolescence. In particular, this refinement is consistent with the viewpoint of a hierarchical sequence of functional development from sensorimotor to association cortex.

P3-Q-95 ALTERANTE FOOT PLACEMENT STRATEGIES: AVOIDANCE OF MULTIPLE OBSTACLES

Brittany Baxter[1], Michael Cinelli[1]

[1]Wilfrid Laurier University

BACKGROUND: Navigating through a cluttered environment is a task constantly performed with great efficiency and while an undesirable foothold may have various seemingly equal alternant options for avoidance, it is not chance that determines the method we employ. Patla et al. (1999) proposed three major determinants for the selection of alternant foot placement; 1) minimal displacement, 2) maintenance of forward progression, and 3) maintenance of stability, which are supported by the work of Moraes and colleagues (2004, 2005, 2007). The objective of this study was to determine individuals' foot placement selections when avoiding two consecutive ground-level obstacles. METHODS: Eight participants ($\bar{x}$= 23.6, SD= 2); 1 male and 7 females walked along a 13m by 6m travel path toward a goal. On 50% of the trials, participants had to avoid stepping on two consecutive planar obstacles (15cm wide by 70cm long) located approximately 8m from the start where participants would normally place their feet. The obstacles were projected onto the ground using a data projector mounted from the ceiling. The participants experienced 3 possible experimental conditions randomly presented: 1) both obstacles appeared after participants reached steady state locomotion (i.e., 4 steps); 2) both obstacles appeared when participants were 2 steps away; and 3) the first obstacle appeared when the participants were in steady state and the second appeared when they were 2 steps away. RESULTS: Two different stepping strategies appeared and were consistent within participants, the majority (n=5) stepped medially to avoid both obstacles (MM) and the rest (n=3) used a steering strategy (i.e., medial-lateral stepping combination (ML). Walking speed during the approach phase (i.e., two steps before the first obstacle) showed that the ML group had significantly higher variance (CV(MM)= 3.2, CV(ML)=14.6). CONCLUSIONS: The ML group's greater variability in walking speed may indicate that for any given amount of prior knowledge of obstacle location, they would experience a greater perturbation to their system by stepping medially and thus their subsequent lateral stepping behaviour may have occurred in an effort to recover stability. However, the majority of the participants chose to step medially to avoid both obstacles. The second step of this MM strategy required a cross-over step to occur, a foot placement selection that is argued to sacrifice stability in favour of maintaining forward progression. Congruent with our findings, Moraes et al. (2004) found a preference for stepping medially when avoiding a single obstacle where cross-over stepping was observed to compose a small proportion of medial stepping across all of the possible obstacle orientations. Our results also indicate that regardless of the amount of prior knowledge provided (i.e. the time to allow for proactive responses to occur) each participant remained constant in their avoidance strategy.

P3-Q-96 Changes in paretic and non-paretic lower limb muscle activities during gait on a split-belt treadmill in chronic stroke survivors

Martina Betschart[1], Séléna Lauzière[1], Carole Miéville[1], Bradford McFadyen[2], Sylvie Nadeau[1]

[1]University of Montreal, Center for Interdisciplinary Research in Rehabilitation (CRIR-IRGLM), [2]Faculté de médécine, Université Laval

Background and aim: Recent studies have shown that chronic stroke survivors are able to store an adapted gait pattern induced by walking on a split-belt treadmill with asymmetric belt speeds. When the

belt speeds were returned to identical speeds, an after-effect was observed showing a reduced asymmetry of step length and double stance duration. The aim of this study was to better understand how the motor system induces such adaptations towards symmetry by characterizing lower limb muscle activity during post-adaptation. Methods: Surface electromyography (EMG) was used to analyze bilateral muscle activity of six lower limb muscles for 15 chronic stroke survivors (mean age and time post-stroke: 49±13 yrs and 84±93 months). The participants were asked to walk on an instrumented split-belt treadmill (Bertec FIT) under different conditions: three minutes with identical belt speeds (baseline); six minutes with the belt speed doubled on the non-paretic (NP) side (adaptation) and three minutes with identical belt speeds (post-adaptation). The protocol was then performed on the paretic (P) side. Ground reaction forces provided the spatiotemporal asymmetry (step length [SL] and double stance duration [DSD]) expressed using an NP/P ratio. EMG was band-pass filtered (20-400Hz) and RMS values were calculated and normalized for amplitude (peak RMS value obtained during baseline) and time (corresponding gait cycle). Repeated measures ANOVAs were used to compare differences of spatiotemporal and EMG values among conditions and sides. Pearson correlation was applied to identify associations between changes in muscle activity and spatiotemporal parameters. Results: SL and DSD increased after fast belt walking and reduced after slow belt walking when compared to baseline ($p \leq .001$). These changes corresponded to a reduced asymmetry of the SL (7/8) and DSD (12/12) during post-adaptation. Mean RMS values on paretic dorsiflexors increased by 21% ($p=.004$) during the post-adaptation period after walking on the fast belt. For the condition where the non-paretic leg was walking on the fast belt, the paretic plantarflexors EMG activity increased during post-adaptation (18%, $p=.012$) as did the non-paretic hip flexors (20%, $p=.027$) when compared to baseline. Only increased paretic dorsiflexor EMG activity was correlated with changes in SL symmetry ratio ($r=+.653$, $p=.008$). Conclusions: As shown by others, the present findings demonstrated that chronic stroke survivors have the capacity to adapt their locomotor pattern. The less asymmetrical gait pattern was related to increased muscle activity for distal paretic lower limb muscles and proximal non-paretic lower limb muscles. Analysis on temporal information of muscle activity in combination with biomechanical parameters (joint angles, joint moments) will provide better understanding of the motor adaptation in gait poststroke created by the use of split-belt treadmill and its use for rehabilitation training.

P3-Q-97 Visuo-locomotor coordination for manual wheelchair versus biped navigation: A Preliminary Study

Caroline Charette[1], Francois Routhier[2], Bradford McFadyen[1]

[1]Université Laval, [2]Laval University

Background and aim : Like biped gait, wheeled mobility requires one to be able to adapt their locomotion at will in order to change direction (i.e., avoid obstacles or take new course). While there has been great interest in assessing and training manual wheelchair (MWC) skills and performance, there are still surprisingly few studies to understand the visuo-locomotor coordination underlying MWC navigation. The objective of this study was to understand MWC navigational behaviour in relation to biped gait during direction changes in healthy subjects. Methods: To date, five able-bodied male subjects (29±7.4 years) were trained for 15-20 minutes on a Sunrise Quikie Q7 MWC using the Wheelchair Skills Training Program (www.wheelchairskillsprogram.ca). Four Optotrak sensors (Certus, NDI, 120 Hz) and 21 infrared markers were used to analyse three dimensional motion. A monocular eye tracker (Mobile XG, Applied Sciences Laboratories) was used to track gaze behaviour from the right eye.

Subjects were asked to perform locomotion using 2 different transport modes (walking and propelling the MWC) towards a target either directly in front of them (straight ahead condition) or 45 degrees to the right indicated by a vertical pole (2.54 cm in diameter) placed 4m from the starting point (direction change condition). A repeated measures ANOVA was used to compare changes in approach speed across conditions. Paired T-tests were used to compare differences in minimal clearance (MCLR), point of deviation (DEV) and visuo-locomotor coordination (gaze, head, and trunk/wheelchair movements) between MWC to biped locomotion. Results: For speed, there was a main effect for direction and a direction by mode interaction with slower speeds for MWC direction change. DEV was later for MWC direction change and always involved a counter movement with greater MCLR (25.8±8.1 cm) as compared to gait (16.1±4.9 cm). In straight-ahead locomotion, subjects predominantly fixed their gaze on the end target for both transport modes while there was a clear trend for subjects to fixate on the vertical pole more for MWC direction change. However, head movement always preceded gaze changes which were followed by trunk movement for both modes during direction change (the trunk and MWC turned together). Yet, while subjects turned the trunk at the same time during approach regardless of locomotor mode, head movement was earlier for MWC locomotion. Conclusion: These preliminary results suggest that there is constant temporal whole body coordination to the target regardless of locomotor mode. Thus, head movement to anticipate path deviations and lead steering for locomotion appears to be stereotypic across transport modes while specific gaze behaviour depends on the mode and environmental demands.

P3-Q-98 Body configuration at first stepping foot contact critically determines the ability to recover from large sideways perturbations in healthy young subjects.

Digna de Kam[1], Jolanda Roelofs[1], Astrid van der Zijden[1], Stephen Robinovitch[1], Vivian Weerdesteyn[1]

[1]Radboud University Medical Center

BACKGROUND AND AIM: Accidental falls are common in the older population and particularly sideways falls are associated with an increased hip fracture risk [1]. Reactive stepping is an important protective mechanism to prevent falls in daily life. In the present study we aimed to identify the key determinants of successful side-stepping to recover from large sideways perturbations in healthy young subjects. METHODS: Twelve healthy young adults stood on a translating rubber mat in a semi-tandem position. They were subjected to 33 large leftward perturbations at varying intensities and we recorded 3D full-body kinematics. To identify determinants of successful recovery (i.e. fall or no fall), we extracted two sets of variables from the 3D data; 1) the body configuration at the instant of first foot contact [2] and 2) spatiotemporal step variables. Body configuration variables included the vertical leg and trunk inclination angles in the frontal plane. Spatiotemporal step variables included step onset, length, duration and velocity. We restricted our analyses to side-stepping strategies (n=129), as cross-over steps resulted in falls in the vast majority of trials (91%) and were only successful at low intensities. Stepwise logistic regression analyses were conducted to determine the predictive ability of either body configuration parameters or spatiotemporal step variables on the probability of success. For both analyses, perturbation intensity was also entered in the model. RESULTS: Balance was successfully recovered in 32.6% of the trials. The regression model with body configuration variables correctly classified 86.0% of the trials as success or failure (R^2=0.598). The Odds Ratio's (OR) for leg angle and perturbation intensity were 1.18 and 0.99, respectively. Trunk inclination angle was not retained in the final model. In the model with spatiotemporal step variables, only step velocity and perturbation

intensity were retained. Its predictive ability was slightly but significantly poorer (R^2=0.564, 85.3% of trials correctly classified) than for the model with body configuration. CONCLUSIONS: The vertical leg angle at first stepping foot contact is a strong predictor for successful side-stepping after a lateral perturbation. A similar result has previously been reported for backward stepping [2]. Since all subjects needed multiple steps to recover from the perturbations, this finding implies that the first step is of critical importance for successful balance recovery. An good first side-step may enable subjects to more adequately perform subsequent steps. Improvement of leg angle during side-stepping may be an important therapeutic target for populations with increased fall risk. REFERENCES: 1. Rubenstein et al. 2006, 2. Weerdesteyn et al. 2012.

P3-Q-99 Postural sway and gaze can track the chaotic motion of a visual target

Vassilia Hatzitaki[1], Anastasia Kyvelidou[2], George Sofianidis[3], Nick Stergiou[2]

[1]Eidikos Logariasmos Kondilion Erevnas A.P.TH, [2]University of Nebraska at Omaha, [3]Aristotle University of Thessaloniki

BACKGROUND AND AIM: Practicing postural tracking of predictable visual target motions improves the link between perception and action which may be critical for maintaining balance in abruptly changing environmental conditions (1). Nevertheless, use of periodic and predictable visual cues eventually leads to open-loop control and subsequently loss of functional visuo-motor adaptability. The present study investigated how well healthy young adults can track visual target cues along a spectrum of complexity (periodic, chaotic, noise) when voluntarily swaying in the Anterior-Posterior (AP) and Medio-Lateral (ML) direction. METHODS: Five healthy young volunteers (25.6 3.7 years) stood over the mid-line of two adjacent force plates (Balance Plate 6501, Bertec) while tracking a moving target (stimulus motion update: 50 Hz) that was moving either horizontally or vertically in front of them. Postural sway was sampled (100 Hz) via an A/D acquisition board (Vicon Motion Systems) and feedback in real-time via an overhead projector (View Sonic, PJ510) on a large projection screen (2.2m horizontal x 1.6m vertical) located in front of the participant at a distance of 2 m, at eye level. Gaze data were also sampled with an eye-tracking system (50 Hz, Dikablis, Ergoneers). Participants performed 30 weight shifting cycles in 120 s while tracking one of three visual target motions: a chaotic (Lorenz attractor), a noise (brown) and a periodic (sine) target motion. The degree of force-target and gaze-target coupling was assessed using Cross-Approximate Entropy (Cross- ApEn) which quantifies the degree of asynchrony between two related time series. The effect of target complexity and sway direction were analyzed employing a 3x2 repeated measures ANOVA. RESULTS: Force-target Cross-ApEn was affected by the target's complexity ($F = 201.62$, $p<.001$) with the sine producing the lowest value (.078), followed by the Lorenz (.103) and the brown noise (0.192). The gaze-target coupling revealed lower Cross- ApEn values for the Lorenz compared to the sine target while both target motions produced a greater coupling when compared to the brown noise ($F = 33.39$, $p<.001$). Both the Lorenz and sine target motions were followed with greater accuracy by the eye when swaying in the ML compared to the AP direction ($F= 3.71$, $p<.05$) . CONCLUSIONS: Our results confirm that humans entrain more accurately gaze and postural sway to a chaotic signal than to a noisy or even periodic signals. Thus, based on the theoretical model of optimal movement variability (2), tracking of a chaotic signal may provide a better stimulation to improve perception-action coupling and adaptability in postural control. REFERENCES 1.Hatzitaki V, Voudouris D, et al Gait Posture. 2009 Feb;29(2):296-9. 2.Stergiou N, Decker LM. Hum Mov Sci. 2011 Oct;30(5):869-88.

