## **Poster Session 3**

### Tuesday, June 25 between 10:00 and 12:00

#### L - Falls and falls prevention; Aging

#### P3-L-152 Analysis Of 857 Cases With In-Hospital Falls

## *Hiroyuki Harada<sup>1</sup>*, Yasushi Naito<sup>1</sup>, Shyougo Shinohara<sup>1</sup>, Keizou Fujiwara<sup>1</sup>, Masahiro Kikuchi<sup>1</sup>, Yuuji Kanazawa<sup>1</sup>, Risa Tona<sup>1</sup>, Ippei Kishimoto<sup>1</sup>

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Background and aim: To reveal the risks of in-hospital falls and to work out countermeasures against them. Methods: We retrospectively evaluated 857 in-hospital falls which have been reported to risk-management department, out of 617275 patients who were hospitalized in our hospital from April 1, 2009 to June 30, 2011. The following factors were considered; (A) age, (B) main department, the primary disease, (C) the time zone in which the fall occurred, (D) presence or absence of psychotoropic drugs, (E) situation. We also investigated the complications of falling. Results: In-hospital falls occurred in 0.14% of all the in-patients. (A) The patients in their 70s were most likely to fall. (B) The falls happened most frequently in the department of neurology. (C) The largest number of falling occurred between midnight and 8 a.m., (D) 444 patients out of 861 were taking psychotropic drugs such as sleep pills and sedatives. (E) Most falling took place during moving between the bed and another place, often lavatory. Most complications of falling were mild injury such as bruise and there was no death. However ?@intracranial hemorrhage occurred in 3 patients, and 11 patients suffered from bone fracture. Conclusion: Old age, neurological diseases and psychotropic drugs may increase the risk of falls. The understanding of risks for in-hospital falls is important to protect patients against unexpected accidents in the hospital.

## P3-L-154 Using Motion Analysis in Single Leg Standing Task to Predict Fall Risk for the Elderly

## *Chun-Ju Chang*<sup>1</sup>, Yu-Shin Chang<sup>1</sup>, Sai-Wei Yang<sup>1</sup>

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BACKGROUND: Elderly with falling experience, age over 75 years old, or female may be the factor results in falling. In clinical evaluation, falling experience and Berg balance test are used to predict the fall risk between elderly, but both of them show ceiling effect. Based on our finding, we suggest that single leg standing time will be simpler and more accurately than other assessments to help predicting the fall risk among elderly, and COP trajectory can be an characteristic during the single stand task. METHODS: Step 1: We analyzed 30 elderly adults from previous study, and according to the falling experience, they were grouped into healthy and falling elderly group. Step 2: Then we followed up these subjects for 1 year, there was only 1 elderly falling down during this period, and it seemed that falling experience and BBS could not predict the fall risk accurately. The results also showed that community elderly with independently walking ability could stand by single leg between average 10.98 to 20.64 secs. We suggested using single leg standing time to help grouping the healthy (20 secs) and falling elderly(10 secs or less). Step 3: After the adjustments of grouping criteria, we recruited 24 elderly which could walk independently in this study. The subjects were between 65 to 75 years old, and without postural related diseases. All of them were informed to stand by dominant leg for at least 30 secs for 3 trials, and the standing time and the COP trajectory were acquired by 0.5m foot pressure plate (RSscan Inc., Belgium) in sampling rate 30Hz for 30 secs. For all data, using independent t-test to analyze between groups, and SPSS version 12.0, and the p < 0.05 is considered for statistical significant. RESULTS: Based on previous study, we first found

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out using falling experience and BBS could not predict the fall risk accurately for the walking indepently elderly. Both 2 groups had no difference in the score of single leg standing (3.80±0.41 vs. 3.60±0.91, p = 0.730), which meant they were able to lift leg independently and hold 5-10 secs. Comparing to the actual standing time, the subjects could stand from 3.77 to 20 secs, and these extremely difference could not reflect in the BBS single leg standing item. In present study, after grouping the elderly by single leg standing time, the demographic data showed there were significant difference between single leg standing time, falling experience, and COP trajectory. And in each 5 secs interval, we also could find out that healthy elderly had stability postural control during single leg standing task (COP trajectory 0.49~0.60 mm), but the falling elderly showed significantly COP increased (1.49 to 2.52 mm) while they failed the task. CONCLUSIONS: The data showed there was a different COP trajectory between healthy elderly and those with fall risk. To confirm this result, we will keep recruiting subjects and following up their postural control stability, to help predicting the fall risk.

Demographic data in present study+						
۵	HE group₊ <sup>j</sup>	FE group↔	сь с <mark>у</mark>			
	(n = 9)¢	(n = 15)₽	r			
Single leg standing	28.70±2.79↔	6.38±2.69↔	<0.001* <i>2</i> * <sup>2</sup>			
time (sec)₽	(22.01~30)+	<b>(0~9.96)</b> ₽	<0.001 +			
Cander 1	Female: 7₽	Female: 11₽	<b>ب</b> ر.			
Gender	Male: 2+	Male: 4+	-4-			
Age (yr)₽	68.44±3.84₽	71.11±2.76₽	0.1100			
Height (cm)₽	159.28±5.09₽	156.27±9.81₽	0.427÷ "			
Weight (kg)↔	59.18±9.79₽	59.51±9.56	ي ⇔0.943			
Fall amarianaa (tima).	Name 1~3 time in		<0.001*a#			
rail experience (time)*	each subject					
BBS-single leg stande	4.00±0.00₄ <sup>3</sup>	2.63±0.52+3	<0.001*¢ <sub>¢</sub>			
COP trajectory.	0.55±0.09₽	1.95±1.31₽	<0.001*0			

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## COP trajectory in each timing interval.

#### P3-L-156 Biomechanical Balance Parameters In Frontal Plane Predict Prospective Falls In Elderly Adults

#### *Tzurei Chen<sup>1</sup>*, Li-Shan Chou<sup>2</sup>

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BACKGROUND AND AIM: The ability of a balance assessment to predict the prospective risk of falling in elderly adults is critical to a timely prescription of preventive interventions. Few studies have investigated the ability of biomechanical parameters, which are derived during dynamic activities to predict future falls. Therefore, the purpose of this study was to assess the feasibility of using biomechanical measures of gait imbalance (center of mass (COM)-Ankle angles in frontal

and sagittal planes) to prospectively predict falls in community-dwelling elderly adults. METHODS: Sixty elderly adults over the age of 70 years were recruited in this one-year longitudinal study. A comprehensive laboratory motion analysis on the Timed Up and Go test was performed for all participants. Logistic regression was used to test the ability of the COM-Ankle angles to predict prospective falls. RESULTS: When the biomechanical balance predictors were added to all the confounders, the explained variance was increased from 25.3% to 50.2%, and the sensitivity and specificity were 66.7% and 88.4%, respectively. Participants with a smaller COM range of motion during sit-to-walk and a larger frontal plane COM-Ankle angle during pivoting were less likely to become fallers. CONCLUSIONS: Our results indicated that dynamic biomechanical balance parameters could provide valuable information about a participant's future fall risks beyond what can be explained by demographics, cognition, depression, strength, and past fall history. Among all biomechanical parameters investigated, frontal plane balance control parameters appear to be the most significant predictors for future falls.

## P3-L-158 Falls-associated parameters in a cohort of 641 elderly- the TREND study

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BACKGROUND AND AIM: In an ageing society falls are a common personal, occupational, social and economic burden. It results in functional impairment, reduced quality of life and increased mortality. Understanding factors associated with falls is a prerequisite of preventing them. METHOD: Potential parameters associated with falls, as well as occurrence of and frequency of falls during the last 12 months were assessed in 641 individuals between the age of 50 and 80 years in the frame of the baseline assessment of the TREND study (www.trend-studie.de). Parameters were then exploratively compared between non-fallers, single fallers and multiple fallers with did not differ significantly with regard to age, weight and height. RESULTS: Five hundred fifty-eight participants reported to experience no fall in the last 12 months, 46 to experience one, and 37 more than one fall during this period. Compared to non-fallers, multiple fallers had a higher walking speed (13.4 vs. 12.4 sec for 20 meters, gender-adjusted p=0.002, lower grip strength (26 vs. 31 kg, p=0.0005 a higher Beck's Depression Inventory (BDI) score (12.2 vs. 7.7, p<0.0001), answered more regularly the question "Are you out of breath while taking stairs" with yes (53% vs. 28%, p=0.007, as well as the statement "It is more difficult to cope with everyday life than before" with yes (401% vs. 22%, p=0.025), and reported more often to suffer from Rem Sleep Behaviour Disorder (11% vs. 22%, p=0.004). Inclusion of all factors in a model explained 11% of the difference, BDI alone 6%. Individuals experiencing one fall during the last year showed comparable values to non-fallers. No significant differences between the cohorts were observed for the parameters/scores/diagnoses:visual acuity, pallaesthesia, MiniMental State Examination, Trail Making Test, motor part of the Unified Parkinson's Disease Rating Scale, intimamedia-thickness and physical activity, actual intake of benzodiazepines, neuroleptics, alcohol and drugs, as well as medical history for coronary artery and other heart diseases, stroke, mild cognitive impairment, arterial hypertension, diabetes, hyperlipidemia, hypercholesterolemia, smoking, thyroid dysfunction, arthrosis, arthritis, musculoskelal dysfunction, bone fractures. CONCLUSION: In this cohort of healthy elderly, high BDI was the strongest predictor of falls. Diversity of factors that are significantly associated with frequency and occurrence of falls, and the relatively low influence of all of them on the overall model are in line with existing hypotheses that risk of falling in elderly is multidimensional and includes factors that are currently not assessed even in very detailed assessments of longitudinal cohort studies.

## P3-L-160 Effect of a plantar perceptual learning task on walking stability in the elderly: a randomized controlled trial

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OBJECTIVE: Recently, it was demonstrated that plantar perceptual training improves postural control. Morioka and Yagi (2004) reported on a randomized control trial carried out on healthy adults, whereby their center-of-gravity sway and functional reach test values significantly improved following plantar perceptual training using a hardness discrimination task. Moreover, their research highlighted similar improvement in hemiplegic stroke patients and elderly individuals (2003, 2009, 2011). We have previously demonstrated that this task significantly improves the center-of-gravity sway of healthy adults standing on one leg (2011); however, the efficiency of the plantar perceptual learning task was only verified for postural control during standing but not walking. Therefore, the aim of this study was to assess the effects of plantar perceptual training on postural control during walking in healthy, community-dwelling, elderly individuals. METHODS: Eighty-six elderly individuals (mean age, 73.84 years) participated in this randomized control trial; they were evenly assigned to either an intervention or a control group. The intervention group was given a task to discriminate hardness differences while standing on sponge mats of different levels of hardness, while the control group underwent the same task without being required to differentiate between them. The tasks were carried out 10 times over a 4-week period. Trunk acceleration during walking was measured on the day prior to the initial training day and on the day after the last training day. A wireless triaxial accelerometer, fixed to a belt at the level of the L3 spinous process, was used to measure acceleration in the mediolateral (ML), vertical (VT), and anterioposterior (AP) directions. The root mean square (RMS) of data obtained was subsequently calculated. RESULTS: Plantar perception was significantly improved in the intervention group following training (p < 0.01). In addition, the ML-RMS, VT-RMS, and AP-RMS acceleration values were significantly greater after training in the intervention group compared to the control group (p < 0.05). DISCUSSION: In comparison to young individuals, the elderly showed significantly decreased plantar perception (Perry, 2006). It has been reported that postural balance declines as plantar perception decreases (Morioka, 2012). Reduced plantar perception has also been implicated as a risk factor for falling in elderly individuals (Menz, 2006). These findings suggest that somatosensory information from the plantar surface is important for postural balance during walking in the elderly. In this study, the number of incorrect responses decreased significantly as training proceeded. This suggests that the perceptual capacity of the plantar surface improved as a result of the plantar perceptual learning task, which in turn enabled errors in postural balance during walking to be corrected, thus resulting in improved upper-body dynamic stability during walking.

## P3-L-162 Risk Factors for Head Impact during Falls in Older Adults Residing in Long-Term Care

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BACKGROUND AND AIM: Falls are the leading cause of injury-related deaths and hospitalizations in older adults. One of the most significant injuries associated with falls in seniors is traumatic brain injury (with over 60% of cases caused by falls). A barrier to prevention is lack of objective evidence on the factors that influence the risk for impact to the head in the event of a fall. A reasonable (common sense) hypothesis is that healthy individuals coordinate "safe landing" responses during falls (e.g., upper limb arrest strategies) to prevent head impact. However, the nature and effectiveness of these responses may be affected by a variety of physiological mechanisms. We explored the hypothesis by analyzing real-life falls captured on video in two long-term care (LTC) facilities, and comparing these to health records. We hypothesized that among falls in LTC, risk for head impact is associated with age, gender, impairment in physical or cognitive function, chronic disease diagnoses, and use of psychotropic medications. METHODS: Over a 4-year period (2008-2012), we video-captured 235 falls experienced by 84 residents (mean (SD) age = 81±9; 62% female) who provided written consent allowing us to access their health records. Each fall was analyzed by a 3-member team using a validated questionnaire to determine whether impact occurred to the head. We also collected information related to

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physical and cognitive function, disease diagnoses, and use of medications from the computerized Minimum Data Set system. We used a generalized linear statistical model with robust standard errors to calculate the odds ratio (OR) for head impact associated with the various factors. RESULTS: Head impact occurred in 29% of falls. Compared to men, women showed higher risk to impact their head during a fall (OR=2.7; 95% CI 1.3-5.4), despite being just as likely to attempt to arrest the fall with their arms. Other risk factors for head impact include poor vision (OR=3.1; 95% CI 1.1-8.5) and hypertension (OR=1.9; 95% CI 1.0-3.8) (Figure 1). Age, other chronic disease, and psychotropic medications did not show significant effects on the risk for head impact. CONCLUSIONS: Our results provide insight on how physiological factors influence the risk for head impact during falls in LTC. Poor vision caused over a 3-fold increase in odds for head impact, likely via its effect on the coordination of safe landing responses. Hypertension caused a 2-fold increase in risk for head impact, perhaps by increasing the likelihood for syncope and thus decreasing protective mechanisms during falls. Gender was also a significant predictor of head impact, with women being almost three times more likely to impact their head during a fall. Our results suggest that treatment of visual impairment, hypertension, and deficits in muscle strength may reduce the likelihood for impact and injury to the head from falls in the LTC environment.





## P3-L-164 The complexity of standing postural control in older adults: A modified detrended fluctuation analysis based upon the empirical mode decomposition algorithm

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Background and aim: Human aging into senescence diminishes the capacity of the postural control system to adapt to the stressors of everyday life. Diminished adaptive capacity may be reflected by a loss of the fractal-like, multiscale complexity within the dynamics of standing postural sway (i.e., center-of-pressure, COP). We therefore studied the relationship between COP complexity and adaptive capacity in 22 older and 22 younger healthy adults. Methods: COP magnitude dynamics were assessed from raw data during quiet standing with eyes open and closed, and complexity was quantified with a new technique termed empirical mode decomposition embedded detrended fluctuation analysis (EMD-DFA). Adaptive capacity of the postural control system was assessed with the sharpened Romberg test. As compared to traditional DFA, EMD-DFA more accurately identified trends in COP data with the EMD process in prior to

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find the intrinsic scales of time series itself (Fig.1) rather than the given specific windows in traditional DFA and produced short and long-term scaling exponents (i.e., áShort, áLong) with greater reliability (Fig. 2). Results: The fractal-like properties of COP fluctuations were time-scale dependent and highly complex (i.e., áShort values were close to one) over relatively short time scales. As compared to younger adults, older adults demonstrated lower short-term COP complexity (i.e., greater áShort values) in both visual conditions (p>0.001). Closing the eyes decreased short-term COP complexity, yet this decrease was greater in older compared to younger adults (p<0.001) (Fig. 3). In older adults, those with higher short-term COP complexity exhibited better adaptive capacity as quantified by Romberg test performance (r2=0.38, p<0.001) (Fig.4). Conclusions: These results indicate that an age-related loss of COP complexity of magnitude series may reflect a clinically important reduction in postural control system functionality and the new short term exponent of the COP magnitude series from EMD-DFA could be used as a new biomarker for the evaluation of the balance stability.



## P3-L-166 Risky gaze behaviour adopted by older adults during virtual walking is linked to cognitive decline

## Mark Hollands<sup>1</sup>, Jennifer Stanley<sup>2</sup>

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Aims The current study aimed to quantitatively assess differences in gaze behaviour between young and older adult groups with higher and lower risk of falling during a virtual walking paradigm. Methods The gaze behaviour of nine

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young adults, seven lower-risk older adults (LROA) and seven higher-risk older adults (HROA) was measured while they watched five first-person perspective movies representing the viewpoint of a pedestrian walking through various environments. Participants also completed a number of cognitive tests: Stroop task, visual search, trail making task (TMT), Mini Mental Status Examination (MMSE), and reaction time, visual tests (visual acuity and contrast sensitivity) and assessments of balance (Activities Balance Confidence Scale (ABC) and Berg Balance Scale) to aid in the interpretation of differences in gaze behaviour. Results The HROA group spent significantly more time fixating aspects of the travel path than LROA and young adult groups (f(2,20)= 3.79, p<.05). Post hoc analysis using LSD showed that the HROA fixated the travel path for a significantly greater percentage of time than the LROA and the young adults (figure 4-2). HROA were also significantly slower in performing a number of the cognitive tasks than young adults and scored significantly lower on the ABC scale than the LROA and young participants. Correlations were conducted to compare the extent to which travel path fixation durations co-varied with scores on the tests of visual, motor, and cognitive function. A positive significant correlation was found between the speed of response to the incongruent Stroop task and travel path fixation duration r(21) = .44, p<.05. Conclusion The results indicate that our virtual walking paradigm can identify age-related changes to gaze behaviour which are associated with increased falls risk and that these differences likely result from age-related cognitive decline.