P3-Q-100 Influence of different standing conditions on Light Touch effect which focus on the relation between subjective attention strength

Tomoya Ishigaki[1], Kozo Ueta[1], Shu Morioka[1]

[1]Kio University

Background and aim of the study: On standing position, fingertip contact (< 1 N) at a fixed point reduces postural sway. This phenomenon is called the light touch (LT) effect. The LT effect can be achieved by a fixed-point contact (Jeka, 1997). However, if the sensory input from the fingertip, the LT effect can be achieved without a fixed-point contact (Backiund Wasling, 2005). The contributing factors of the LT effect have not been clarified yet. Therefore, the purpose of this study was to examine the contributing factors of the LT effect and the relationship between the subjective attention strength (SAS) and LT effect, under different standing conditions. Methods: The subjects included 17 right-handed healthy adults (mean ± SD age, 22.7 ± 2.2 years). Each subject stood with eyes closed and feet closed together. The 4 standing conditions were as follows: the control condition (C), concentrating attention on body sway; the normal LT condition (NLT), with fixed-point contact; the sensory LT condition (SLT), with sway-referenced contact; the attention LT (ALT), concentrating attention on the fingertip. We measured postural sway and fingertip contact force within 20 s. Postural sway was measured with a stabilometer (G-6100, Anima), and the sampling rate was set at 100 Hz. Total trajectory length (TTL) and root mean square area (RMSA) were calculated. Fingertip contact force was measured only for NLT, using a strain gauge (ELF System, Nitta), and the sampling rate was set at 20 Hz. The SAS in each condition was measured using a Visual Analog Scale (VAS). C was measured first. Then, each condition was measured once at random. After all the measurements were obtained, the VAS was measured via a questionnaire. One-way repeated-measure ANOVA was used to compare the 4 postural sway conditions (Holm post hoc test). Then, the Pearson product-moment correlation coefficient was used to calculate correlation coefficients between SAS and postural sway. P-values were set at .05. Results: In all the conditions, a significant decrease in TTL compared with C was observed ($p < .01$). In the comparison between NLT, SLT, and ALT, all the combinations significantly differed ($p < .01$; only SLT vs. ALT $p < .05$). A significant decrease in RMSA was observed only under NLT compared with under other conditions ($p < .01$). The postural sway decreases were significantly positively related to SAS under NLT (TTL: $r = .59$, $p < .05$, RMSA: $r = .60$, $p < .05$). Under SLT and ALT conditions, only the RMSA decrease was negatively related to SAS significantly (SLT: $r = -.59$, $p < .05$; ALT: $r = .65$, $p < .01$). Conclusions: Our findings suggest that focusing attention on the fingertip was a minimal contributing factor to achieving a LT effect, and adding the factor to the LT effect might reduce TTL. In addition, a fixed-point contact was necessary to reduce the RMSA. Finally, SAS and postural sway were related, but the effect differed by whether fixed-point contact was present or not.

P3-Q-101 Effect of balance training on postural control in elderly people

Christoph Maurer[1], Isabella Wiesmeier[1]

[1]Universitätsklinikum Freiburg

BACKGROUND AND AIM: Multiple factors have been proposed to contribute to the deficits of postural control in the elderly, namely sensory, motor, and higher level adaptation deficits. Known degradations in sensory systems include an increased vibratory sensation threshold, reduced visual perception, and reduced vestibular function. Degradation of the motor system includes a reduction of muscle strength.

Deficits in higher-level adaptive systems include elderly people's lack to adapt to external perturbations. Using a model based approach, we aimed to identify which deficits dominate postural control of the elderly and which deficits are sensitive to balance training. METHODS: We analyzed postural control of 40 healthy elderly people with a mean age of 74 years. Half of them were randomly allocated into an intervention group and the other half were assigned to the control group. The intervention group received an intense ten week's balance training, whereas to the control group did not receive any intervention. Data of the intervention group was compared with data from 19 healthy young volunteers (mean age 28 years) and 16 healthy middle-aged volunteers (mean age 48 years). Postural control was characterized by spontaneous sway measures and measures of perturbed stance. We observed centre-of-pressure (COP) sway paths and angular and translational excursions of the body in space. Perturbations were induced in terms of a pseudorandom anterior-posterior tilt of the body support surface. Stimulus-response data were interpreted on the basis of a simple negative feedback model. RESULTS: As already known before, we found that spontaneous sway measures (RMS, MV and MeanFreq) were significantly higher in elderly than in young people. Gain, a measure based on the transfer function between external stimulus and body response, is highest in elderly and lowest in young people, being almost equally distributed across the frequencies tested. Balance training leads to a significant reduction of Gain in the intervention group. Based on model simulations, we found an increased reliance on proprioception, an increase in overall time delay, and a lower motor feedback in elderly subjects. CONCLUSIONS: Elderly people seem to rely more on proprioceptive than on vestibular or visual cues indicating that the vestibular system ages more or faster than the proprioceptive system. After balance training, there is a shift from proprioception to spatial orientation cues (vestibular and visual). In addition, we reproduced the common finding that time delay is increased in elderly people. We assume that the decrease of motor feedback may be caused by the loss of muscle mass in elderly people. We found significant correlations between clinical balance scores and the identified model parameters of postural control.

P3-Q-102 Sensory reweighting of proprioceptive input during balance control as function of age and disease

Jantsje Pasma[1], Denise Engelhart[2], Alfred Schouten[3], Andrea Maier[4], Carel Meskers[1], Herman van der Kooij[2]

[1]Leiden University Medical Center, [2]University of Twente, [3]Delft University of Technology, [4]VU University Medical Center

Background and aim: Sensory (re)weighting is the automated and unconscious process of dynamically combining sensory inputs, e.g. proprioception, graviception and vision, during balance control. Typically, reliable sensory inputs are weighted more than unreliable and noisy sensory inputs, to prevent decline of balance control. Malfunctioning of sensory reweighting in case of sensory deterioration may be an important determinant of impaired balance in elderly with the consequence of physical impairment and falls. In this study, we used closed loop system identification techniques (CLSIT) to assess sensory weighting and reweighting of proprioceptive input of the ankle during upright stance as function of age and disease. Methods: Ten healthy young (age 25.4±2.2 years), ten healthy elderly (age 76.8±1.8 years), ten elderly with cataract (age 76.7±6.8 years) and ten elderly with polyneuropathy (age 73.7±8.0 years) were asked to maintain balance while the proprioceptive input of each ankle was disturbed by rotation of the support surface (SS) around the ankle axes. SS rotations were applied with specific frequency

content and the perturbation amplitude increased over trials. Body sway and the total reactive ankle torque were recorded. The sensitivity functions of the ankle torque to the perturbation amplitude was determined using CLSIT. The gain of the sensitivity function (S) describes the ratio of the perturbation amplitude and the ankle torque as function of frequency and represents the proprioceptive weighting. Parameters describing the sensitivity functions were estimated using optimized model fits, of which one was the proprioceptive weight (Wp). Results: Healthy elderly were more sensitive to SS rotations as reflected by a significantly higher gain of S ($p<0.001$) compared with the young. In comparison with healthy elderly, elderly with a cataract had a significantly higher gain of S ($p=0.038$), unlike elderly with polyneuropathy ($p=0.37$). In all groups, the gain of S decreased significantly with increased disturbance amplitude ($p<0.001$). There was no interaction effect between perturbation amplitude and groups ($p=0.68$).The estimated Wp was significantly higher in healthy elderly compared with the young ($p=0.001$). Compared with healthy elderly, elderly with cataract had a significantly higher Wp ($p=0.003$), unlike elderly with polyneuropathy ($p=0.24$). In all groups, Wp decreased with increased perturbation amplitude ($p<0.001$). There was an interaction effect ($p=0.001$) between perturbation amplitude and groups. Conclusions: Using CLSIT, proprioceptive weighting and reweighting could be established as function of age and cataract; healthy elderly rely more on proprioceptive input compared with the young and elderly with cataract rely even more on proprioceptive input. Assessing the interplay between available sensory inputs is necessary to identify the weakest link in impaired balance as a primary therapeutic target.

P3-Q-103 Can young adults adjust their recovery step during unexpected tripping?

Zrinka Potocanac[1], Jaap van Dieën[2], Sabine Verschueren [1], Jacques Duysens[1], Mirjam Pijnappels [2]

[1]KU Leuven, [2]MOVE Research Institute Amsterdam, Faculty of Human Movement Sciences, VU University Amsterdam

BACKGROUND AND AIM: With an aging society and an increasing number of falls and fall-related injuries, fall prevention is of utmost importance [1, 2]. Tripping over obstacles is one of the main causes of falls [3]. When tripping over an obstacle, one needs to reduce the forward angular momentum that the body obtains from impact with the obstacle [1, 4]. This can be achieved by strong push-of forces of the support leg and a large recovery step, but this ability is often impaired in older adults. Although experiments have shown that tripping response adjustments occur when a trip is anticipated [5], it can be questioned whether people are able to control and adjust their recovery step during balance recovery. If so, this might provide possibilities for fall prevention training in older adults. We therefore aimed to investigate whether young adults are able to adjust their recovery foot landing position after an unexpected trip by avoiding a virtually presented forbidden landing zone (FZ). We hypothesized that young adults would be able to adjust their recovery steps, and that the rate of successful FZ avoidance would improve over trials. Moreover, we wanted to evaluate the characteristics of the adjusted steps and their consequences for balance recovery. METHODS: Sixteen healthy young adults (25±3 years) walked at their comfortable speed over a walkway equipped with 14 hidden obstacles. Subjects were tripped 10 times in between a random number of normal walking trials. Five of the trips included a presentation of a FZ at trip onset, positioned at the subject's preferred recovery foot landing position, hereby forcing subjects to adjust their response in order to avoid landing on the FZ. RESULTS: Subjects succeeded to avoid the FZ in 80% of trials, using either shortened steps (84%) or stepping to the side of the FZ (16%). Their performance improved over trials, and some subjects even switched strategies over

trials. These step adjustments had only minor effects on the body's angular momentum at and following recovery foot landing. CONCLUSIONS: Young adults are able to adjust their tripping responses without negative consequences on balance recovery. If the same can be found in elderly this opens new hopes for fall prevention training. REFERENCES: [1] van Dieën et al., Safety Sci, 2005 [2] van Dieën et al., JEK, 2008 [3] Robinovitch et al., Lancet, 2013 [4] Cordero, PhD thesis Twente University, 2003 [5] Wang et al., J Biomech, 2012

P3-Q-104 Obstacle Avoidance Strategies Across Two Age Groups of Children

Nicole Reinders[1], Robyn Hubbert[1], Micheal Cinelli[1], Pam Bryden[1]

[1]Wilfrid Laurier University

Background: The ability to steer in a cluttered environment and to make appropriate gait adaptations to avoid collisions is imperative in order to achieve safe locomotion throughout the environment. The development of visually-guided locomotion occurs after the onset of adult-like locomotion (i.e., 5 years of age). However, it remains unknown as to what age children are able to accurately used perception to guide actions when avoiding a single obstacle. The current study aimed to determine obstacle circumvention strategies employed by both 6-8 year old (N=12) and 10-12 year old (N=11) children. Methods: Children (n=12 at 6-8 years and n=11 at 10-12 years) were instructed to walk along a 9m path towards a goal (that was either visible or non-visible from the start) and avoid a stationary pole placed 5m along the path. The pole was placed either 20cm left of the midline of the goal, in-line with the goal, or 20cm to the right of the midline. NDI Optotrak camera system was used to record body kinematics and quantify the COM position in both the M/L and the A/P directions. Results: There were no differences in the actions between the two age groups. Both groups of children avoided the obstacle to the right significantly more often when the obstacle was in the centre (~70%) and left positions (~90%) than when it was located in the right position (~30%) ($p<.01$). In addition, both groups of children maintained smaller M/L distance between their bodies and the obstacle at the time of crossing when it was in the centre position (~20cm), than when it was to the left or the right (~30cm)($p<.01$). Both groups of children also displayed smaller M/L distances at the time of crossing when the goal was visible (25cm vs. 27cm)($p<.05$). Conclusion: Since children almost always avoided to the right when the obstacle was on the left and to the left when the obstacle was on the right, they were able to accurately perceive areas of open space and act accordingly. These actions were performed similarly regardless of whether or not a goal was visible from the start. It was hypothesized that the goal would be used to set up a locomotor axis and in its absence one would not be established, leading to different actions. This was not the case. Children also showed a rightward bias when the obstacle was located in the middle of the pathway, which could be due to either foot dominance or comfort level. If the children were right-foot dominant, they could have chose to step wide with their right foot more often at the time of avoidance, leading to more rightward avoidances. Unfortunately, the current task could have been too simple to elicit differences in actions between the two groups of children.