## *Tanvi Bhatt<sup>1</sup>*, Prakruti Patel<sup>1</sup>

<sup>1</sup>University of Illinois

Background: Higher incidence of falls during walking task has shifted focus of rehabilitation programs towards dual task training. Prioritization of fast walking has been studied as one of the strategies for improving dual task walking performance however; the effect of slow speed walking on cognitive-motor interference remains to be determined. This study therefore examined the effect of slow walking on cognitive motor interference of dual tasking (DT) walking. We hypothesized that compared to self-selected walking speed, slow walking while DT will improve the performance on cognitive tasks, and reduce the cognitive cost of dual tasking. Methods: Young adults (N=20) first walked at their self-selected and slow speeds (single task-ST) followed by walking while performing 1) a visuomotor (VM) reaction time task, and 2) the Stroop test (STR) at both self selected and slow speeds. Gait velocity, step length, and cadence were recorded using GaitRite electronic walking. The cognitive tasks were also performed in sitting (ST-cognition). The cognitive parameters included reaction time and number of correct responses on the Stroop test. Motor and cognitive costs of

dual tasking between preferred and slow speed walking, were computed [(ST-DT)/ST\*100]. Results: Compared to ST, DT at self-selected speed showed marked reduction in velocity, step length and cadence with them being were lower for the STR task (p<0.001) compared to VM task. While focusing on slow walking, subjects further decreased the gait velocity (p<0.01) and step length (p<0.05) in STR test condition. In comparison, the VM task did not show any effect of slow walking on velocity and step length. consequently, the STR test had a greater motor cost than VM task for slow walking (p<0.05). Performance on VM task declined (seen by increase in reaction time) during both self-selected and slow speeds DT walking compared to sitting (p<0.05), with no significant difference in VM cognitive cost between selfselected and slow walking (p>0.10). In comparison for STR task, although there was an increase in cognitive cost during self-selected walking (seen by lower number of correct responses) compared to sitting however, during slow speed walking, STR performance improved (seen by reduced cognitive cost) compared to self-selected walking (p<0.5). Cognitive costs for STR task were significantly lower than VM task irrespective of walking speed. Conclusion: The results suggest that slow walking can improve performance on distinctly different tasks requiring considerable attention and planning such as STR test. Whereas, VM tasks might share neural circuitry with locomotor function and compete for attentional resources, making it more challenging to optimize the VM tasks while walking. Focusing on prioritizing fast gait may compromise cognitive abilities posing a safety-risk in complex environments (eg. mall walking or catching a train) that require dual-processing.

## P3-L-170 Distribution of gray matter atrophy in older people with concern about falling: A voxel-based morphometric study

# *Kim Delbaere*<sup>1</sup>, Carola Tuerk<sup>1</sup>, Haobo Zhang<sup>1</sup>, Wei Wen<sup>1</sup>, Stephen Lord<sup>1</sup>, Jacqueline Close<sup>1</sup>, Henry Brodaty<sup>1</sup>, Perminder Sachdev<sup>1</sup>

<sup>1</sup>University of New South Wales

BACKGROUND AND AIM: Ageing is strongly associated with reductions in gray matter (GM) volume. Balance requires motor control and integration of sensorimotor information, which is achieved through the involvement of many brain structures. Decreased regional GM volumes have been associated with poor balance and slow gait. In addition, it has been suggested that anxiety, worry and neurotic personality traits are associated with reduced brain volume. This exploratory study investigated correlations between concern about falling and voxel-wise GM volumes in a large sample of community-dwelling older adults. METHODS: 281 community-dwelling older people aged 70 - 90 years underwent structural magnetic resonance imaging and a comprehensive medical assessment. The Falls Efficacy Scale International (FES-I) was used to assess participants' concern about falling across a wide range of daily activities. Falls were recorded prospectively for 12 months. Voxel-based GM volumes were generated for each participant with Voxel-Based Morphometry (VBM) using SPM5 program (Statistical Parametric Mapping, SPM). The significance level for the correlated clusters was set at voxel-level inference of p<0.01 (uncorrected) combined with cluster-level inference of p<0.05 (FWE-corrected). Regional GM volumes in different regions of interest were also extracted based on voxel-wise GM volumes. These regional GM volumes were then correlated with FES-I score. The GM volume for each voxel was regressed on the raw score of FES-I, adjusted with covariates including age, gender, total intracranial volume, scanner, and the Framingham cardiovascular risk score. RESULTS: FES-I was negatively correlated with total brain volume (r=-0.212, p≤0.01) and GM volume (r=-0.210, p≤0.01). VBM-analysis revealed a negative association between the FES-I and GM volumes of (1) the left cerebellum and the bilateral inferior occipital gyrus (Brodmann Areas (BA) 18 and 19) (number of voxels in the cluster = 3053, p<0.001), and (2) the bilateral superior frontal gyrus (BA 9) and the left supplementary motor area (BA 32) (number of voxels in the cluster=1577, p=0.004). CONCLUSIONS: Our analyses show that concern about falling is associated with total brain atrophy and GM atrophy. The association between the FES-I and volumes of specific GM regions indicates that concern about falling relates to volumetric decreases in areas linked to

visual processing and recognition, motor control and executive functions. These results reiterate the importance of psychological factors in healthy aging and falls.

## P3-L-172 Influence of Parkinson's disease on segmental coordination during turning with and without vision

## Sakineh Akram<sup>1</sup>, James Frank<sup>1</sup>, Mandar Jog<sup>2</sup>

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BACKGROUND AND AIM: Postural instability is a common symptom of Parkinson's disease (PD) [1]. Turning is specially challenging for individuals with PD and the incidence of falls is higher during turning than straight walking [2, 3]. We recently reported that when on-the-spot turns are performed to predictable targets and with no time constraints, both healthy elderly and individuals with PD turn en bloc [4]. Anastasopoulos and colleagues [5, 6] suggested that an en bloc turning strategy is selected when there is minimal need for visual guidance to a target. The purpose of this study was to examine the influence of PD on segmental coordination when turning under eyes open and eyes closed conditions. METHODS: Fourteen individuals with PD (on antiparkinsonian medication) and nineteen age-matched healthy controls participated in this study. Four Optotrak 3D imaging system cameras (Northern Digital Inc., Canada) recorded the sequence and timing of reorientation of body segments as participants made 90° on-the-spot turns to their right with their eyes open and closed. RESULTS: Regardless of the visual condition, healthy controls and individuals with PD turned their head, shoulder and pelvis simultaneously, followed by reorientation of their feet. For both groups the head turned faster in eyes open condition resulting in a small head-on-shoulder rotation early in the turn. CONCLUSIONS: When turning toward predictable target locations, both healthy controls and PD participants "on" medication employed a similar en bloc turning strategy under both vision conditions, suggesting that vision is not required to guide the turn. The en bloc strategy may be unsafe when turning toward unpredictable locations that require visual guidance. While in such situations healthy individuals are able to change the strategy from en bloc to sequential segmental turning, PD patients might not be able to do so and continue to turn en bloc which may contribute to the greater incidence of instability in such situations for PD patients. REFERENCES: 1. Kandel ER, Schwartz JH, Jessel TM. Principles of neural science. The McGraw-Hill Companies, 2000. 2. Bloem BR. et al. J Neurol. 248: 950-958, 2001. 3. Giladi N. et al. Neurology. 42: 333-339, 1992. 4. Akram S. et al. ISPGR, 2012. 5. Anastasopoulos D. et al. Mov Disord. 26:2201-2211, 2011. 6. Anastasopoulos D. et al. Exp Brain Res. 193:323-336, 2009.

## P3-L-174 An examination of dynamic momentum control during gait using regions of stability

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BACKGROUND AND AIM: Dynamic balance control during walking has been assessed in terms of the interaction between position and velocity of the whole body center of mass (COM) in relation to the base of support (BOS), where insufficient COM momentum could be a cause for gait imbalance. Given that acceleration regulates momentum, examining COM acceleration would provide further insights on balance control. The objective of this study was to examine control of dynamic stability during single stance of walking, with the use of COM velocity and acceleration. METHODS: Whole body motion data were collected from healthy young and elderly adults, and elderly fallers (n = 15/group) while walking. COM control in the antero-posterior (AP) and medio-lateral (ML) directions was examined. Using a single-link-plus-foot inverted pendulum model, boundaries for the region of stability were determined based on the COM position at toe-off and its instantaneous velocity (ROSv) or its peak acceleration prior to toe-off (ROSa). RESULTS: Although no significant difference in forward COM velocity was detected between healthy young and elderly subjects, the peak forward COM acceleration differed significantly. Elderly fallers demonstrated a significantly smaller forward COM velocity and acceleration with their COM located significantly closer to the BOS at toe-off as compared to healthy subject groups,

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which resulted in their mean data point within the ROSv (Fig.1). Similar results were obtained in the ROSa, where the data for elderly fallers were located significantly closer to the forward boundary. No significant group differences were detected in any of the COM measures in the ML direction. CONCLUSIONS: Healthy young and elderly subjects utilized similar momentum to propel the body forward, but controlled the momentum differently, suggesting age-related differences in momentum control during walking. Significantly decreased forward COM velocity, acceleration and separation between the COM and BOS at toe-off in the AP direction observed in elderly fallers may be indicative of their reduced momentum control ability and a protective strategy for potential falls as well as reduced muscular strength. Examining COM acceleration in addition to its velocity would provide a greater understanding of a person's momentum control, which would allow us to better understand the mechanisms underlying gait imbalance or falls.



Figure 1: Normalized COM velocity at toe-off vs. normalized COM position in the AP direction

## P3-L-176 Learning by doing: can perception of affordance for aperture crossing be improved immediately after experience in actual passage?

#### *Masaaki Yasuda*<sup>1</sup>, Takahiro Higuchi<sup>1</sup> <sup>1</sup>Tokyo Metropolitan University

Introduction Franchak et al [1] demonstrated that experience walking through apertures facilitated perceptual judgment for aperture cross-ability. This was inconsistent with previous research which failed to show an immediate effect of experience during wheelchair use [2]. Franchak et al. explained that perceptual judgment could be improved immediately if actual passage provides opportunities to detect fine differences between passable and impassable apertures (i.e., high-resolution experience). The present study was designed to investigate this explanation under walking (Exp. 1) and wheelchair-use situations (Exp.2). Methods Forty-nine (Exp.1) and 37 (Exp.2) young adults were randomly assigned to one of three (or four) groups: high-resolution, low-resolution, or control (two controls in Exp.1).

For actual passage, they tried to pass through while walking and holding a 69-cm horizontal bar (Exp.1) or while using a wheelchair (66 cm in width); the minimum aperture width was similar in both experiments (about 70 cm). Seven different aperture widths, including their minimum passable width, were presented with 1-cm or 5-cm intervals for the high- or low-resolution conditions, respectively. A fixed, 90-cm aperture (i.e., much wider than minimum passable width) was presented for the control group, whereas for another control group seven different widths with 1-cm intervals (87-93 cm) were presented. Accuracy of perceptual judgment of passable/impassable widths was measured before and after actual passage. Results/Conclusion The results of Exp.1 showed that perceptual judgment was improved after passage both under the high- and low-resolution conditions. In contrast, no improvement was observed in any condition in Exp.2. These findings seemed to suggest that perceptual judgment improved immediately after actual passage using a familiar form of locomotion. References 1. Franchak JM, et al.: Learning by doing: action performance facilitates affordance perception. Vision Res. 50: 2758-65, 2010 2. Higuchi T, et al.: Visual estimation of spatial requirements for locomotion in novice wheelchair users. J Exp Psychol Appl. 10: 55-66, 2004

## P3-L-178 Neuropsychological, balance and gait risk factors for falls in people with multiple sclerosis: a prospective cohort study

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Background: Falls are common in people with multiple sclerosis (MS).1 However, information of underlying impairments that contribute to fall risk factors in MS is still preliminary.2 The objective of this study was to determine whether impaired performance in tests of vision, proprioception, lower limb muscle strength, reaction time, standing and leaning balance, stepping, gait and neuropsychological functioning are associated with falls in people with MS. Methods: 210 community-dwelling people (21-74 years) with MS (Disease Steps 0-5) attended an MS physiotherapy clinic for the neuropsychological, sensorimotor, speed, balance and gait tests. Participants were then followed up for falls for sixmonths with falls calendars. Results: In the six months follow-up period, 83 participants (39.7%) experienced no falls, 57 (27.3%) fell once or twice and 69 (33.0%) fell three or more times. Frequent falling (3+) was associated with increased postural sway (eyes open and closed), poor leaning balance (as assessed with the coordinated stability task), slow choice stepping reaction time, reduced gait speed, reduced executive functioning 9as assessed with the Trails B-A test) and reduced fine motor control (performance on the 9-hole pegboard test). Increased sway with the eyes closed, poor coordinated stability and reduced performance in the 9-hole pegboard test were identified as variables that significantly and independently discriminated between frequent fallers and non-frequent fallers (Model  $\chi$ 2=30.1, df=3, p<0.001). The area under the ROC curve for this model was 0.712 (95% CI = 0.638 - 0.785). Discussion: The study findings elucidate important balance, coordination and cognitive determinants of falls in people with MS. Multifaceted fall prevention strategies have been found to be effective in the general older community but are yet to be evaluated in people with MS. Future studies investigating intervention strategies targeting falls should consider fall risk factors which are potentially amenable to intervention (e.g. impaired cordination and balance), as well as factors that need to be accounted for when considering any approach to delivering an intervention (e.g. executive function impairments). The findings of this large prospective study suggest assessment of physical and cognitive fall risk factors is required in clinical practice to tailor intervention strategies according to the fall risk profile of individuals with MS. References: 1. Cattaneo D. et al. Risks of falls in subjects with multiple sclerosis. Arch Phys Med Rehabil 2002;83:864-7. 2. Cameron MH, Lord SR. Postural control in multiple sclerosis: implications for fall prevention. Curr Neurol Neurosci Rep 2010;10:407-12.

## P3-L-180 Investigating the relationship between fatigue, balance and walking in people with Multiple Sclerosis

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BACKGROUND AND AIM: Fatigue levels and standing balance are common impairments in people with Multiple Sclerosis (PWMS) and both issues have been linked to falls. The six-minute walk test (6MWT) has been shown to be a reliable measure of functional mobility, with PWMS showing reduced distance compared with health controls. This reduced performance in the 6MWT has been strongly associated with balance confidence. A retrospective study analysing falls history in PWMS has shown that walking endurance as measured by 6MWT was reduced in fallers compared to non fallers. The aim of this study is to investigate the effect of the 6MWT on fatigue levels and balance control and determine if there are any correlations between standing balance and fatigue levels in PWMS. METHODS: Randomised cross over observational design. Thirty four PWMS (mean age 49.8 /- 10.4, mean EDSS of 3.5, female n=26) completed two assessments in random order on non-consecutive days. Fatigue levels were measured using the Fatigue Severity Scale (FSS) and the Modified Fatigue Impact Scale (MFIS). Each session involved one of two 6 minute tasks; (1) six minutes of seated rest, and (2) the 6MWT. Perceived Fatigue and standing balance measures were collected before and after each 6-minute task. Data was collected on perceived fatigue using a Visual Analogue Scale for Fatigue (VAS-F). Standing balance was measured by sway path length of Centre of Pressure (CoP) and body sway of C7 vertebra using an 8 camera motion capture system (Vicon, UK) and 2 force platforms (AMTI, USA). Standing balance was assessed under 4 conditions: Eyes open feet apart (EOFA), eyes open feet together (EOFT), eyes closed feet apart (ECFA) and eyes closed feet together (ECFT). RESULTS: The 6MWT resulted in a significant increase in perceived fatigue levels (p<0.01). There was a significant interaction effect of 6MWT on C7 sway path length for three out of four standing conditions (all p<0.01), and in CoP sway in the ECFT standing condition (p<0.05). CoP sway in the fresh ECFT standing condition correlated with the FSS (r= 0.378, p<0.05). Increases in C7 sway induced by the 6MWT correlated with the MFIS (r=0.406, p<0.05). CONCLUSIONS: This study demonstrates the effect of walking induced fatigue on standing balance in PWMS and highlights the relationship between standing balance and fatigue in this population.

## P3-L-182 Falls and fractures in Parkinson's disease: study of sun exposure time and bone metabolism markers

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BACKGROUND AND AIM: In patients with Parkinson's disease (PD), falls and any fractures are important factors deteriorating their daily-living activities and qualities. Osteoporosis is a well-known risk factor of a bone fracture. Bone metabolism markers are useful in the assessment of osteoporosis. Previous studies conclude that vitamin D deficiency, compensatory hyperparathyroidism and hyperhomocysteinemia were risk factors of osteoporosis in PD. However, there is no study investigating bone metabolism by multiple biochemical markers and comparing them with falls and fractures. To evaluate falls and bone fractures in PD, we studied the time of sun exposure and multiple biochemical markers of bone metabolism and compared them with controls. METHODS: PD patients, chronic stage of cerebrovascular disease (CVD) patients and normal controls (NC) were consecutively recruited. Unified PD rating scale part III (UPDRS3) and Hoehn-Yahr staging (HY) were examined in PD. The time of sun exposure (tSE) and the count of fall (F) per day during a week were recorded in all participants. Biochemical markers of bone metabolism were analyzed, which included bone alkaline phosphatase, undercarboxylated osteocalcin and intact type I procollagen N-propeptide (iPINP) for bone formation markers and type I collagen crosslinked N-telopeptide and tartrate-resistant acid phosphatase for bone resorption markers and total homocysteine (tHcy), 1a, 25-dihydroxy-vitamin D (VD), intact parathyroid hormone, ionized calcium, calcium and inorganic phosphate as other bone metabolism-related markers. All parameters were statistically examined. RESULTS: 46 (18 males) PD patients, 29 (22) CVD patients and 13 (3) NC could be enrolled. Mean age were 72, 75 and 71. In PD, mean disease duration, HY and UPDRS3 were 83 months, 3 and 22. Mean tSE and F were 30-60 minutes and 1-2 times in PD, 30-60 minutes and 0-1 times in CVD, and more than 60 minutes and 0 times in NC. In biochemical bone metabolism markers, mean tHcy was significantly higher in PD than NC (p<0.05), which were 9.7 and

8.1 nmol/ml. Mean iPINP was significantly lower (p<0.01) in CVD than PD or NC, which were 38.4, 59.5 and 50.8 μg/l. CONCLUSINS: Our results indicated that the potential abnormality of bone metabolism influenced in osteoporosis and may induce a fall-related fracture in PD and CVD. Abnormal VD and parathyroid function were unclear.

## P3-L-184 Dynamic eye movement models provide insight into how fall prevention improves motor control in aging

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BACKGROUND AND AIM: As society ages and frequency of falls increases in older adults, counteracting motor decline is a challenging issue for developed countries. Physical activity based on aerobic and strength training as well as motor activity based on skill learning both help benefit balance and reduce the risk of falls, as assessed by clinical or laboratory measures. However, how such programs influence motor control is a neglected issue. This study examined the effects of fall prevention (FP) training on saccadic control in older adults. METHODS: Saccades were recorded in twelve participants aged 64-91 years before and after 2.5-months training in FP. Traditional analysis of saccade timing and dynamics was performed together with a quantitative analysis using the Linear Approach to Threshold with Ergodic Rate (LATER) model, enabling us to examine the underlying motor control processes. RESULTS: FP reduced the rate of anticipatory and express saccades in inappropriate directions and enhanced that of express saccades in the appropriate direction, resulting in decreased latency and higher left-right symmetry of motor responses. FP reduced withinparticipant variability of saccade duration, amplitude, and peak velocity. LATER analysis suggested that FP modulates decisional thresholds. CONCLUSIONS: This study extends our knowledge of motor training influence on central motor control, and introduces the Threshold Interval Modulation with Early Release-Rate of rIse Deviation with Early Release (TIMER-RIDER) model to account for the results.