P3-Q-105 The effect of unilateral muscular fatigue on blind navigation

Natalie Richer[1], Martin Bilodeau[1], Étienne Bisson[2], Yves Lajoie[1]

[1]University of Ottawa, [2]Queen's University

BACKGROUND AND AIM: Muscular fatigue affects the quality and treatment of sensory information [1] and introduces a perturbation to the neuromuscular system, which alters muscle strength and postural control [2,3]. The effect of muscular fatigue on static posture has been extensively studied. There is, however, a lack of studies on the effect of muscular fatigue on walking abilities, particularly in the absence of vision. The aim of this study was to examine the impact of inducing muscular fatigue in the plantar flexors of the dominant leg on navigation precision in a blind navigation task. The hypothesis was that inducing fatigue would increase speed, linear distance travelled (LDT), distance to target (DT) and angular deviation (AD) as opposed to blind navigation without muscular fatigue. METHODS: 11 males and 9 females between 18 and 25 years of age (21.5 ± 1.57 years) were recruited. They were healthy with no recent injury to the lower limb or history of recent falls. The blind navigation task consisted of an 8 m walking path with a clearly defined start and finish line. Participants had 5-s before each trial to examine the target, after which they used opaque goggles to exclude visual feedback. Participants were asked to walk towards the target and stop when they believed they had reached it. After 8 control trials with no muscular fatigue, fatigue was produced in the plantar flexors of the dominant leg. Participants were asked to maintain 50% of their maximum voluntary contraction for as long as possible using a leg press. Following fatigue, participants were asked to perform 2 successive trials of blind navigation (fatigue 1 and fatigue 2). This cycle was performed 10 times. One-way ANOVAs with repeated measures on Condition (control, fatigue 1, and fatigue 2) were performed for speed, LDT, DT, and AD. Further ANOVAs were performed post-experiment to compare step number (SN) and step length (SL). RESULTS: Results demonstrated that LDT ($F_{1,19} = 10.87$, $p = 0.004$) and SN ($F_{1,19} = 5.26$, $p = 0.033$) were significantly increased in fatigue 2 as opposed to control trials. Results also demonstrated that LDT ($F_{1,19} = 9.62$, $p = 0.006$) and SL ($F_{1,19} = 6.34$, $p = 0.021$) were significantly longer in fatigue 2 than in fatigue 1. CONCLUSIONS: The main finding in this study was that LDT, SL and SN were increased in the second trial of navigation post-fatigue. Thus, once participants were fatigued, there was a change in their ability to reach a target line with precision but only for the second trial post-fatigue. The participants seemed to have difficulty with readapting their walking mechanisms after some recuperation had taken place. Interestingly, this adjustment provoked participants to walk further and consequently closer to the target, as they were undershooting prior to fatigue. References: [1] Paillard. (2012). Neurosci Biobehav R,36:162-176. [2] Harkins et al. (2005). J Athl Train,40:191-196. [3] Bizid et al. (2009b). Eur J Appl Physiol,106:375-380.

P3-Q-106 Sensorimotor integration used for rhesus monkey postural control

Lara Thompson[1], Adam Goodworth[2], Csilla Haburcakova[3], Daniel Merfeld[3], Conrad Wall III[3], Richard Lewis[3]

[1]University of the District of Columbia, [2]University of Hartford, [3]Massachusetts Eye and Ear Infirmary, Harvard Medical School

BACKGROUND AND AIMS Although previous studies have focused predominantly on either normal or severe bilateral vestibular loss in humans, animal models could prove useful for studying the effects of various levels of vestibular function on posture. Two questions we posed were: Can feedback controller models previously used to study human sensorimotor integration be implemented to describe rhesus monkey posture? Do monkeys with normal or mildly impaired vestibular function have the ability to modulate their reliance on sensory feedback? METHODS To answer the above questions, a dynamic roll-tilt input stimulus was applied to a balance platform to evoke rhesus monkey trunk roll responses for

normal and mild vestibular impaired states. Sway behavior was characterized via stimulus-response curves (i.e., hindtrunk root-mean-square (RMS) roll as a function of stimulus amplitude) and system transfer functions. A feedback controller model, previously used solely to describe sensory feedback in standing human posture, was implemented. To determine model parameters, (measured) transfer function results were used in conjunction with the feedback controller model. RESULTS Similar to normal human responses, the rhesus monkey with normal vestibular function exhibited nonlinear increases in hindtrunk RMS roll for increases in stimulus amplitude (or sway saturation). However, for a state of mild bilateral vestibular hypofunction (mBVH) the monkey exhibited less sway saturation than the normal state (indicative of a lower vestibular contribution). Furthermore, the transfer function gain of the animal in the mBVH state increased compared to normal. CONCLUSIONS The rhesus monkey's model results were consistent with the sensory reweighting hypothesis (i.e., the animal relied upon graviceptive cues more heavily as stimulus amplitude increased) in that: 1) the normal model parameter results were consistent with greater weighting of graviceptive cues at larger platform tilts and 2) the model parameter results for the mildly impaired state showed increased graviceptive weighting for increased platform tilts, but not to the extent seen in the normal state. The results suggest that the (human) feedback controller model can be modified for standing rhesus monkeys to quantify graviceptive (and proprioceptive) contributions in normal and mildly impaired states. The experimental and model results reported here establish the beginnings of a baseline database of primate postural responses to varied levels of vestibular function. Furthermore, because model parameters differed between normal and mild vestibular impairment, our results imply that such feedback models could be useful in tracking a patient's rehabilitative progress following use of, for example, vestibular prostheses.

P3-R-107 Dual task costs of cognitive-functional versus cognitive-non-functional tasks among older adults

Maayan Agmon[1], Einat kodesh[2], Racheli Kizony[3]

[1]University of Haifa, [2] University of Haifa, [3]University of Haifa and, Sheba Medical Center, Israel

Background: The ability to dual task (DT) while walking is becoming more imperative to daily living, especially with the increasing habit of walking while talking on the phone seen in all ages. Dual task performance was studied extensively among the elderly and decline of this ability is related to increased risk of falling. However, only few studies examined the differences in DT cost of functional-cognitive tasks relevant to daily living, versus, non-functional-cognitive tasks. Thus, the ecological validity of DT research paradigm needs further examination. Aim: to examine the differences in DT cost of performing a cognitive-functional task versus cognitive-non-functional tasks while walking, among older adults. Methods: Thirty-three community dwelling older adults (aged 72.2±5.9 years) performed 3 types of cognitive tasks while walking; listening to a shopping list on the phone while walking and reciting it at the end (functional task), subtraction by 3 and verbal fluency (non-functional tasks). The tasks were also administered as single tasks and order of administration was random. Gait was measured using a sensor-based portable system. To date, for each condition, DT cost was calculated for walking distance and performance of the cognitive task. Cognitive tests were administered as well. ANOVA repeated measures was used to examine the differences between DT costs of the 3 conditions. Results: Dual-task cost for walking distance was significantly lower in the functional task (mean ± SD 17.62% ±12.34) than in the verbal fluency task (24.61% ±17.27) ($F=5.5(1:32)$; $p<.03$). No significant differences were found with walking distance of subtraction task and between DT costs of the cognitive tasks. The cost of the

walking distance was significantly higher than the cost of the cognitive task performance in the functional (3.35% ±23.75) and verbal fluency (5.16% ±25.31) conditions only ($t(32)=2.73$, $p=.01$; $t(32)=3.31$, $p<.01$, respectively). Significant correlations were found between the Montreal Cognitive Assessment and the cost of walking distance in the verbal fluency ($r=-.58$;$p<.01$) and subtraction ($r=-.42$;$p<.02$) tasks. In addition, more participants did not have cost of the cognitive-functional task while walking (58%), compared with subtraction (18%) or verbal fluency (42%) tasks. Conclusions: The results indicate that the cognitive-functional task required less attention than the verbal fluency. However, performance pattern (motor vs. cognitive costs) with data analyzed to date, was similar in the functional and verbal fluency conditions despite the differences in mental processes required to execute each task (i.e. working memory and retrieving words from memory). Interestingly a relatively high percentage of people did not have a cognitive cost while walking concurrently with these tasks. This observation suggests that the traditional categorization of the cognitive tasks according to mental processes should be further discussed.

P3-R-108 Dynamics of sensory reweighting following sudden loss or return of sensory orientation information contributing to balance control

Lorenz Assländer[1], Robert Peterka[2]

[1]Albert-Ludwigs-University of Freiburg, [2]Oregon Health & Science University

Background and Aims: Humans use visual, proprioceptive, and vestibular information to control standing balance and compensate for external disturbances. Previous work showed that the relative sensory contributions (sensory weights) depend on environmental and stimulus conditions [1]. Much less is known about the temporal dynamics of sensory weight changes (reweighting) following transitions where access to accurate information from a sensory system is lost or restored. The aim of the present study is to characterize the dynamic time course of the reweighting process. Methods: Standing balance of 12 young adults was perturbed in 6 different test conditions by a continuous 367.2-s application of a constant-amplitude 0.56-Hz sinusoidal surface-tilt, visual-tilt, or galvanic vestibular stimulus that evoked center-of-mass (CoM) body sway in the frontal plane. In 3 test conditions, access to visual information was manipulated by turning lights on and off every 20.8 s during sinusoidal galvanic or surface-tilt stimulation. In the other 3 test conditions, access to accurate proprioceptive information, signaling body sway relative to the stance surface, was manipulated by turning on and off sway-referencing of the surface every 20.8 s during sinusoidal galvanic or visual-tilt stimulation. The time-course of CoM sway and the variability of sway (i.e. sway not correlated with the sine stimulus) were averaged across subjects and across the 41.6-s periods corresponding to light on/off or sway-referencing on/off segments of a trial. Changes in the amplitude of the sinusoidal CoM response were analyzed to determine the time course of the sensory reweighting process. Results: The on/off and off/on transitions evoked changes in CoM response amplitudes in all 6 test conditions. CoM amplitude changes following lights on/off and off/on transitions occurred within one or 2 sine cycles indicating rapid compensation for loss or restoration of visual information. CoM amplitude changes following the sway-referencing off/on transition were similarly rapid indicating that compromised proprioceptive information triggers rapid adjustments. However, following restoration of accurate proprioceptive cues CoM amplitude changes were slower (requiring 3-5 sine cycles). CoM sway variability showed consistent changes following on/off and off/on transitions. The time course of variability changes matched those of CoM amplitude changes and variability always increased following loss of sensory information.

Conclusions: Reweighting occurred following all transitions investigated but dynamics varied depending on the type of sensory transition. Changes in sway variance always accompanied sensory reweighting in a manner consistent with a previous study demonstrating the relationship between sensory weights and sway variability [2]. Work supported by NIH grant DC010779. [1] Peterka, J Neurophysiol, 88:1097-1118, 2002. [2] van der Kooij and Peterka, J Comput Neurosci, 30:759-778, 2011.

P3-R-109 Developing an item bank for the examination of gait adaptability post-stoke using a mixed-methods framework

Chitra lakshmi K Balasubramanian[1], David Clark[2], Emily Fox[3], Amy Stagliano[1], Lou Demark[4], Craig Velozo[1]

[1]University of North Florida, [2]University of Florida, [3]University of Florida, Brooks Rehabilitation Hopsital, [4]Brooks Rehabilitation Hospital

BACKGROUND AND AIM: Gait adaptability (GA) is defined as the ability to modify walking to environmental conditions and is crucial for safe and successful ambulation. While GA is often impaired after a stroke, clinicians lack a rigorous assessment tool to quantify these limitations. Specific examination of GA will guide the design of targeted interventions to improve GA post-stroke. Therefore, our long term goal is to develop a clinical assessment tool for GA post-stroke. Our present aims were to develop an item-bank of tasks for examination of GA post-stroke and to investigate the feasibility of galvanic skin response (GSR) as an objective physiologic indicator when establishing the hierarchy of task difficulty. METHODS: Item-bank development is accomplished using an 8-stage mixed-methods (qualitative and quantitative) approach (Velozo 2012). Here we report results from the initial 3 stages. Qualitative stage 1 involved literature review to identify existing clinical assessment items that examine GA. The construct of GA was conceptualized based on the framework proposed by Patla and Shumway-Cook (1998). Qualitative stage 2 involved identification of items that examine GA from existing clinical assessments, eliminating redundant or misfit items (item winnowing) and item categorization based on dimensions of GA assessed (item binning). Quantitative data from GSR were also collected. GSR measures the electrical conductance of the skin and is known to increase in response to physiological stress or anxiety providing a basis to identify a hierarchy of item difficulty for GA assessment post-stroke. GSR data were collected from 15 older adults (walking speed = 0.7 - 1.0 m/s) while performing 9 GA tasks. GSR data averaged over the task period was compared across tasks using a repeated measures analysis. RESULTS: A review of literature identified 15 existing clinical assessments that contained at least a subset of tasks assessing GA. The total number of tasks identified was 138. This number was reduced to 44 GA tasks after item winnowing (46 tasks were redundant, 37 did not involve GA). The 44 GA tasks were then grouped (item binning) into 14 dimensions of GA (such as negotiating obstacles, walking on varying terrain, walking while carrying an object, etc.). Nine tasks, each representing a different dimension, were tested with GSR. Many of these tasks demonstrated statistically significant ($p < .05$) increments in task difficulty based on GSR amplitude, as shown in Figure 1. CONCLUSION: We qualitatively identified an item-bank of 44 assessment items that may be used to assess GA post-stroke. Quantitative measurement with GSR provided preliminary evidence of item difficulty levels which may supplement conceptualization of the item hierarchy in the item-bank. Ultimately, however, behavioral outcomes are required to validate the hierarchy of item difficulty. Lastly, computerized adaptive testing will be used to reduce testing burden of the item-bank.

P3-R-110 Instrumented balance assessment using Wii Balance Boards in people following stroke: Reliability and potential clinical application

Kelly Bower[1], Jennifer McGinley[1], Kimberly Miller[2], Ross Clark[3]

[1]The University of Melbourne, [2]The University of British Columbia, [3]Australian Catholic University

BACKGROUND AND AIM: The Wii Balance Board (WBB) shows promise as a relatively inexpensive and highly accessible assessment tool. In healthy young adults the WBB, used with customised software, demonstrates acceptable test-retest reliability for standing balance assessment and excellent concurrent validity with force platforms for centre of pressure data. However, the reliability of the WBB used to assess balance after stroke is unknown. The aim of this study was to assess the test-retest reliability of standardised static and dynamic balance tests performed using WBBs with customised software in individuals after stroke. METHODS: Thirty adults who were more than three months post-stroke and able to stand unsupported were recruited from a single outpatient facility. Participants completed two testing sessions separated by one week. Standardised assessments using the WBBs were: (1) static standing with eyes open and eyes closed, (2) static weight-bearing asymmetry, (3) sit-to-stand, and (4) dynamic mediolateral weight shifting. Output variables obtained included measures of centre of pressure velocity, body weight asymmetry, force development and weight shifting speed. Reliability was assessed using intraclass correlation coefficients (ICC). Standard error of measurement (SEM) scores, minimal detectable change (MDC) scores and Bland-Altman plots were used to further evaluate agreement. RESULTS: All 30 participants (mean (SD) age 68.3 (15.1) years; median (IQR) time since stroke 13.5 (5-45) months) completed both testing sessions. Excellent test-retest reliability was found for all WBB-derived variables (ICC = 0.82-0.98). SEM and MDC scores ranged from 4.6% to 14.6% and 7.7% to 44.4%, respectively, with larger scores seen in the WBB variables derived from the static balance tests. CONCLUSIONS: Instrumented assessments of static and dynamic balance using WBBs were found to be highly reliable in individuals after stroke. The resulting MDC scores may assist clinicians in evaluating change in performance over time. Commonly used clinical tests of balance can lack sensitivity and provide little objective information on movement strategies employed. Instrumented balance assessment using the WBBs may prove to be a more responsive measure of balance performance that provides clinicians and researchers with additional, potentially valuable information to complement and enhance existing clinical testing protocols.

P3-R-112 Altered Spinal posture in people with Parkinson's disease and the relationship with balance

Carolyn Fitton[1], Malcolm Burnett[1], Dorit Kunkel[1], Geert Verheyden[2], Ann Ashburn[1]

[1]University of Southampton, [2]University of Leuven

Fitton C, Burnett M, Kunkel D, Verheyden G, Ashburn A, on behalf of the PD Dance Team*

BACKGROUND AND AIM: Poor posture is a known feature of Parkinson's disease (PD). This bent posture has been associated with stiffness or muscle rigidity, slow movements (bradykinesia), and with increasing disease severity, abnormalities of postural reflexes and balance. A shuffling pattern of walking with forward body lean, increased flexion of the hips and thoracic spine, increased posterior tilt of the pelvis and loss of plantarflexion at the ankle and heel strike during gait is characteristic of PD. Poor performance on measures of balance and functional tasks are common. Our findings will provide unique information about the position and movement of the spine in relation to balance control. The purpose

of our study was to examine differences in spinal posture between people with PD and age-matched healthy controls, and to explore the relation between spinal posture and balance ability. METHODS: Data collection included SpinalMouse measurements assessing thoracic, lumbar, sacral and overall spinal posture in the sagittal plane in upright standing and balance assessment using the Berg Balance Scale (BBS). The healthy control data was collected on a previous study RESULTS: Thirty-eight people with PD (mean age 71 (SD 7.6), 19 female), and 22 age matched (68 (SD 9.4), 14 female) healthy controls participated in this observational, cross sectional study. In standing, people with PD had a more overall forward leaning spinal posture (mean 7.3^{o}, versus 0,73^{o}). They are more flexed at the thoracic spine (mean 59.8^{o}, versus mean 54.4^{o}) had a greater lumbar lordosis (mean -25.1^{o}, versus mean -20.6^{o}) and had more forward tilted sacral position (mean 14.0^{o} versus mean 5.5^{o}) in comparison to healthy controls. The overall incline of the spine in people with PD negatively correlated with the BBS (r=-0.46, P=0.004), thus people with a more forward leaning posture had a lower score on the BBS. Similarly, people with an increased lumbar lordosis (r=-0.374, P=0.021) also had a lower BBS score. CONCLUSIONS: Differences in spinal posture between people with PD and healthy controls were apparent in standing. In this sample, the PD participants had a more forward leaning posture, greater lumbar lordosis and greater sacral tilt in comparison to healthy controls and this was related to poorer balance ability as measured using the BBS. The postural changes in PD measured using the SpinalMouse indicate that these changes influence balance control in our sample. Interventions aimed at improving posture and balance are indicated. We are currently exploring this in a feasibility randomised controlled trial that explores the effects of ballroom dancing on spinal posture and balance ability in PD. * Ashburn A, Roberts L, Pickering R, Roberts H, Wiles R, Kunkel D, Fitton C, Robison J, Burnett M, Hulbert S.

P3-R-113 Quantifying dynamic instability in cerebellar ataxic gait

Winfried Ilg [1], Zofia Fleszar[1], Cornelia Schatton[1], Bjoern Mueller[1], Nicolas Ludolph[1], Ludger Schoels [1], Martin Giese[1], Matthis Synofzik[1]

[1]Hertie Institute for Clinical Brain Research

Background: The cerebellum is well-known to be crucially involved in balance and locomotion. One of the most characteristic and sensitive signs of cerebellar damage is gait ataxia. Clinically, ataxic gait is typically characterized by an increased step width, variable foot placement, irregular foot trajectories and a resulting instable stumbling walking path with very high movement variability and high risk of falling (1). However, the exact features of dynamic instability in ataxic gait have not yet been assessed in detail. Here, we aimed to provide an exact quantitative analysis of this dynamic instability for different gait phases in ataxic gait. Methods: We analysed gait patterns from 15 patients suffering from cerebellar degeneration or degeneration of afferent pathways (median age: 61, median SARA: 15.7) compared to 15 age-matched healthy subjects. Subjects were instructed to walk normally at a self-determined pace. From each subject 15-20 gait cycles were recorded, assessed within 5-6 trials. For quantifying dynamic instability we used the approach of extrapolated centre of mass (XCoM), where the XCoM denotes the position of the CoM extrapolated in the direction of its velocity. Based on this, a measure of stability is established by determining the 'margin of stability' b, the minimum distance from XCoM to the boundaries of the base of support (BOS) (2,3). Results: The dynamic stability measure b averaged over the whole gait cycles revealed no significant differences between patients and controls and appeared to be negative for both groups. This phenomenon is caused by the fact, that within reasonable fast gait movements, negative values for b (XCoM lying outside the BOS) in anterior direction do inevitably occur,

indicating that the movement cannot be stopped within that step. Therefore, more meaningful measures concerning stability were obtained by the analysis of stability conditions at the foot contact of the stepping leg. Compared to controls, patients showed a significant lower stability margin b in mediolateral ($p<0.001$), but not in anterior-posterior direction ($p=0.15$). In addition, variability of b was significantly higher in patients for both directions ($p<0.01$). The variability in b correlated with the clinical SARA score ($r=0.55, p=0.03$), confirming variability as an striking feature in ataxic gait. Conclusion: Our results indicate that the reported measures allow capturing and characterizing dynamic instabilities in ataxic gait. Therefore, these measures are suitable to serve as outcome and monitoring parameter for quantifying changes in balance control in intervention studies. In addition, the analysis of instabilities in specific gait phases could help to distinguish different patterns of ataxic gait (e.g. cerebellar vs. afferent degeneration). References: (1)Ilg W, and Timmann D. Mov Disord 28: 1566-1575, 2013. (2)Pai YC, and Patton J. J Biomech 30: 347-354, 1997. (3)Hof A, et al. J Biomech 38:1-8, 2005

P3-R-114 Stair-specific algorithms for identification of touch-down and foot-off when descending or ascending a non-instrumented staircase

Richard Foster[1], Alan De Asha[1], Neil Reeves[2], Constantinos Maganaris[3], John Buckley[1]

[1]University of Bradford, [2]Manchester Metropolitan University, [3]Liverpool John Moores University

BACKGROUND AND AIM: The majority of falls occur on stairs and it is therefore important to study the biomechanics of stair negotiation. When staircases are instrumented with force platforms, GRFs can be measured and used to accurately define important temporal events during stair ambulation such as touch-down and foot-off. When non-instrumented staircases are used (no GRF), other methods of event detection are required to calculate important parameters such as stance and swing phases. These parameters are useful in understanding the influence of clinical conditions or the effects of differing stimuli on stair ambulation and stepping dynamics. This study presents four event detection algorithms for defining touch-down and foot-off during stair descent and stair ascent using segmental kinematics. METHODS: Young (N=17) and older (N=15) adults completed stair descent and ascent trials over a four-step instrumented staircase. Trials were repeated at 3 stair riser height conditions (85 mm, 170 mm, and 255 mm). For stair descent, vertical velocity minima of the whole body centre-of-mass was used to define touch-down, foot-off was defined as the instant of trail limb peak knee flexion. For stair ascent, vertical velocity local minima of the lead-limb toe was used to define touch-down, foot-off was defined as the local maxima in vertical displacement between the toe and pelvis. Performance of these algorithms was determined as the agreement in timings of kinematically derived events to those defined kinetically (GRF). To assess the criterion validity of the new algorithms, agreement metrics for detecting stair ambulation touch-down and foot-off events were compared to commonly used and/or recently developed existing overground gait kinematically derived event detection algorithms [1-3]. RESULTS: Kinematically derived touch-down and foot-off events showed good agreement (small mean difference and 95% limits of agreement) with kinetically derived events for both young and older adults, across all riser heights, and for both ascent and descent. In addition, agreement metrics were better than those returned using existing kinematically derived event detection algorithms developed for overground gait. CONCLUSIONS: Touch-down and foot-off events during stair ascent and descent can be determined with reasonable precision from segmental kinematics using newly presented event detection algorithms. Findings also indicate that the new stair-specific algorithms performed better at detecting stair ambulation touch-down and foot-off events than when using existing overground gait event detection

algorithms. The new algorithms performed equally well in both young and older adults, and across differing stair riser conditions, suggesting they can be used over a wide range of stair ambulation studies with differing methodology. Refs: [1] Hreljac et al. J Biomech, 33:783-6, 2000. [2] O'Connor et al. G & P, 25:469-74, 2007. [3] Zeni et al. G & P, 27:710-4, 2008.

P3-R-115 INSOLE PLANTAR PRESSURES CAN RELIABLY ASSESS GAIT ALONG BOTH LINEAR AND CURVED TRAJECTORIES

Marco Godi[1], Anna Maria Turcato[1], Antonio Nardone[1], Marco Schieppati[1]

[1]Fondazione Salvatore Maugeri

Background and aim. Plantar pressure assessment is commonly used for the clinical evaluation of gait during activities such as walking or running and has proven useful to detect foot pathologies (1-2). Previous studies have found high test-retest reliability of in-shoe pressure technology for evaluating pressure distribution during linear walking (2). However, in natural motion straight walking is intermingled with turns. Knowledge of the pattern of distribution of pressures during curved walking may be useful for comparing healthy subjects with patients, for detecting changes due to nervous system diseases, or for estimating the evolution of the walking disorder and the potential advantage of gait rehabilitation. Therefore our aim was to determine the test-retest reliability of plantar pressure assessment for curved as well as linear trajectories, and estimate the minimum number of steps required to obtain excellent reliability for each output variable. Methods. Sixteen young healthy participants were recruited. Each performed, two days apart, two sessions of walking (50 steps) along three different trajectories: straight, clockwise and counter clockwise. The Pedar-X system was used to collect pressure distribution. The foot was divided into eight regions: medial and lateral heel, medial and lateral arch, I metatarsal head, II-V metatarsal heads, hallux, lateral toes. Reliability was assessed for four clinically relevant variables: Peak Force (PF); Peak Pressure (PP); Contact Area (CA), and Stance Duration (S), using the intraclass correlation coefficient (ICC). Results. There was no difference in ICC between left and right foot during either linear or curved walking . Though ICC values of the four output variables showed good reliability, the ICC was significantly greater for PF, PP and CA than S ($p < 0.01$). In fact, the range of ICC values was from 0.88 to 0.99 for PF, PP, CA for all foot regions and walking trajectories. On the contrary for S, ICC was below 0.70. Estimation of the number of steps to reach ICC of 0.90 in all regions of the foot, showed that for PF, PP and CA, an ICC value of 0.90 could be achieved in all foot regions and walking trajectories with about 50 steps. On the contrary, to achieve ICC of 0.90 for S, more than 200 steps would be needed. Conclusions. A high level of reliability for in-shoe loading variables can be obtained using the Pedar-X system. Notably, the negligible differences in ICC between linear and curved walking allow use of this device for gait assessment along mixed trajectories in both the clinical and research setting. Curved trajectories are an important aspect of walking in daily life and this measurement technique can now be used to identify the characteristics and the differences of gait in healthy subjects and in subjects with neurological pathologies in which turning may be a problem. 1. Rosenbaum et al. Foot Ankle Surg 1997;3:1-14. 2. Orlin et al. Phys Ther 2000;80:399-409.

P3-R-116 Associations between quantitative mobility measures derived from components of conventional mobility testing and parkinsonian gait in older adults.