## M - Neurological diseases; Coordination of posture and gait

## P3-M -186 Spatial hyperschematia without spatial neglect after insulo-thalamic disconnection

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Different spatial representations are not stored as a single multipurpose map in the brain. The right-damaged brain patient can show a distortion, a compression of peripersonal and extrapersonal space. Here we report the case of a patient with a right insulo-thalamic disconnection without spatial neglect. The patient, compared with 10 healthy control subjects, showed a constant and reliable increase of her peripersonal and extrapersonal egocentric space representations - that we named spatial hyperschematia - yet left her allocentric space representations intact. This striking dissociation shows that our interactions with the surrounding world are represented and processed modularly in the human brain, depending on their frame of reference.

## P3-M -188 Slowed afferent conduction time contributes to postural instability in patients with hereditary spastic paraplegia

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INTRODUCTION: Hereditary spastic paraplegia (HSP) is characterized by progressive lower extremity spasticity and weakness, due to retrograde axonal degeneration of the corticospinal tract and the posterior spinal columns. Given its

length, the reticulospinal tract may also be affected, but its involvement has neither been confirmed, nor denied in the literature. As HSP patients have postural instability and fall frequently, we investigated whether delayed postural responses contribute to their instability. To distinguish between a delay in afferent and efferent (reticulospinal) signals, we combined postural responses with a startling acoustic stimulus (SAS). The SAS directly triggers a postural response and thereby, bypasses afferent proprioceptive input. METHODS: We performed two separate experiments. First, 18 HSP patients and 9 healthy participants stood on a movable platform and were instructed to withstand forward and backward balance perturbations without taking a step or grabbing a handrail. Second, 12 of the HSP patients and all 9 healthy participants were subjected to backward perturbations while a SAS accompanied the start in 25% of the total of 20 trials. Muscle activity was measured using surface electromyography of tibialis anterior, rectus femoris, gastrocnemius and biceps femoris, and body movements were measured using a motion analysis system. RESULTS: HSP patients were less successful than healthy subjects in recovering balance without stepping or grabbing following both backward ( $53\pm13\%$  vs  $82\pm18\%$ , p<0.001) and forward perturbations ( $60\pm23\%$  vs  $89\pm14\%$ , p=0.002). Furthermore, latencies of the postural responses were delayed in the HSP patients (34 ms in gastrocnemius and 60 ms in biceps femoris during forward, and 38 ms in tibialis anterior and 50 ms in rectus femoris during backward perturbations). Delayed responses were associated with larger COM excursions. A SAS accelerated the postural response to backward perturbations in all participants, but the HSP group benefited much more than the controls (tibialis anterior, 45 vs 17 ms acceleration, p=0.005; rectus femoris, 53 vs 18 ms, p=0.005). In fact, in the HSP patients the onset latencies with SAS were no longer different from those in the controls. DISCUSSION: Our results suggest that delayed postural responses in HSP patients contribute to their postural instability. Combining the perturbations with a SAS yielded normal latencies, which indicates that the conduction of efferent signals by the reticulospinal tract is normal. Hence, we suggest that the delayed postural responses are caused by slowed conduction time of the posterior spinal columns.

## P3-M -190 Evaluation of the Reliability of a Questionnaire for Gait Disorders in Parkinson's Disease Patients

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Aim: The aim of the study was to evaluate the reliability of a self-report questionnaire of gait disorders (8QGD) in Parkinson's disease (PD) patients. Methods: 2 patients (31 men a 11 women); mean age 67 years (SD 7.6); mean disease duration 10 years (SD 3.5) completed the 8QGD which was sent by mail. In 8QGD the patients estimated (Item 1) their gait at the worst state; (2) the effect of their gait disorders on Activities of daily living, and (3) compared the severity of gait disorders with their other motor symptoms of PD. The remaining 5 items of 8QGD evaluated the occurrence of phenomena such as (4) freezing of gait, (5) levodopa-resistant freezing in the On state, (6) falls, (7) the degree to which the patients' activity is limited due to fear of falling and (8) the occurrence of injuries. They filled out the same questionnaire together with their doctor during an outpatient visit, when they underwent examinations of UPDRS III, subscore for postural instability and gait disorders (PIGD), Timed up and Go test (TUG) and dynamic posturography. The Intraclass correlation coefficient was used for correlation between both questionnaires. We compared the examination results with the questionnaire results using the Pearson correlation. Results: We did not find a difference between the self-reported questionnaire and the one filled out together with a doctor (r = 0.89, p < 0.001). The 8QGD results correlated with PIGD (r = 0.60, p < 0.001) and a weaker correlation was found to UPDRS III (r = 0.37, p < 0.05) and the score of dynamic posturography (r = -0.35, p < 0.05). We did not find a correlation between 8QGD and TUG. Conclusion: The self-reported 8QGD is a reliable tool for detection of gait disorders and postural instability in PD patients. Support: IGA NT11190-6/2010, VZ MSM0021620849 and PRVOUK-P26/LF/4.

## P3-M -192 Gait instability measured by dual task gait test and leukoaraiosis

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Objective Gait unsteadiness is considered as the first step of major health concerns such as fall and dementia. Gait dysfunction has to be measured under dual task gait test (DTGT). The aim of this study was to investigate the relationships between DTGT and brain magnetic resonance imaging (MRI). Material and methods Data were collected through a Gait Instability Network including DTGT. Twenty five patients aged less than 76 years old were tested (age: 71  $\pm$  5 y, F: 8, M: 17, MMSE: 28  $\pm$  2) The assessment includes 5 successive steps: auto questionnaires, nurse evaluation, clinical balance tests, cognitive tests, medical examination, and DTGT. Gait analysis was provided by a three-axis accelerometer (Locometrix), three variables were selected: walking speed (WS), stride frequency (SF) and stride regularity index (SR). The Dual Task (DT) consists in walking and backward counting one by one from fifty. MRI including cortex trophycity, hippocampal Scheltens score, and age-related white matter changes (ARWMC) was performed under blind condition. Results Under DT condition, each gait variable decreases significantly. WS: from 1.13  $\pm$  0.24 to 0.98  $\pm$  0.23 m/s (p=0.02), SF: from 0.91  $\pm$  0.09 to 0.79  $\pm$  0.13 Hz (p<0.001), SR: from 211  $\pm$  51 to 160  $\pm$  60 dimensionless (P<0.002). Out of 25 patients, 3 had a vestibular disorder, one had post-stroke effects. No clinical explanation can be found for 21 patients other than hippocampal atrophy (Scheltens score 1.4  $\pm$  0.6), and/or leukoaraiosis (ARWMC score: 4.3  $\pm$  4.3). Conclusion: These results illustrate the interest of measuring not only walking speed and stride regularity, but also stride frequency under DTGT, and raise the question of the role of leukoaraiosis in gait instability.

## P3-M -194 Executive function relates to specific gait and balance metrics in Parkinson's disease

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Background. Previous studies showed the role of executive function (EF) on gait performance in Parkinson's disease (PD). However, the relationships between specific balance and gait components with specific EF components are not understood. In addition, studies that relate cognition with balance and gait rarely assess mobility with objective measures. The main objective of the study is to investigate the relationships between three different components of EF with specific postural sway and gait features. Methods. A total of 29 patients with idiopathic PD, tested in the practical "off" state, and 14 healthy-controls underwent a battery of cognitive tests assessing the 3 major components of executive function (updating, switching, and inhibiting), as well as cognitive processing speed (reaction time) and attention (clock test). Balance and gait were assessed with the Instrumented Stand and Walk test (ISAW), which consists of standing quietly for 30 sec, walking for 7 meters, turning 180°, and walking back to the starting point. Associations between motor and cognitive performance were examined with Pearson Product moment correlations. Correlations were corrected for UPDRS severity and gait speed. Results. A longer double support time was related to worse accuracy in the Go-No Go test (r=-0.4, p=0.04) and a shorter stride time was related to a slower performance in the Go-No Go task (r=0.5, p=0.01). Lower postural sway frequency dispersion was related to slower performance in the Stroop test (r=0.4, p=0.02). In contrast, RMS of postural sway was associated with cognitive attention (r=-0.5, p=0.01). Spatial and temporal gait characteristics were associated with cognitive processing speed, but not to stability during gait or static balance. Conclusion. Stability during gait, gait timing, and sway regularity were associated only with the Response Inhibition component of EF, suggesting common neural control of postural stability and response inhibition. In contrast, sway amplitude and stride length were related to less specific, non EF, components of cognition. Supported by grants from PANUC NINDS and NIA.