Jeffrey Hausdorff[1], A Weiss[1], A Buchman[2], S Leurgans [2], V Vander Horst [3], R Dawe[4], A Mirelman[1], L Barnes [5], R Wilson[5]

[1]Tel Aviv Sourasky Medical Center, [2]Rush Alzheimer's Disease Center, Rush University Medical Center, [3]Department of Neurology, Beth Israel Deaconess Medical Center, [4]Department of Diagnostic Radiology and Nuclear Medicine, Rush University Medical Center,

Background and Aim: To derive objective measures that provide a more detailed characterization of mobility in older adults assessed in the community setting and examine the extent to which these measures are associated with parkinsonian gait. Methods: During conventional mobility testing in the community-setting, 351 ambulatory non-demented participants in the Memory and Aging Project wore a belt with a whole body sensor that recorded both acceleration and angular velocity in 3 directions. We used measures derived from these recordings to quantify 5 subtasks including: a) walking, b) transition from sit to stand, c) transition from stand to sit, d) turning and e) standing posture. Parkinsonian gait and other mild parkinsonian signs were assessed with a modified version of the Unified Parkinson's Disease Rating Scale (mUPDRS). Results: In a series of separate regression models which adjusted for age and sex, all 5 mobility subtask measures were associated with parkinsonian gait and accounted for 2% to 32% of its variance. When all 5 subtask measures were considered in a single model, backward elimination showed that measures of walking sit to stand and turning showed independent associations with parkinsonian gait and together accounted for more than 35% of its variance. In similar analyses, only walking was associated with bradykinesia and sway with tremor. Conclusions: Quantitative mobility subtask measures vary in their associations with parkinsonian gait scores and other parkinsonian signs in older adults. Quantifying the different facets of mobility has the potential to facilitate the clinical characterization and localization of impaired mobility in older adults. This work was supported in part by NIH grants R01AG17917 and RO1NS078009.

P3-R-117 Development of Novel Walking Analyzing Device, Caterpillar Type Treadmill

Yuka Iijima[1], Takumi Ishikawa[1], Takayuki Shiina[1], Hiroshi Takemura[1], Hiroshi Mizoguchi[1]

[1]Tokyo University of Science

Walking is one of the most fundamental motions in our daily lives. However walking always has a risk of falling. Particularly for elderly people, falling causes often serious injury. The 10% to 40% of elderly have experienced falling for one year. And 5% of fallers have fracture accident. Walking analysis of elderly is very important to prevent falling. Recently, walking has been analyzed by a lot of methods with various devices such as motion capture system, accelerometer, pressure distribution measurement system, electromyogram (EMG), force plate and so on. However most of the conventional methods need to repeat measurements, to use complicated devices, and to wear specific suits or take much time for analysis. These methods were difficult to apply for the clinical use, because it is very difficult to measure and analyze of elderly and disorder person in hospital by doctors. Therefore, new analysis device is needed that anyone can do without specific preparation and time. To answer the needs, we are developing new device, "CAterpillar Type TrAnsParent treadmill (CaTTaP)". This device has a caterpillar which is made of transparent acrylic plates, and the transparent caterpillar can roll as well as conventional treadmills. And under the caterpillar, there is a high speed camera which captures the color plantar images by 60 fps during a walking. The speed of the caterpillar can be controlled by 0.1km/h and the maximum speed of the caterpillar rolling is 6.0km/h . We can measure various walking conditions which can change walking velocity of subjects' comfortable speed and slow/fast speed for anyone from young people to elderly. Using only CaTTaP and a computer, we can analyze walking easily.

Accelerometer, electromyogram and motion capture system needs a lot of space and preparation time wearing suits with marker. Force plate and pressure distribution measurement system needs to measure many trails. However, we can acquire the subjects' repeating walking data with usual wear at the requested walking speed in small space and analyze the subjects' walking. Most of walking parameters, which are step length, step width, step time, plantar contact area, plantar skin deformation and so on, can be calculated by only using continuously captured plantar images on the CaTTaP. In the future, we will estimate characteristics of walk which tend to fall and contribute to prevention of falling with CaTTaP.

P3-R-118 The effects of walking perturbation intensities on the dynamic and postural balance examined by the destabilizing/stabilizing forces.

Nabil Ilmane[1], Simon Croteau[1], Cyril Duclos[1]

[1]University of Montreal

Background and aim Balance training programs are currently developed to use perturbations to improve balance during gait. However, the intensity of perturbation should be related to the actual abilities of the participants to limit falls and confidence reduction during training. It is thus important to test whether an optimal training intensity can be determined to improve balance and postural responses during gait or other functional tasks. Using the concepts of stabilizing and destabilizing forces model, the objective of the present study was to determine the level of postural, dynamic and global balance difficulty of walking perturbations at different intensities. Methods Ten healthy young adults walked on a split-belt treadmill (Bertec Fit) instrumented to record kinetic data. Gait kinematic was measured using a three-dimensional motion system (NDI Certus). Data were collected during natural and fast speed, and during gait perturbations. Perturbations were generated by a change of one treadmill belt speed during one stance phase every 6 to 15 gait cycles. Six perturbation levels (50%, 70%, 90%, 125%, 150% and 175% of natural speed) were applied randomly on either foot. Five trials of each perturbation were performed over 5 experimental gait trials. Mean and extreme values for stabilizing force, destabilizing force and the ratio of the two forces (stability index) were computed from kinematic and kinetic data and compared across conditions for the perturbation and the three following steps using ANOVAs. Results During the perturbation steps, balance difficulty increased (i.e. higher stabilizing forces and lower destabilizing forces) in the raised belt speed conditions (125-175%), but decreased in lowered belt speed conditions (50-90 %) compared to balance difficulty at natural speed ($p<.05$). In the following step, the effect on balance difficulty was opposite (difficulty decreased for raised belt speed, decreased for lowered belt speed). All changes in difficulty changed proportionally to the intensity of perturbation. However, for the highest intensities of perturbation (50 and 175%), balance difficulty was still significantly higher at the third and fourth steps compared to natural speed ($p<.05$). Finally, the highest balance difficulty obtained for each intensity was significantly higher than balance difficulty in the fast speed condition ($p<.05$). Conclusions The difficulty to maintain balance was measured during perturbation and following steps. Difficulty was higher in the first or second step post-perturbation, and up to the fourth step for the more intense perturbations. Higher difficulty than in fast gait condition supports the interest of perturbation to stimulate postural control, in addition to target reactive balance. It might thus be possible to determine the optimal level of balance difficulty using the stabilizing/destabilizing forces to improve balance in patients with high fall risk.

P3-R-119 Field assessment of gait: Valid measures of step length and step width provided with a simple, inexpensive device

Albert Kim[1], Junyoung Kim[1], Shirley Rietdyk[1], Babak Ziaie[1]

[1]Purdue University

Background and Aim: Our goal was to develop an inexpensive and accurate gait tracking device that could be easily implemented in the field by researchers and clinicians. Measures of step length (SL) and step width (SW) variability are critical because they are linked to falls. However, these measures cannot be captured with current devices for field research, such as accelerometers. The simplest and most widely available approach was to use the Smartphone camera (attached at the waist) to capture SL and SW. Using a camera may appear impractical due to the following challenges: calibration of a moving camera, obstruction of the field of view, trunk motion, etc. We have addressed these challenges in the development of a new device, the SmartGait. Methods: SmartGait measures SL, SW, and trunk motion with the camera and inertial sensors of a Smartphone (Apple, iPhone 5s, iOS7), and a 90-degree wide-angle lens. The Smartphone was attached to the belt, and circular markers (d=4.5cm) were centered over the proximal phalanges (Fig 1). The image is processed to isolate and locate the foot markers, which were used to calibrate each video frame (sample rate 30Hz). Trunk motion is measured by the embedded gyroscope sensor (sample rate 100Hz), which is applied to the image compensation. Five young, healthy adults walked on an 8 m walkway at three speeds; approximately 50 steps were collected per subject. Gait was simultaneously measured with the SmartGait and an optical tracking system (Optotrak 3020, NDI). Error was the absolute difference between the SmartGait and Optotrak measures. Content validity was assessed with intra-class correlation coefficients (ICC). Results: The mean absolute error was 16±20 mm for SL and 21±16 mm for SW. The mean ICC for SL was 0.83, 0.82, and 0.90, for slow, preferred, and fast gait speeds, respectively, demonstrating an excellent level of agreement (Fig 1). The mean ICC for SL was 0.84, 0.79, and 0.88, for slow, preferred, and fast gait speeds, respectively, demonstrating excellent agreement (Fig 1). The error in variability was 7±6 mm and 15±13mm for SL and SW variability, respectively. The main source of error was the magnitude of trunk motion, which was quantified by the inertial sensor and used to correct the viewing angle of the image, but this increased the burden to the iPhone's CPU, which reduces the sampling rate. We are working to improve the integration of data from the inertial sensor. Another source of error was obstruction of the foot markers with larger thigh diameter; which also increases the load on the CPU, affecting measurements in subsequent steps. Therefore, the software will be improved to better handle when a marker goes out of view. These improvements will be presented at the conference. Conclusions: SmartGait demonstrated strong concurrent validity for assessing SL and SW. SmartGait has tremendous promise as an inexpensive and widely-available gait assessment device for field research.

P3-R-120 Can wearable inertial movement sensors detect impaired voluntary postural adjustments in people with low back pain?

Karen Lomond[1], Mahmoud El-Gohary[2], Juvena Hitt[3], Rebecca Ouelette-Morton[3], Kyle MacGregor[3], Jesse Jacobs[1], Sharon Henry[3]

[1]Central Michigan University, [2]APDM Inc, [3]University of Vermont

BACKGROUND & AIMS: Chronic low back pain (LBP) associates with altered neural control of movement such as impaired lumbopelvic coordination [1,2] and delayed anticipatory postural adjustments with

arm movements [3]. Rehabilitation programs attempt to remediate postural impairments that contribute to LBP; however, they fail to demonstrate superior long-term treatment outcomes. One possible reason is that patients do not perform the exercises accurately due to a lack of time and cost-effective means to objectively assess movement impairments in the clinic. This protocol examined whether wearable inertial motion monitors can effectively discriminate between patient-selected vs. clinician-modified lumbopelvic coordination patterns of persons with LBP during a quadruped arm-raising task. METHODS: 16 persons with a history of chronic LBP wore wireless inertial sensors (Opal ©, APDM, Inc) on the lumbar spine (L1 and L5 spinous processes) and pelvis. Subjects performed 3 quadruped arm raises with each arm using their preferred, self-selected movement pattern, during which a physical therapist (PT) observed lumbopelvic movement patterns (i.e., unmodified trials). Following these 3 unmodified trials, the PT attempted to correct observed movement impairments with instruction using both verbal and tactile feedback, after which subjects performed 3 unassisted arm raises while attempting to incorporate the PT's feedback (i.e., modified trials). Paired t-tests were used to assess differences in the ranges of lumbar spine motion between the unmodified and modified trials. RESULTS: For space, only results from the right arm raises are presented. The PT's modifications resulted in increased trunk rotation ($p = 0.02$) and in reduced trunk sidebending ($p = 0.05$) motion but trunk flexion and extension motion were not significantly reduced with the PT's modification ($p=0.08$). CONCLUSIONS: The inertial motion sensors were successfully able to delineate between unmodified and modified trials for trunk rotation and sidebending. The motion sensor data revealed that the PT modifications were effective at changing unwanted trunk sidebending motion but not rotation during this task . However, our previous work suggests that range of angular motion may not be as sensitive to PT modification as changes in angular velocity [1]. Thus, it appears that PT modification in the quadruped arm raise task primarily reduced the speed at which the lumbopelvic rotation occurred, rather than the range of motion. Objective data from inertial sensors, combined with PT evaluations, may improve clinicians' ability to diagnose, prognose and subgroup people with LBP in ways that direct treatment, examine response to treatment and may lead to the development of new, clinic-friendly tools to quantify lumbopelvic movement impairments. REFERENCES: [1]Jacobs et al. (2012). J Orthop Sports Phys Ther 42:A77-A78. [2]Silfies, et al. (2003). Human movement science, 22(3), 237-252. [3]Hodges & Richardso

P3-R-121 Evaluation methods of CB-Brace for knee osteoarthritis.

Yasuhiro Mine[1], Yoshiyuki Kobayashi[2], Kaoru Kimura[3], Tamotsu Sakima[3]

[1]Toyo University, [2]National Institute of Advanced Industrial Science and Technology, [3]SAKIMA Prosthetics & Orthotics Co.

Introduction: Knee-Osteoarthritis (K-OA) is attributable to denature or deteriorate of meniscus or cartilage in the knee joint by aging and obesity, this symptom become difficult standing position and gait by pain of the knee. It is said that the number of K-OA Patients in Japan are about 7 million peoples. In order to correspond to this disease, Tamotsu Sakima of SAKIMA Prosthetics & Orthotics Co. developed the double hinge knee brace with center bridge(CB brace). As the specification of CB brace, the medial compartment is corrected by 3 point support correction to be kept high rigidity by the center bridge at the back of knee orthotic, so that the load and the pain by the K-OA can be effectively alleviated. Methods: The purpose of this study establishes an evaluation method by gait analysis for quantitatively evaluating on the improvement in the gait of CB brace user. Optical three dimensional motion capture

analysis system was used for gait analysis. We configured three measurement methods.①The line connecting hip joint and center of ankle joint is called Mikulicz line, we confirmed the ratio of the medial compartment of knee by measuring gap between center of knee joint and Mikulicz line.②We carried out gait analysis without wearing and wearing 6 kinds of knee orthotic. In order to distinguish stance phase and swing phase in measurement environment without a force plate, we developed method to be recognized to camera by lighted red LED self-luminous marker of the same wavelength to compare stroboscopic device of camera. Also, the extent of the knee pain of the each subject can be objectively determined by referring visual analogue scale for each trial.③We carried out measure to structure characteristic of duralumin-made CB brace during gait. Results: These measurement results of Mikulicz line were able to confirm the gap ratio by cause varus deformity. The results of gait analysis without wearing and wearing 6 kinds of knee orthotic were shown. The average of VAS without wearing knee orthotic was 26.7. To be less than this number was effective to relieve the pain by wearing knee orthotic. Also there is a tendency to increase of gait speed to relieve the pain. At the measurement of structure characteristic of CB brace, we obtained the result to the average of rotation angle at center of joint arm. Conclusion: This time, we carried out gait analysis of knee orthotic using optical three dimensional motion capture analysis system. Thus, it is suggested that relation between VAS for evaluations of knee pain and gait speed can evaluate suitability of wearing knee orthotic. In future, we will consider establishing evaluation methods of CB-Brace based on these obtained data.

P3-R-122 Comparison of performance on the Balance Evaluation Systems Test (BESTest) and Sensory Organization Test (SOT) in community dwelling older adults

James Moore[1], Neva Kirk-Sanchez[1], David Mandel[1]

[1]University of Miami

BACKGROUND AND AIM: The Balance Evaluation Systems Test (BESTest) is a comprehensive, clinical balance assessment that examines six balance control systems: biomechanical constraints, stability limits/verticality, anticipatory postural adjustments, postural responses, sensory orientation, and stability in gait. The sensory orientation section uses the Modified Clinical Test for Sensory Interaction on Balance (mCTSIB) to identify any increase in body sway associated with altering visual or surface somatosensory information. The mCTSIB has been described as a "derivative" of the Sensory Organization Test (SOT). The SOT objectively identifies deficits in the use of the three sensory systems that contribute to balance and postural control: somatosensory, visual and vestibular. The purpose of this study was to examine the construct validity of the BESTest for community-dwelling older adults by examining the relationship between scores for each system/section of the BESTest, specific items from each section of the BESTest and scores from the SOT and each of the six conditions of the SOT. METHODS: Thirty-nine community-dwelling older adults recruited from the Miami-Dade community participated in the study: mean age of 74.8 ± 8.05 years, 15.1 ± 3.5 years of education, 72% female, and 51% Hispanic/Latino. Subjects participated in a balance screening which included the BESTest, 10 meter walk test at slow and fast speeds, and the SOT. Pearson product-moment correlation coefficient was used to determine the presence and magnitude of relationships. RESULTS: The sensory orientation section and total BESTest score were moderately correlated to the composite SOT score ($r=0.54$, $p=0.003$) and to conditions 2 (eyes closed, fixed surface)($r=0.53$, $p<0.001$), 3 (eyes open, fixed surface, sway-referenced visual surround)($r=0.43$,$p=0.006$), 5 (eyes closed, sway-referenced surface) ($r=0.48$,$p=0.002$), and 6 (eyes open, sway-referenced surface and visual surround)($r=0.54$,$p=0.001$).

Specific items of the BESTest were moderately correlated to composite SOT score: forward lean (r=0.43,p=0.01), single leg stand (r=0.44,p=0.007). Specific timed items of the BEST were moderately inversely correlated (p<0.001) with the composite SOT: gait with obstacle (r=-0.58), dual task Timed Up and Go (r=-0.61). The time to complete the 10MW at normal (r=-0.55) and fast (r=-0.50) speeds was also moderately inversely correlated (p<0.001) to the composite SOT. CONCLUSIONS: In this study, the SOT composite score was related to the sensory orientation score of the BESTest and to several physical performance tests known to be affected by balance. The results of this study support the validity of the BESTest for the assessment of balance and postural control in a community-dwelling population. The BESTest provides the clinician with a non-instrumented clinically feasible option for balance assessment.

P3-R-123 Content validity and feasibility of a survey to investigate participation in gait rehabilitation studies by individuals with stroke

Kara Patterson[1], Nicole Gallant[2], Tracey Ormiston[2], Mandy Whitechurch[2], Chad Patience[2], Janet Brown[2]

[1]University of Toronto, [2]Western University

BACKGROUND: One of the most difficult aspects of research is recruitment[1]. Information about factors influencing participation exists for stroke medical trials[2] but not for post-stroke gait rehabilitation trials. Post-stroke gait research participation may be influenced by different factors (e.g. sensorimotor and gait impairments)[3]. An important first step, and the primary aim of this work, is to develop a tool to assess factors influencing post-stroke gait research participation. Survey feasibility and content validity was examined in addition to the relationship between survey responses and sensorimotor and gait impairment. METHODS: The survey (validated by 12 content experts) contains descriptions of 8 hypothetical gait studies for which respondents indicate if they would participate (willingness to participate in a hypothetical study predicts actual participation[4].) The hypothetical studies varied in location, time commitment, visit duration and participant effort. Survey feasibility (defined as comprehended by participants; completed in 20 minutes; returned a range of responses) was investigated with individuals post-stroke. Data extracted from patient charts included velocity, swing time and step length symmetry ratios[5] as measures of gait impairment and Chedoke-McMaster Stroke Assessment (CMSA) leg and foot scores as measures of motor impairment (0-7; 7=no impairment.) The relationship between these variables and the total number of studies to which individuals agreed to participate (TOTSTUDY) was examined with Pearson correlations. RESULTS: Participants (n=18; mean (SD) time post stroke =36.8(11.2) days) completed the survey without difficulty in a mean of 7.5(3.6) minutes. Mean CMSA leg and foot scores were 5.8(0.8) and 5.5(0.9) respectively. Mean preferred velocity was 0.86(0.27)m/s and swing time and step length symmetry were 1.17(0.28) and 1.11(0.12) respectively. Mean TOTSTUDY was 5.2(2.9) and TOTSTUDY was significantly associated with velocity (r=0.52, p=0.03.) The largest proportion of respondents (83%;) agreed to participate in a single 1-hr session at home without any measurement devices (e.g. EMG). The smallest proportion of respondents (44%) agreed to a laboratory study with 2- 2.5hr visits/wk for 6wks with multiple measurements. CONCLUSIONS: Survey administration in the stroke population is feasible. Preliminary results suggest that the number of gait studies in which a post-stroke individual may participate is related to their gait function. Ongoing work will include a larger group of individuals with a greater range of function. The results may provide insight for recruitment strategies and design of future gait studies. REFERENCES: [1] Blanton S et al. Phys Ther 2006;86:1520-33. [2] Kasner SE et al. Neurology 2009;72:1682-88. [3]

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P3-R-124 Visual sampling in Parkinson's disease: current methodological issues

Samuel Stuart[1], Lisa Alcock[2], Brook Galna[2], Sue Lord[2], Lynn Rochester[2]

[1]Institute for Ageing and Health, [2]Institute for Ageing and Health/Newcastle University

BACKGROUND: Visual sampling (VS) is described by the combination of fixations and saccades required to gather information about the environment when completing a task. VS measurement is used to investigate the complex role of vision during real-world activities in Parkinson's disease (PD). Earlier research is limited to static simple motor tasks (e.g. button pressing or mouse clicks) or measurement of VS alone via computer testing, but more recent investigations involve VS measurement during real-world activities (e.g. walking, driving, obstacle crossing etc.). However, there remains no gold standard for the measurement or reporting of VS during such activities. Accordingly, the objective measurement of VS varies with respect to instrumentation, testing protocols, and mediating factors that may influence VS. AIM: The aim of this review was to examine previous literature measuring VS during real-world activities in PD to inform the development of robust protocols. Within this review a real-world activity was considered to be a goal-orientated motor task involving more than one body segment (e.g. reaching or walking). METHODS: Medline, Embase, PsychInfo, Scopus, Web of Knowledge, PubMed and the Cochrane library databases were searched. Two independent reviewers and an adjudicator screened articles that described quantitative VS in healthy controls and PD. RESULTS: Twenty full-text articles were screened and 15 met the inclusion/exclusion criteria. A wide range of instruments (i.e. electro-oculography; n=7, head-mounted eye-trackers; n=5, desk-mounted eye-trackers; n=1, and 2D video capture; n=2) and outcome measures were reported which were generally used in a task-dependent manner. Temporal resolutions were lower (50 - 60 Hz) for devices that allow mobility compared to static VS devices (1000 Hz), which impacts on precision and accuracy of outcomes tested. Instrument reliability and validity was insufficiently reported across all studies, and few considered mediators of VS such as visual or cognitive deficits which are common in PD. CONCLUSIONS: Future research is required to accurately characterise VS impairments in PD during real-world activities. No single measurement or combination of measurements has been identified as the most informative indicator of these processes. Although mobile eye-trackers provide the most comprehensive measurement to date, the validity and reliability of using such devices during real-world activities in older adults or PD has yet to be determined. To aid the development of more robust protocols we propose a series of recommendations for future VS research protocols, such as the use of ≥50Hz devices for saccade detection and the routine assessment of visual and cognitive impairments.

P3-R-125 Test re-test reliability of center of pressure measures of standing balance in people with knee osteoarthritis

Judit Takacs[1], Mark Carpenter[1], S. Jayne Garland[1], Michael Hunt[1]

[1]University of British Columbia

BACKGROUND AND AIM: Balance is necessary for independent function, and deficits in balance are associated with an increased risk of falling. Assessment of changes in standing balance following an intervention requires accurate measurement of one or more balance parameters. One of the most

common methods of measuring standing balance is using a force platform, with outcomes assessing the velocity, variation, and displacement changes of the centre of pressure (COP). Since falls are common in positions where only one leg is stable on the floor [41% of falls occur during weight shifting], it is important to assess standing balance in positions that are more challenging and reflective of functional ability, such as single-leg stance. The reliability of COP measures of balance during single-leg standing has not been reported in individuals with knee osteoarthritis (OA), who have known deficits in balance. Reliability data of balance measures in more challenging positions such as single-leg standing are needed in order to determine which measures of balance may be optimal for use in future studies, such as training interventions. Therefore, the purpose of this study was to assess the test re-test reliability of COP measures of standing balance during single-leg stance in older adults with knee OA. METHODS: Adults aged 50 and older with radiographic evidence of knee OA performed single-leg standing balance trials on a laboratory-grade force platform on two occasions, no more than 14 days apart. Participants were asked to stand on their more symptomatic limb with arms by their sides and head facing forward for three, ten second trials. COP measures collected included: standard deviation in the mediolateral and anteroposterior directions, mean path length, mean velocity, and mean area. The mean of the three trials was calculated. Intra-class correlation coefficients (ICC), standard error of measurement (SEM) and the minimum detectable change (MDC) were calculated for each variable. RESULTS: ICC values ranged from 0.54 - 0.87, suggesting mixed reliability of measures. Reliability was lowest for the COP area (ICC = 0.54), and highest for COP velocity and path length (ICC = 0.87 for both). SEM values were low for standard deviation in the mediolateral direction and COP path length, and highest for COP area. ICC, SEM, and MDC values can be found in Table 1. CONCLUSIONS: These results suggest that COP values, in particular path length and velocity, are appropriate for assessment of standing balance in people with medial knee OA. Further, MDC values can be used to assess meaningful change in standing balance following treatment.

P3-R-126 Flexibility of turning strategies while walking in healthy adults

Naofumi Tanaka[1], Ryushin Hashiba[2], Hiroki Hashikami[2], Shino Kazahari[2], Asako Hirayama[2], Yoshihiro Muraoka[3], Shin-Ichi Izumi[1]

[1]Tohoku University Graduate School of Medicine, [2]Medical Court Hachinohe West Hospital, [3]Waseda University

BACKGROUND AND AIMS: Turning while walking is a complex task requiring postural adjustment and modification of the motor program during turning to change direction. It is an essential locomotor activity for everyday living. Impaired turning is associated with a high risk of falls. Previous studies have identified two main strategies for turning: spin turn and step turn. The aim of this study was to investigate whether the preference for spin or step turns while walking was different between when the direction in which to turn was predetermined and randomly determined just before turning in healthy adults. METHODS: Twenty healthy adults (mean age ± standard deviation; SD, 26.5 ± 5.4, 10 women) participated in this study. They were instructed to walk straight ahead at their usual pace until they were to turn 90° to the right or left during the right stance phase of walking, in response to an acoustic cue one step before turning when the left foot was contacted on the floor (cueing task), or according to the direction indicated before they walked (predetermined task). For the cueing task, four different types of cues (no cue, cue to turn right, cue to turn left, cue to keep walking straight) were prepared. When no cue was delivered, the subjects were to keep walking straight. Two cues of each type, making

eight cues in total, were delivered in random order. For the predetermined task, two trials of each of three different directions (right, left, straight) were conducted. Turn type was determined using a three-dimensional motion analysis system consisting of six cameras. Trunk sway in the roll (medio-lateral) and pitch (antero-posterior) directions was measured using an inertial sensor strapped to the lower back. We used paired t-test to compare the effect of the task condition on balance. Statistical significance was set at $P<0.05$. RESULTS: While all participants except one preferred spin turn in the predetermined task (97.5% of trials in all participants), 13 participants preferred step turn in at least one of the two trials in the cueing task (47.5% of trials). The means (± SD) of the maximum ranges of roll and pitch angles did not differ between the two task conditions (8.4 ± 2.2 and 7.3 ± 2.7 degrees for roll angle in cueing and predetermined task; 6.6 ± 2.0 and 6.5 ± 1.5 degrees for pitch angle in cueing and predetermined task, respectively). CONCLUSIONS: Healthy young adults in our study preferred step turn in the cueing task while they preferred spin turn in the predetermined task. These task conditions could be useful for clinicians who wish to evaluate the flexibility of frail older adults in selecting turning strategies.