## P3-M-196 Inhibitory Deficits Are Associated With Freezing of Gait in Parkinson?s Disease

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#### Poster Abstracts

BACKGROUND AND AIM: Many people with Parkinson's disease (PD) experience a problem called freezing of gait (FoG), in which they feel like their feet are stuck to the ground when they want to walk. FoG has been associated with deficits in executive function (EF), but EF is not a unitary construct, and it is not yet clear which aspects of EF are most relevant for FoG. Here, we used a well-established three-component model of EF to ask which component is most clearly associated with FoG. METHODS: Participants were divided into three groups: participants with PD without self-reported FoG, participants with PD with self-reported FoG, and age-matched control participants. Each group completed the same series of cognitive tasks that were chosen to differentiate among the major EF components: updating working memory, switching between task sets, and inhibiting prepotent responses. Task performance was compared across groups using t-tests. RESULTS: Compared to control participants and Parkinsonian participants without FoG, participants with FoG performed significantly worse in tasks that required inhibiting prepotent responses. However, they did not perform worse in tasks that required task-switching or working memory updating. Participants with FoG were particularly likely to demonstrate intermittent response hesitation in the context of a Go-nogo task, without any general slowing in a simple reaction time task. CONCLUSIONS: These results suggest that FoG is associated with a specific deficit in inhibitory control, rather than with a general deficit in EF. In particular, participants with FoG had trouble discerning whether or not to inhibit a response, in a context where inhibition was sometimes required. These findings are consistent with a possible causal relationship between impaired inhibition and FoG. Stepping requires synchronization between two elements: (1) an anticipatory postural adjustment (APA) to shift weight off of the stepping foot, and (2) picking up the stepping foot. If the APA is early or late (under-inhibited or over-inhibited) with respect to the picking up of the foot, then the step will not proceed. This may lead to alternating APAs without a step, explaining the rapid motor oscillations (knee trembling) that characterize FoG.



## P3-M -198 Subcortical and cortical contributions to posture and movement planning and preparation for forward reaching in standing post stroke.

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#### Poster Abstracts

BACKGROUND AND AIM: Reaching forward to grasp an object in standing involves anticipatory postural adjustments (APAs) that precede and accompany goal directed arm movement, and reactive postural responses that may further stabilize balance and prevent falling. These integrated processes require the coordinated control from both cortical and brainstem centers. Use of a startling acoustic stimulus (AS) as well as noninvasive transcranial magnetic stimulation (TMS) prior to intended action during an instructed delay task, permits us to probe central neuronal excitability for posture and movement planning and preparation. Our purpose was to determine the subcortical (with AS) and cortical (with TMS) contributions to posture and movement planning and preparation for the initiation of a standing forward reach in adults with chronic hemiparesis and healthy controls. METHODS: Subjects included nine participants with chronic hemiparesis due to stroke and 5 age-matched healthy controls. Using a simple reaction time paradigm, subjects were standing on separate forceplates and received a warning light cue to "get ready to reach" followed 2000 ms later by a go light cue to "reach as quickly as you can" with the paretic arm to touch a target ball for a total of 90 trials. In 30 of the reach trials an acoustic startle stimulus of 124 dB was randomly applied at -1500, -1000, -500, -200, 0, or 100 ms relative to the "go" cue. On a separate day this procedure was repeated with a TMS suprathreshold stimulus over the contralateral motor cortex. For both AS and TMS trials, the APA-reach sequence was characterized by the onset and maximal displacement of both the center of pressure (COP) and the paretic hand movement and the onset/offset of EMG from tibialis anterior, soleus, anterior and middle deltoid and the sternocleidomastoid muscles. RESULTS: We found a marked reduction in the incidence of startle-evoked responses in stroke subjects compared to controls during the planning period for both APAs and the goal intended reach. Consequently, both delays and diminished amplitudes were seen for postural and goal directed movements at reach execution. In contrast, we found stroke subjects had a TMS-evoked release of the APA-reach sequence compared to controls who showed no change in corticomotor excitability during the motor planning phase. Two distinct profiles emerged with cortical vs. subcortical contributions to motor planning for this task, 1) Subjects with startle-evoked responses did not show TMS- evoked a release of the planned movement and 2) Subjects lacking startle-evoked release of the planned movement demonstrated TMS-evoked release of the movement. CONCLUSIONS: There are alternations in motor planning and preparation for both postural and goal directed movements post-stroke. These changes in motor planning and preparation may be related to a disruption of brainstem and cortical interactions.

## P3-M -200 Imposing asymmetry through split-belt walking in patients Parkinsons disease

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Background and aim of study: Patients with Parkinson's disease (PD) have high incidence of falls, possibly due to a decreased ability to adapt the gait patterns to different walking conditions. Moreover, gait asymmetry has been implicated in patients with PD. The aim of the study was to investigate the effects of imposed gait asymmetry on the walking pattern of patients with PD during treadmill walking. Methods: Eight PD patients, who were OFF-medication, (5 freezers and 3 non-freezers; mean Hoehn and Yahr scale, 2.75) and six healthy age-matched controls participated in the study. The paradigm consisted of walking on a split-built treadmill during the following randomized conditions: 2 min (tied-belt at 3 km/h); 2 min (split-belt, one belt increased to 4 km/h); 2 min (tied-belt at 3 km/h); 2 min (split-belt, the other belt increased to 4 km/h); 2 min (tied-belt at 3 km/h). Mean and coefficient of variability of step length, step width and step time during tied-belt, split-belt and transition steps (from 3 to 4k/h and vice versa) were determined. Step length symmetry (fast step length - slow step length / fast step length slow step length) was also calculated. Independent t-test and repeated measure ANOVA were used to compare the results between the two groups. Results: During tied-belt conditions, PD subjects had shorter step length and time and greater variability compared to controls (p < 0.05). During the transition, PD subjects made shorter and wider steps at the perturbation side compared to controls. During the split-belt conditions, both groups gradually increased their step length symmetry (see figure 1). However, PD

patients reached a plateau earlier (after about 70 strides). The final level of symmetry was greater in controls. Conclusions: Split-belt perturbations had greater effects on PD subjects and adaptation to enforced asymmetry was less efficient in PD subjects. This prolonged gait inflexibility may impact on functional mobility when walking needs to be accommodated to a complex environment.

## Figure 1: Average step length symmetry during split-belt periods of healthy elderly



Strides

## P3-M -202 The validity of sensor-based gait assessment in Parkinsons Disease

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BACKGROUND AND AIM: Studies investigating gait in Parkinson's Disease (PD) apply a highly standardized assessment protocol, which may not reflect daily life walking. Technological advance allows gait measurement using unobtrusive inertial sensors and this may provide a more valid method for gait analysis. We investigated 1) the difference between sensor-based versus GaitRite measurement of gait variables; and 2) the difference between walking in a standardized lab environment and in an uncontrolled environment using the inertial sensors. METHODS: 6 PD patients (Age: 50-87 years; Disease duration: 3-21 years; H&Y: 1-3) walked 5 times over an 8 meter GaitRite walkway in a standard gait lab. Gait parameters were also measured using newly developed inertial measurement units (IMU) (EXEL srl, Italy) mounted at the top of the participants' feet as part of the EU-funded CuPiD-project. The IMU's included a tri-axial accelerometer, a gyroscope and a magnetometer. Afterwards, patients walked up and down a 30 meter long public corridor using the sensors. In both circumstances patients were instructed to walk at their preferred speed. IMU data collection was synchronized and operated through a simple custom-written smartphone application. We used nonparametric statistics to compare the various walking conditions (GaitRite, sensor-based, real life walking). Only right foot data are reported as medians and interquartile ranges, excluding turning signals. RESULTS: Stride length was the same in all 3 conditions.

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Stride length variability was significantly greater by 0.86% (p=.046) when determined by sensor-based measurement (3.93% [3.41-4.47]) compared to GaitRite (3.07% [2.64-3.39]). Stride duration was significantly lower by 1.38% (p=.046) in the sensor-based measurement (1.09 seconds [1.06-1.19]) compared to GaitRite (1.11 seconds [1.08-1.21]). Stride duration was also reduced by 4.16% (p=.046) during real life walking (1.05 seconds [1.04-1.09]) compared to the standardized setting (1.09 [1.06-1.19]), indicating a higher cadence. Surprisingly, stride duration variability was the same in all 3 conditions. CONCLUSIONS: Further work is needed to address the differences between the sensor-based method and the gold standard GaitRite system, although the difference was within an acceptable range. These preliminary results indicate the potential contribution of sensor-based measurement for obtaining ecologically valid measures of gait in PD. ACKNOWLEDGEMENT: 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).

## P3-M -204 Abnormal external oblique muscle activity in camptocormic patients with Parkinson's disease

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Background: Patients with Parkinson's disease (PD) often experience camptocormia, abnormal truncal flexion that appears in standing position and disappears in supine position. The pathophysiology of camptocormira has not been well understood. Camptocormia is refractory to medications in general and impairs patients' quality of life even though other motor symptoms are well controlled. We have reported that lidocaine injections into the external oblique muscles can improve camptocormia in PD patients. This result suggests that overcontraction of external oblique muscles can be one of the pathophysiological mechanisms of camptocormia. Aim: The aim of this study is to investigate the pathophysiology of camptocormia in PD patients through performing surface electromyography over multiple truncal muscles. Method: We performed truncal surface electromyography in 13 patients with PD (8 female 5 male, age 69.5 (SD 8.0)). Nine patients had camptocormia clinically. Electrodes were positioned in the lateral abdomen (just above the external oblique muscle) bilaterally. Patients were asked to lie supine on a tilt table in the horizontal position with wearing blindfold. Then, the table was tilted up to the vertical position (90 degrees) to replicate a standing posture without voluntary motor command (passive standing). Surface electromyography was recorded throughout the postural changes. Result: All patients did not show any discharge in supine position. All of the 9 patients with camptocormia showed truncal flexion during the passive standing procedure. Six out of 9 patients showed discharge in bilateral (3 patients) or unilateral (3 patients) external oblique muscles before the appearance of truncal flexion. The four patients without camptocormia did not show any discharge in the external oblique muscles. Conclusion: A role of the external oblique muscles is truncal flexion. Contraction of the external oblique muscles before the appearance of truncal flexion suggests that the external oblique muscles may trigger truncal flexion, which can be one of the pathophysiological mechanisms of camptocormia in PD patients.

## P3-M -206 Gait adaptability training improves obstacle avoidance capacities and dynamic stability in patients with degenerative cerebellar ataxia

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Background: Balance and gait problems in patients with degenerative cerebellar ataxia lead to reduced mobility, loss of independence, and frequent falls. It is currently unclear, however, whether balance and gait capacities can be improved by training in this group of patients. In this pilot study, we aimed to examine the effects of gait adaptability training on obstacle avoidance capacities and dynamic stability during adaptive gait. Methods: Ten patients with degenerative

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cerebellar ataxia received gait adaptability training (10 sessions, 1 hour each) during a period of 5 weeks. Training was performed on a treadmill instrumented to project visual cues on the belt's surface attuned to the participant's walking pattern (C-mill). Before and after the training period, participants were assessed with regard to their obstacle avoidance capacity. They had to avoid stepping on an obstacle that was suddenly dropped on a treadmill in front of their nondominant foot (30 trials per assessment; Weerdesteyn et al., 2003) and we determined the rate of successfully avoided obstacles. In addition, dynamic stability (margin of stability, MoS; Hof et al., 2005) was assessed in the sagittal and frontal planes for the steps prior to obstacle presentation (control steps), the shortened step in front of the obstacle, and 5 subsequent steps. We also conducted the obstacle subtask of the Emory Functional Ambulation Profile (EFAP) and the Scale for the Assessment and Rating of Ataxia (SARA). Results: After training, success rates on the obstacle avoidance task were significantly larger than pre-intervention (94.8±5.4% vs 78.5±16.8%, p=0.019). The shortened step in front of the obstacle resulted in reduced dynamic stability in the sagittal plane (i.e. smaller MoS compared to the control steps). Compared to pre-intervention, the participants tended to allow even smaller MoS in the shortened pre-crossing step (p=0.078) post-intervention, in order to successfully avoid the obstacle (cf. results for success rates). However, they more quickly restored their MoS to control step values in the subsequent steps (p=0.004). Dynamic stability in the frontal plane was less affected by the obstacle and did not demonstrate effects due to training. The EFAP scores improved significantly after training (11.8±0.9sec vs 12.8±1.4sec, p=0.004), as did the SARA scores (8.3±2.8 vs 8.7±2.8, p=0.011). Conclusion: This pilot study provides evidence of a beneficial effect of gait adaptability training on obstacle avoidance capacity and dynamic stability in patients with degenerative cerebellar ataxia. Future research will focus on the neuronal substrate of this improvement as well as on the sustainability of these improvements. References Weerdesteyn et al., J Mot Behav 2003;35:53-63 Hof et al., J Biomech 2005; 38(1):1-8.

# P3-M -208 The neural network learning functional electrical stimulation (FES) for the correction of drop-foot in hemiplegia

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Background Functional electrical stimulation (FES) has been used for the correction of drop foot after the occurrence of an upper motor neuron disease, such as a stroke. For the correction of drop foot, the common peroneal nerve was electrically stimulated during swing phase of the gait. There are some gait cycle detection systems for the correction of drop foot by FES. We carried out neural network learning FES by using the signals of a tri-axial accelerometer and a gyroscope. The purpose of this study is to evaluate whether this system can detect the gait cycle of hemiplegic patients and correct the drop foot gait. Methods Six hemiplegic individuals in chronic stages participated in this study. A tri-axial accelerometer and a gyroscope were were fixed on the tibial tubercle of the affected knee. A heel sensor was placed on the affected sole as a control signal. The recorded signals were transferred to the computer for processing using Neural Network Learning (NNL). NNL enables detection of gait cycle by using only a tri-axial accelerometer and a gyroscope by means of converting their signals into signals showing swing and stance phases, like the signals of a heel sensor. For walking with neural network learning FES, the sensors were placed on the tibial tubercle of the affected knee and the tibialis anterior muscles and peroneal nerve were stimulated using surface electrode stimulation device. For the assessment, the walking speeds and the step cadences of the neural network learning FES assisted gait using a 10m course were measured and compared with the non-FES assisted gait. Results All hemiplegic individuals successfully could walk with neural network learning FES. Patients with FES from signals of only the tri-axial accelerometer and gyroscope had faster walking speed and fewer steps than patients without FES. The walking speeds were 0.54 ± 0.08 m/s (mean ± SD) of the non-FES assisted gait and  $0.58 \pm 0.10$  m/s of the FES assisted gait, respectively. The walking speed was significantly greater with the AHSS assisted gait (p < 0.05; Wilcoxon signed ranks test). Discussion The neural network

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learning FES produced statistically significant improvement in the correction of the drop foot in hemiplegic patients. All patients were able to walk faster with neural network learning FES assisted gait than with the non-FES assisted gait. Although gait analysis using a tri-axial accelerometer has been carried out, clinical validity of using a tri-axial accelerometer and neural network learning for hemiplegic individuals has not been reported. In this study, by using neural network learning FES from the signals of an accelerometer and a gyroscope, the gait ability of hemiplegic individuals was improved. Conclusion The results demonstrate that neural network learning FES produced statistically significant improvement in the correction of the drop foot.

### P3-M -210 Dynamic postural control under visual constraint in post-stroke hemiplegic patients

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BACKGROUND AND AIM: Perception used for the postural control is a prerequisite for executing motor tasks, enabling both healthy and post-stroke individuals to perform daily activities in response to changing environmental demands. This study aimed to investigate the manner in which post-stroke hemiplegics execute basic whole-body movements from the perspective of perception-action coupling. We asked the participants to perform a sit-to-stand movement (STS) with and without constrained vision, and analyzed their body's centers of mass (COM) and of pressure (COP). METHODS: Eight hemiplegic and eight healthy individuals performed the STS with their eyes closed and eyes open. During this movement, their COM in the anterior-posterior, upward-downward, and right-left directions, and COP in the anteriorposterior and right-left directions were computed. To evaluate the control of COM and COP with and without vision, the variability in the position and velocity of COM and in the position of COP were analyzed. RESULTS: COP variability in the right-left direction was smaller at lift-off in hemiplegic participants when their eyes were closed than when their eyes were open, whereas this variability remained unchanged in the healthy participants. No significant differences were found in the variability of COP in the anterior-posterior direction, nor COM positions and velocities in the three directions in both groups of participants whether their eyes were open or closed. CONCLUSION: Our findings suggest that when visual information is not available, hemiplegic patients attempt to control right-left movement as a critical movement direction at lift-off during STS. Vision is one of the modalities of perception involved in postural control. Because people have motor and perceptual deficits following strokes, they may have greater dependence on vision than healthy individuals do. The adjustment in the regulation of movement arising from perceptual constraints that was observed only in the case of post-stroke invididuals indicates adaptation to changes in envionmental situations encounted in daily life.

## P3-M -212 Understanding Balance Differences in Multiple Sclerosis: An Investigation of Differences in Sensory Feedback on Stability

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Background: The ability to control stability in the medio-lateral (ML) direction is imperative in controlling balance during stance and locomotion. New evidence suggests that balance differences may exist between individuals with Multiple Sclerosis (MS) with mild disability (no subjective balance impairment (nSBI)) and healthy age-matched individuals (hAMI) during clinical balance tests with the use of sensitive, research grade equipment. The purpose of this study was to determine the magnitude of differences in balance control between individuals with MS (nSBI) and hAMI using both a postural and dynamically challenging tasks. Methods: Participants (N=14) with MS (nSBI, n=7, Mage= 42) and hAMI (n=7, Mage= 41.75) stood on a force platform with feet together and arms by their sides for 45s with either eyes open or closed to assess static control of balance (COPRMS displacement, velocity). Participants also performed a 9m walking

task (6.2m straight 2.5m change in direction) to assess differences in gait characteristics (i.e., velocity, step length/width, double support time, trunk sway) and dynamic stability margin (ML distance between COM and BOS). Results: Individuals' ML-COPRMS displacement and velocity were calculated during standing. Results showed more sway (p<0.05) and sway velocity (p<0.01) in the ML direction during static stance with eyes closed for individuals with MS (nSBI).Gait characteristics and lateral dynamic stability margin (during single support phase of gait) were calculated and separated into three distinct walking task phases (approach (straight walking), anticipatory postural adjustment (2 steps prior to turn) and turning). Preliminary results showed no differences between groups during each walking task phase for most gait parameters and lateral dynamic stability margin. However MS (nSBI) walked much slower than hAMI (p<0.001). Conclusions: The preliminary findings from this study show that individuals with MS (nSBI) appear to rely heavily on vision to control balance during a postural challenging task. This was demonstrated when individuals with MS (nSBI) displayed significantly worse postural control capabilities (i.e. ML-COP¬¬RMS ¬displacement and velocity) when vision was removed. This suggests that individuals with MS (nSBI) must be using vision to fixate a stable reference point in order to maintain postural stability. Evidence of this was also observed during the steering task. MS (nSBI) participant used the light cue during the steering task as a stable reference point to set up their locomotor axis and displayed similar dynamic stability to hAMI. However, the MS (nSBI) participants maintained this level of dynamic stability at the expense of walking slower. This decreased walking speed may be a compensatory mechanism to either spend more time processing visual information or that the individuals may require more sensory stimulation from the soles of their feet in order to allow for equivalent balance control.