P3-R-127 ESTIMATING CENTER OF PRESSURE AND CENTRE OF MASS PATTERNS IN STROKE SUBJECTS DURING DAILY LIFE ACTIVITIES USING FORCE SENSING SHOES

Fokke Van Meulen[1], Jasper Reenalda[2], Corien Nikamp[2], Jaap Buurke[2], Peter Veltink[1]

[1]Unversity of Twente, [2]Rehabilitation Center het Roessingh

Background and aim: Stroke is associated with impaired balance control, which may decrease the performance of activities of daily living (ADL). Up till now, balance control often is assessed in the clinical setting using standardized clinical tests (like the Berg Balance Scale (BBS)) or using force plates in the laboratory setting. However, these tests provide limited information about the performance of stroke patients during ADL. Recent developments in sensor technology enable the measurement of relevant balance parameters like center of pressure (CoP) and center of mass (CoM) using special shoes containing force sensors and inertial sensors. This way, balance parameters can be assessed while performing ADL without the restrictions of a lab environment. The aim of this study is to evaluate CoP and CoM movement patterns in stroke patients, during activities of daily living while wearing instrumented shoes containing force sensors and inertial sensors. Methods: Currently, nine of a planned total of twenty individuals with a history of stroke have been included. Subjects walked in a straight line over 10 meters and performed a predefined ADL task while wearing the instrumented shoes. The ADL task was defined as a sequence of the following activities: sitting, rising up from a chair, walking to another room, opening a door, manipulating an object while standing and finally returning to the start position. The instrumented shoes included two force sensors and two inertial sensors per shoe (ForceShoes? - Xsens, Enschede, the Netherlands). The position of the CoP, relative to the position of both feet (in the frontal plane) was measured at a rate of 50 samples per second. The position of the CoM was estimated by low-pass filtering the CoP position at a cut-off frequency of 0.4 Hz. Results: The CoP patterns vary per individual and per task. During stance and walking in a straight line, individuals generally show a small shift of the mean CoP position and CoM position to their non-affected side. While performing the more difficult predefined ADL task, the mean CoP position and the CoM position shifts more towards the individual's non-affected side. Conclusions: The use of force shoes enables the measurement of balance parameters during ADL tasks without being restricted to a laboratory environment. CoP and CoM movement patterns measured during ADL tasks can give more insight in balance control of individuals than current clinical tests or lab measurements with force plates. Results

indicate that in more demanding tasks, the mean CoP and CoM position shifts more towards the non-affected side compared to walking in a straight line. ACKNOWLEDGEMENT This study is part of the INTERACTION project, which is partially funded by the European Commission under the 7th Framework Programme (FP7-ICT-2011-7-287351)

P3-R-128 Inter- and intra-tester reproducibility of the Unipodal Test of Pelvic Stability

Philippe Villeneuve[1], Marie Geronimi[2], Anne Laure Broise[3], Pierre Marie Gagey[3]

[1]Institut de Posturologie, [2]Université du Sud Toulon Var , [3]Association posturologie Internationale

This study evaluate the reproducibility of the Unipodal Test of Pelvic Stability. Results reveal a good intra but lesser inter-practitioner reproducibility. BACKGROUND AND AIM: Clinically, the efficiency of the stabilizing muscles of the hip could be evaluated by the Unipodal Test of Pelvic Stability (UTPS). The UTPS consist by the observing of the relative position of the posterior-superior iliac spine when the patient is stabilized on one leg support. A pelvic lowering in the opposite side of the supporting leg should be the effect of a disease of the stabilizing muscles of the hip on the side of the support. The purpose of this study is firstly, to test the reproducibility intra- and inter-practitioner of the Unipodal Test of Pelvic Stability (UTPS) and secondly, to verify if this test can be instrumentally highlighted with a podobarometric platform and inertial sensors. METHODS: Sixteen healthy subjects which five women and eleven men (34,3 years ± 10,6 : 170,7 cm ± 9,9 : 67,0 kg ± 16,8) are volunteers to take part to this experimental study. They had to maintain itself on the supporting leg during 30 seconds without moving. in a random order, three podiatrists clinically evaluate every subject and each leg during two test sessions, with a 15 minutes resting time. Simultaneously, a podobarometric platform (WinGP 40, BioRescue) and two inertial sensors (MotionPod, Bioval) are synchronized thanks to the RM.Lab software (RM engineering, France) to do the instrumental recordings. RESULTS: The statistical analysis don't reveal significant differences between the two tests of the same practitioner ($p > 0.05$). This result shows that the clinical observations made for the 1st session and for the 2nd session are similar for the same practitioner and the same subject which confirms the reproducibility of the UTPS in intra-practitioner. On the contrary, we show a significant effect on the inter-practitioners reproducibility ($p=0,037$). So, the UTPS test significantly differs between practitioners in the context of this experimental study. Besides, the instrumental measures did not allow to highlight differences between a positive or negative test ($p > 0.05$). CONCLUSIONS: This study shows that the Unipodal Test of Pelvic Stability (UTPS) represents a reproducible and easy usable test in clinical practice for podiatrists. The conditions of execution of the test (the body and arms positions of the practitioners during the evaluation, hand pressure on the patient) could impact his lesser reproducibility in inter-practitioners observations. New investigations should improve the standardization of the conditions of execution of the UTPS test and the reproducibility inter-practitioners.

P3-R-129 Examining Falling Behaviour in Young Adults with a 2D Perturbation Platform

Stephen Robinovitch[1], Shane Virani[1], Colin Russell[1]

[1]Simon Fraser University

Background and aim: The goal of this study was to develop and test the feasibility of an experimental paradigm for examining falling strategies in young adults with a perturbation platform. The experiment utilizes a two-dimensional perturbation platform of surface area 2 x 2 m, covered by a firm gymnasium

mattresses, and driven by orthogonal linear motors. The platform can translate in any direction in the horizontal plane with a displacement (from it's centre position) of up to 0.8 m, a velocity up to 2.2 m/s, and acceleration up to 10 m/s^2. Methods: Nine individuals participated in the experiment (5 men and 4 women), ranging in age from 18 -28. Participants were instructed to walk back and forth on the platform at a natural pace a distance of 1.5 m. Each trial involving the same perturbation distance, velocity and acceleration (using the maximum values described above), with randomization of the perturbation direction (forward, backward, and sideways) and activity at the time of the perturbation. In particular, perturbations were randomly applied at the instant of heel contact during the stance phase of walking (based on feedback of the signal from an underlying force plate), before walking commenced, or at the end of walking. In each trial, the participant was instructed that "their balance may be perturbed and they were to maintain their balance." Limb, head, and trunk positions were recorded at 240 Hz with an eight-camera motion capture system (Eagle system, Motion Analysis Inc., CA, USA). Results: We observed striking differences in the nature and effectiveness of balance recovery responses between perturbations delivered while walking versus standing. For example, in backward perturbation applied during standing, participants fell in 100% of trials and completed two or more recovery steps in only 29% of trials. In contrast, when perturbed while walking, falls occurred only 30% of the time, and two or more recovery steps were completed in 68% of trials. Furthermore, the first step was commenced on average over 100 ms earlier when delivered while walking versus standing (385 (SE = 19.4) versus 487 (SE = 31.6) ms; $p < 0.009$ by paired t-test), reflecting the task-specific nature of stepping-based balance recovery responses. We also observed strong repeatability between the first and second responses for a given perturbation condition. Conclusions: This study illustrates a feasible protocol for examining falling responses with a perturbation platform, and interesting preliminary observations on the effect of context (walking versus standing) on the nature and effectiveness of balance recovery responses.

P3-R-130 New Maximum Entropy Method(MEM) power spectrum notation of the stabilometry

Masahiko Yamamoto[1], Tomoe Yoshida[1], Fuyuko Ikemiyagi[1], Mitsuya Suzuki[1]

[1]Toho University

BACKGROUND AND AIM: The frequency power analysis of stabilometry is greatly unbalanced in the power ratio to low frequency to be shown at the power distribution ratio every frequency. Therefore, the power spectrum evaluation of a high frequency spectrum is difficult. The power spectrum distribution of frequency peculiar to a disease tends to show a high frequency spectrum. Then, how to display high frequency power spectrum was examined and a new power notation was developed. METHODS: We used MEM as the power spectrum analysis and ANIMA G5500 for stabilometer. The power distribution shown in a normal example was assumed to be unnecessary power, and the analytic method which eliminates the power which is common in a normal value average was examined. Since power distribution changed with age also in a normal example, we made the normal power value classified by age (normal mean) from 10 years old to 80 years old every 10 years old. Furthermore, it found the power for every frequency by the ratio of a case power value / normal value power. The frequency band where the case and normal example have a same, power level becomes one. The ratio calculated by this analysis method, so that normal level power is small, the ratio becomes large. Furthermore, the power value of disease cases with normal value approximations appear small. As an example of analysis, the progress data of the example of a vestibular neuritis of 61 years old was used.

RESULTS: The stabilometry data of vestibular-neuritis was recorded, and MEM analysis was conducted. The ratio was calculated by the normal MEM average power value which carried out the age compensation of the analytical data. We can see that the power distribution changes over the course from the acute phase. Further, it was possible to see the changes in the high frequency power ascertaining ever been difficult. CONCLUSIONS: Because this analytical method is the ratio with the normalcy, it is different from the real power level. But it is possible to reveal the frequency of small power distribution. We understood that it could clarify frequency power of the small high frequency area of the power distribution. Show the Figure.

P3-R-131 A novel interpretation of postural control with ensembled EMD embeded DFA

Junhong Zhou[1], Jue Zhang[1], Jing Fang[1]

[1]Peking University

Summary: we used a modified detrended fluctuation analysis to characterize the postural control and found the scaling properties of the fluctuation of posture are varied into three strategies and differences between older and younger adults could be observed. Background: To characterize the properties of postural control, many approaches were utilized. One of the most typical methods to quantify the scaling property of postural fluctuation, which is a non-stationary signal, is detrended fluctuation analysis (DFA). The determination of the scales is essential to the evaluation in DFA and in prior empirical mode decomposition (EMD) was used and found a similar result as stabilogram diffusion analysis. However, even in the EMD, due to the aliasing modes in each intrinsic mode function (IMF), the interpreted properties were not consistent in any time. Method: We now use the ensemble EMD (EEMD) to find the intrinsic scales before the DFA calculation. The ensemble EMD first adds the white noise into the original signal and after hundreds of repeated decomposition processes, the final average results will 1) give more accurate IMFs than normal EMD; 2) no disturbance from the added noise to the signal due to the averaging effect. Thus this EEMD-DFA method might have a more précised interpretation to the signal with more stable intrinsic scales. We first estimated the evaluation accuracy of EEMD-DFA comparing to conventional DFA with random noise of which the scaling exponent a=0.86. And then 10 younger and 10 older subjects were involved and each of them finished 30sec eyes-open standing test to recording the center-of-pressure (COP) data with the sampling frequency at 1000Hz. Then the raw anterioposterior fluctuations were used for analysis without residue from the EEMD calculation. Results: after the EEMD-DFA calculation, the result of known noise showed in Figure 1A and it is clearly that this new EEMD-DFA method has enough accuracy for the evaluation to the correlation property of the time series. Then we could see very consistent scaling changes in both older and younger adults, and typical results are shown in Figure 1B. Three different properties existed for all the subjects, that is, for the older , ashort=1.12±0.13, amid=0.03±0.03, and along=1.53±0.24; for youngers, ashort=0.97±0.13, amid=0.06±0.06, and along=1.16±0.26. Over the time scales, the younger adults showed a higher anti-persistent as well as a more smooth change during the switch of different strategies while the older showed their postural control over time scales distinguished much. Conclusions: According to the EEMD-DFA analysis, we could find stable and age-related scaling properties existed in the postural control for human. The age-related loss of physiological function might result in a more unstable and less tightly controlled postural system as well as much varied strategies which might induce high possibility of falls.

P3-S-132 The effects of adding Vestibular Rehabilitation Therapy to Benign Paroxysmal Positional Vertigo (BPPV) intervention plan on balance of elderly patients: initial findings of the RCT

Nandini Deshpande[1], Karyna Figueiredo - Ribeiro[2], Ricardo Guerra[2], Raysa Freitas[2], Rafaela Santos[2], Bruna Oliveria[2], Camila Silva[2], Lidiane Ferreira[2]

[1]Queen's University, [2]Universidade Federal do Rio Grande do Norte

BACKGROUND AND AIM: Benign Paroxysmal Positional Vertigo (BPPV) is considered to be the most common peripheral vestibular disorder. It is estimated that 25% of the patients affected by dizziness aged 70 and above have BPPV. The gold standard treatment for BPPV, recommended for any age, is the Canalith Reposition Maneuver (CRM). However, after the treatment the patient may continue to demonstrate poor postural stability[1,2]. The purpose of this study is to evaluate the effects of an additional Vestibular Rehabilitation Therapy (VRT) on balance performance of elderly patients with chronic BPPV. METHODS: In this ongoing randomized controlled trial 7 older adults (age: 69.4± 4.79 years) were recruited in the experimental group that underwent CRM, as needed, and balance VRT for thirteen weeks. Five older adults (age: 73.0± 2.24) in the control group were treated using only CRM, as needed. The participants were evaluated at the baseline, one week and thirteen week using the casual gait speed in 6m, Dynamic Gait Index (DGI) and the mean Center of Pressure (CoP) sway velocity of the modified Clinical Test of Sensory Integration on Balance (CTSIBm) on the NeuroCom Balance Master System. Baseline group differences in age, sex, and Body Index Mass (BMI), DGI, gait speed and CoP velocity were assessed using Mann Whitney test. At the one week and thirteen week assessment between group differences in DGI, gait speed and mean CoP sway velocity were assessed by the Mann Whitney test. The Wilcoxon test was performed to compare the within group improvement in DGI, gait speed and CoP velocity between baseline and one week and one week and thirteen week. RESULTS: No significant differences were found between the two groups at baseline (all p values >.05). Differences between the groups were not significant at one week assessment (p>.05) either. At thirteen weeks assessments the experimental group had higher DGI scores (p=.003) than in the control group. In within group comparisons the experimental group's DGI and CoP mean sway velocity significantly improved (p<.05) from baseline to one week assessment and one week to thirteen weeks assessment. The casual gait speed in the experimental group significantly improved from the baseline to the one week assessment (p=.046). There was no significant difference over time in casual gait speed in the control group (p>.05). Compared to baseline, the control group significantly improved their DGI at the one week assessment (p=.042) and CoP mean sway velocity at the thirteen week assessment (p=.042). CONCLUSIONS: This is an ongoing study. The initial findings suggest that the patients who received additional balance vestibular therapy exercises demonstrated overall better trends in balance improvement compared to those who received only CRM. References 1. Chang WC et al. Clinical Rehabilitation 2008;22:338-47. 2. Blatt PJ et al. The American Journal of Otology. 2000;21:356-363.

P3-S-133 Otolith dysfunction caused by acoustic neuroma affects head stability during gait

Kazuo Ishikawa[1], Yoshiaki Itasaka[1], Eigo Omi[1], Koh Koizumi[1]

[1]Akita Graduate School of Medicine

BACKGROUND AND AIM: Gait instability is caused by vestibular lesion, and most of them were measured by the analysis of foot and leg movement in addition to gait shift so far. However, what kind of changes

of head movement during gait are to be resulted in cases with peripheral vestibular lesion has not been fully elucidated. We have examined this in patients with acoustic neuroma (AT) who have functional abnormality of superior or inferior vestibular nerve or both. METHODS: Fifteen patients (5 males, 10 females; mean age: 52.9 years old; mean height: 162.3 cm) with unilateral AT and nine age and height matched healthy subjects as a control were enrolled in this study. Subjects were asked to walk freely with comfortable pace with eyes open and eyes closed at a distance of about four meters. Spatiotemporal components, including gait speed, stride length, stride duration, step width, head movements in three plane, gait shift, toe swing, foot's extension flexion angle were measured by three dimensional movement analysis system. In this study, the analysis was mainly focused on head movements and peripheral vestibular function. Functional status of superior and inferior vestibular nerve was examined by measurement of cervical and ocular vestibular evoked myogenic potential (cVEMP & oVEMP), and comparison was made between the groups. As for the statistical analysis, one-way ANOVA with post hoc analysis was employed. RESULTS: In AT cases, two cases had normal cVEMP and oVEMP. three cases had abnormal cVEMP with normal oVEMP, three cases had normal cVEMP with abnormal oVEMP, and seven cases had abnormal cVEMP and oVEMP. Most of the cases with abnormal oVEMP had CP (canal paraesis). Regarding those abnormality and head movement, AT cases had greater horizontal sway movement, especially in cases with oVEMP abnormality. AT cases with cVEMP abnormality had greater pitch and roll movement than that of the control, especially under gait with eyes closed. No significant change was found in head movement of yaw plane. CONCLUSIONS: It is deemed that peripheral vestibular system abnormality affect the head stability during gait. In addition, superior vestibular nerve system and inferior vestibular nerve system could affect the stability of head during gait in different plane, although yaw plane was relatively stable. These findings were more clearly seen under gait with eyes closed.

P3-S-134 Management of Vertigo And Difficulty Of Gait Caused by Head Injuries

Eigo Omi[1]

[1]Akita University School Of Medicine

Objective: Various kinds of central to peripheral vertigo symptoms are usually caused by blunt trauma of head that can result from injuries such as falls, whiplash type injuries, contact injuries after impact with a solid object, among others. One of the well-known peripheral vertigo is the impairment of vestibular system of which the symptom of vertigo tends to appear in the early stage of injuries and often causes difficulty in gait. Our study is to evaluate patients after head injuries with vertigo associated with gait disorder and to report the results of treatment after extensive diagnostics. Method: Prospective study of consecutive new cases with vertigo after trauma at different periods of onset. During 2001-2012, 5 patients were examined and treated. Result: The average age is 45.8y.o (range 13 to 66y.o; male: 3, female: 2). 2 patient was suffered from temporal bone fracture, 2 patients of labyrinthine concussion and 1 patient of delayed endolymphatic hydrops. All patients underwent electronystagmography, caloric irrigation and audiography tests. In the acute stage of the onset, vigorous vertigo with horizontal rotatory nystagmus was observed in all cases. Canal pareses on the lesion vestibular organ were found in all patients. One of the patients, of temporal bone fracture, has a complication of total hearing loss, and the patient of delayed endolymphatic hydrops was suffered from moderate hearing impairment. On the other hand, the hearing capability was preserved in patients of labyrinthine concussion. All patients were free of vertigo symptoms after medical treatment. The follow-up was 1 year. Conclusion: Vertigo

(vestibular system impairment) associated with gait disorder caused by head injuries can be treated with a high success rate once the underlying disorder has been identified. Detail neurotological test batteries determine the precision and quality of diagnostics. Conservative treatment should be the first choice of treatment. However, surgical measurement should be considered as a part of treatment modalities if conservative treatment is not effective. Even a minor trauma of the head may cause major impact on the vestibular system at different sites. Therefore, patients need to be carefully diagnosed in the early stage of onset for proper treatment.

P3-S-135 Balance control dynamics and sensory reweighting investigated using combinations of pseudorandom surface-tilt and galvanic-vestibular stimuli

Robert Peterka[1], Adam Goodworth[2]

[1]Oregon Health & Science University, [2]University of Hartford

BACKGROUND AND AIMS: A previous study using surface-tilt stimuli (STS) with galvanic-vestibular stimuli (GVS) showed reciprocal reweighting of vestibular and proprioceptive contributions to balance control in eyes-closed subjects [1]. The present study expands upon this earlier study by characterizing balance control in a much wider range of test conditions. METHODS: Standing balance of 9 young adults was perturbed in a manner that evoked frontal-plane body sway in 9 different test conditions. All tests were performed with eyes closed at a fixed stance width. Perturbations consisted of pseudorandom stimuli: 1) STS (2° or 4° amplitudes), 2) galvanic vestibular stimuli (1.5mA amplitude during stance on a fixed surface; 0.75mA and 1.5mA on a sway-referenced surface), or 3) simultaneous STS and GVS in 4 amplitude combinations (2° STS with 0.75, 1.5, or 3mA GVS; 4° STS with 1.5mA GVS). The STS and GVS waveforms were mathematically uncorrelated so sway responses to the two stimuli could be separately analyzed. Frontal plane center-of-mass sway angle was measured. Fourier analysis was applied to the stimulus and sway response to compute frequency response functions (FRFs) that characterized the dynamic properties of balance control in each test condition. FRFs were expressed as gain and phase functions. RESULTS: FRF results from the various test conditions were compared to identify differences in sway dynamics between responses to STS and GVS stimuli, amplitude-dependent changes that could be indicative of sensory reweighting, and interactions between simultaneously presented STS and GVS. The overall shapes of FRF gain and phase curves from STS and GVS responses were qualitatively similar but differed in details. The peak gain of GVS FRFs occurred at a lower frequency (0.3-0.4 Hz) than STS FRFs (~0.6 Hz) and GVS phases had greater lags across the entire bandwidth of test frequencies (0.03-2 Hz). Results from simultaneous STS and GVS showed asymmetric interactions. When STS amplitude was increased from 2° to 4° while GVS amplitude remained at 1.5mA, the STS FRF gain decreased and GVS gain increased, consistent with a coupled reweighting of proprioceptive and vestibular contributions to balance. However, when the GVS amplitude increased from 0.75 to 3mA while the STS amplitude remained at 2°, the GVS FRF gains decreased but the STS FRF gains showed little change. CONCLUSIONS: Evidence for reciprocal sensory reweighting was found with changes in STS amplitude but not with changes in GVS amplitude. This asymmetric effect was not expected. We speculate that the non-physiological nature of GVS, as suggested by the unusual dynamic characteristics of sway responses to GVS, may contribute to our unexpected results. Understanding how humans respond to GVS in a variety of conditions is important for future work aimed at utilizing GVS to improve balance control. Work supported by NIH grant DC010779. [1] Cenciarini and Peterka, J Neurophysiol, 95:2733-2750, 2006.

P3-S-136 Human perception of galvanic vestibular stimulation

Ryan Peters[1], Brandon Rasman[1], Timothy Inglis[1], Jean-Sébastien Blouin[1]

[1]University of British Columbia

Background and Aim: Galvanic vestibular stimulation (GVS) has long been used as a tool for probing vestibular control of balance during both quiet and perturbed stance, as well as during walking. The relationship between GVS current and postural responses has been characterized previously, however, we do not yet know the precise relationship between GVS current and the evoked perception of virtual head/torso movement. Knowing the relationship between GVS and perception would open the door for many new applications of GVS in the future. Methods: As a first step towards quantifying the perception of head/torso movement evoked by GVS, we tested the ability of participants to detect the direction of virtual movements. On each trial, we delivered a half-cycle sinusoidal pulse of bipolar binaural galvanic current with stimulus polarity presented randomly (inducing a perception of right or left rotation). With their head angled down towards their lap and fixed in position, participants performed single-interval two-alternative forced choice trials wherein they were asked to determine the direction of simulated head/torso rotation (right or left?). We used a Bayesian adaptive procedure to adjust sinusoidal pulse zero-to-peak amplitude across trials to obtain an estimate of each participant's psychometric function. Results: Preliminary results indicate that the ability to detect the direction of virtual head/torso movements decreases with increasing frequency. Larger peak amplitudes of GVS current are needed at higher frequencies to result in the same percent correct performance. This result stands in stark contrast to detection of mechanical rotations, which improves with increasing frequency. Conclusion: We speculate that two factors lead to this discrepancy between the perception of virtual (GVS) and mechanical rotations. First and foremost, galvanic current must pass through layers of tissue, bone, and CSF to reach the 8th cranial nerve which potentially low-pass filters the electrical stimulus. Conversely, mechanical rotation directly activates hair cell afferents which increase their firing rate with higher rotation frequency (i.e., the vestibular system naturally high-pass filters the input stimulus). A more subtle second point is that, with mechanical rotations, non-vestibular (e.g., somatosensory and auditory) cues could potentially enhance rotation perception.

P3-S-137 Visual dependence may be related to vestibular hypofunction in cerebral palsy

Yawen Yu[1], Maureen Maniulit[1], Richard Lauer[1]

[1]Temple University

BACKGROUND AND AIM: Cerebral Palsy (CP) is often considered as a movement disorder with major deficits in musculoskeletal components, such as abnormal muscle tone, limited range of motion, insufficient muscle strength. Relatively unknown is how sensory components play a role in postural control in individuals with CP. In our earlier work, individuals with CP have been shown to rely on visual information in balance control. In the current study, we aimed to examine the cause of visual dependence in individuals with CP. METHODS: Five adults with spastic diplegic CP and 7 adults with typical development (TY) participated in the current study. The Rod and Frame Test (RFT) was employed to exam the degree to which individuals rely on visual information. Participants were seated at a distance of 2 meters from a rear-projecting screen in a dark room, upon which a tilted frame and a rotating rod were presented. Each participant completed 4 trials for the horizontal condition, and 4 trials for the vertical condition. Participants were instructed to report immediately when the rod was

perceived as being horizontal (or vertical). Judgment errors were computed as the angular deviation from the true horizontal (or vertical). Head movement was monitored throughout the Rod and Frame Test with a triaxial accelerometer. Head acceleration data was further analyzed by taking the first and last 5-second window of each trial. RESULTS: Adults with CP exhibited significantly greater judgment errors than individuals with TY ($p = .036$). This indicates an increased visual dependency in individuals with CP. The head movement data revealed that different movement strategies were utilized for different judgment conditions (i.e., horizontal and vertical; $p = .015$). In addition, adults with CP exhibited greater variability in head movement than adults with TY during the early temporal window of each trial ($p = .012$). CONCLUSIONS: Our results demonstrated that adults with CP were more visually dependent as exhibited by greater perceptual errors in the RFT. This may be due to hypofunction of the vestibular system in individuals with CP. To compensate for such deficits, greater variation in head movement may be utilized to generate more above threshold signal for the vestibular system. This was particularly true in the early time window in where participants may assume the rod to be far from the target (horizontal or vertical). Nevertheless, the uniqueness of the current work was to demonstrate the connection between the head movement of the participants and the perceptual accuracy of subjective vertical and horizontal.