## N - Cognitive, attentional and emotional influences; Sensorimotor control

## P3-N-214 Estimating Mood from MPF of EMG during Walking

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BACKGROUND AND AIM: In areas such as security, daily life support and nursing, human mood can become very valuable information for selecting the adequate service according to the situation. In this work, we estimate the mood from the surface electromyogram (EMG) information during walking. Identification of mood using EMG has been done with a variety of methods until now, and walking is one of the daily life behaviors including individual specific information. Therefore, it is thought that the EMG analysis during walking is effective in the identification of human mood. METHODS: The purpose of this experiment is the measurement of EMG during walking in a variety of moods. The subjects are three healthy males. The subject performs two types of tasks to evoke mood (music listening and numerical calculation). The tasks are performed on two laptop computers at two distant spaces in the room by turns, and the subject walks back and forth between them. After completion of each task, the subject fills in questionnaires about their mood at that time, and then the subject walks to the other space. The measurer measures EMG of the subject during walking. EMG signals are sampled from four muscles: biceps, triceps, deltoids, and trapezius of the right-hand side upper limb. The result of psychological test is expressed as a score of "pleasure" and "arousal" (from -20 to 20). We have created the linear regression analysis model using principal component scores of mean power frequency (MPF) variation of EMG and psychological test scores as the model variables. RESULTS: We have confirmed a statistically significant positive correlation of the model whose response variable is "pleasure" scores and explanatory variable is the 1st principal component score of MPF of the frequency range from 5 to 50 Hz (p < 0.001). This model can explain about 50% of the amount of the variation in pleasure score (Adjusted R Square: 0.501, Standard error: 3.79). In the frequency range from 5 to 50 Hz, the principal component used for the model has the information that the eigenvalue is 1.556 and the contribution ratio is 38.9%, and contains the information of all the measured muscles almost equally. CONCLUSIONS: We

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have confirmed the statistically significance of the linear model to predict the variation of mood based on the information on the variation in MPF of EMG of the muscles of the upper limb during walking with a variety of mood. This shows the validity of such a mapping. However, since the interpretability of the model is still low, it cannot be said that the model is able to accurately represent the mood variation. To create a model with high accuracy, it is necessary to collect more subjects' data and examine new explanatory variables. In addition, we need to try a variety of patterns about the part of muscle and the method of processing EMG data to find the element related to mood.



#### P3-N-216 Stance stability can affect imagined arm movements.

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INTRODUCTION: Many everyday posture-cognition dual-task situations involve the covert planning or mental rehearsal of a movement, yet this relationship has received little attention. Imagined movements are considered mental simulations of their physical counterparts, sharing many behavioural and physiological characteristics [1]. The postural context is functionally linked to any planned manual movement, since anticipatory postural adjustments (APAs) would be needed both to support the movement and to neutralize its destabilizing effects on stance [2]. If motor planning during imagery incorporates current body-postural constraints, then a change in stance stability should measurably impact an imagined manual movement e.g. change in movement time (MT). In this study, participants performed physical and imagined reaching arm movements under three levels of arm loading (0kg, 1kg & 2kg) while standing in closed or semi-tandem Romberg stance. Since the level of physical loading affects APAs [3], we expected reported imagined MT to be sensitive to both stance and loading manipulations. METHODS: 48 participants (18-30 yrs) with no

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history of balance impairments, stood blindfolded in closed (feet flush together) or semi-tandem Romberg (dominant foot forward) stance. Physical and imagined pointing movements were made with the loaded arm, to a set of targets arranged at waist level; either in a ML or AP direction (Fig 1). Body sway was measured at 60Hz from a hip-attached Polhemus Fastrak sensor, from which a moving window SD (1 s window) and RMS drift were calculated.RESULTS: Physical and imagined MTs increased approximately linearly with target distance. Imagined MTs increased with the level of load on the arm. Stance affected imagined MTs when movements were made in the ML (but not AP) direction, with longer MTs reported in the semi-tandem Romberg stance (Fig 2). Both ML and AP sway increased with arm loading during physical (but not imagined) reaching movements.CONCLUSIONS: Self-reported MT increased with target distance and load on the arm, indicating that the imagined movements were planned in consideration of these factors, as expected from previous work. Critically, self-reported MT was longer when imagining reaching movements along the ML direction while standing in the semi-tandem Romberg stance (in which ML stability was particularly compromised). This suggests that specific stability characteristics of current body posture are factored into the planning of manual movements during motor imagery. REFERENCES 1. Guillot A, Collet C. Neurophysiological foundations of mental and motor imagery. Oxford University Press, Oxford, 2010. 2. Massion, J., Movement, posture and equilibrium: Interaction and coordination. Progress in Neurobiology, 38, 35-56.3. Bouisset, S., Richardson, J., & Zattara, M. (2000) Are amplitude and duration of anticipatory postural adjustments identically scaled to focal movement parameters in humans? Neuroscience, 278, 153-156.



Fig 1. Manual pointing task



Fig 2. Experimental results

### P3-N-218 Fear Of Falling And Multi-Tasking During Stair Descent In Community Dwelling Older Women

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Background and aim: Descending stairs is a leading cause of falls and trauma for older adults. Little, however, is understood about fear of falling (FOF) and stair descent. Using dual task paradigms, it has been established that gait by itself requires attention and general executive functioning, but little is understood about dual task costs (particularly visual interference) during stair descent in older adults, and no one has specifically looked at this with respect to fear of falling. The present objective was to study the ability of community dwelling older women with FOF to descend a staircase with and without divided visual attention as compared to older women without FOF. Methods: To date, nine older women (70.3 ± 6.8 years) with fear of falling based the Activities-specific Balance Confidence scale, and also having reported at least one fall in the previous year, were compared to 14 women (control group;  $71.2 \pm 5.06$  years) with no documented fear or falls over the previous year. All subjects descended a five step staircase at self-selected speed under 4 conditions including no simultaneous visual stimulus, and a simultaneous visual Stroop task presented on screens at the bottom of the staircase during descent at: initiation of approach; foot contact at the top of the staircase in preparation for descent (transition); contact on the second step down (steady state). Conditions were randomised. Using motion analyses (Optotrak) and voice recordings, dependent variables reported here are railing use, forward trunk centre of mass velocity, minimum foot clearance over all step edges, and Dual Task Cost (DTC) as the difference between response times to visual Stroop during stair descent and at baseline. Non-parametric statistics were used to compare between groups and across conditions. Results: 62.5 % of the FOF group used the handrail in some way for the majority or all of their trials compared to 35.7% for the control group. There were no group differences for gait speed. Minimum foot clearances tended to be lower for the FOF group, particularly at transition where only the control group showed dual task effects. DTCs were not significantly different between groups, but were still generally higher for the FOF group who also tended to maintain similar costs for steady state descent as for approach and transition. Conclusions: Preliminary findings suggest that for fit, community dwelling older adults, FOF has subtle effects on stair descent behaviour. Yet, there is some indication of greater caution (handrail use) and possible sustained attention during steady state descent. Surprisingly, subjects with FOF appeared, if anything, to use riskier minimum foot clearances even though they walked with similar descent speeds to the control group. Data collection continues as does further analyses related to posture control and executive functioning.

## P3-N-220 Investigating the cognitive processes underlying gait and falls in young and older healthy adults: Returning to an executive model.

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BACKGROUND AND AIM: The clinical assessment and treatment of gait impairments and falls often focuses on visual and motor functioning, while largely ignoring cognition. Previous research has identified the role of higher-cognitive executive processing in gait performance (Hausdorff et al., 2005; Yogev-Seligman et al., 2008). However, more recent studies propose multisensory integration as an alternative underlying process of spatial cognition (Newell et al., 2011). While an integration of sensory information is important, successful gait and navigation also requires proprioceptive and vestibular inputs. This study aimed to examine the relationship between different higher-cognitive processes and walking gait performances in young and older healthy adults. METHOD: This study examined normal gait performance in young and older adults using SHIMMER wireless inertial sensors. Executive function, multisensory integration, motor function and memory performances were correlated with temporal gait parameters for young and older adults. Comparisons were also made for older adult fallers and non-fallers (based on fall history). It was hypothesised that

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executive performance would correlate best with gait performance, with some significance for each of the remaining cognitive tasks. RESULTS: Results further demonstrate the relationship between executive functioning and walking gait. The implications of these results on the proposed executive model of gait is discussed. CONCLUSIONS: This study contributes to the understanding of the specific cognitive systems and processes underlying gait, and may help to determine whether impaired executive control or faulty multisensory integration processes underpin falls. Therefore, potential implications for specific cognitive assessments and interventions for fall-prone populations, such as older adults and clinical samples (TIA/stroke patients) are manifest.

## P3-N-222 Effects of attentional focus on imagery and execution of sit-to-stand movements in healthy young and older adults

#### Kanokwan Srisupornkornkool<sup>1</sup>, Suvobrata Mitra<sup>1</sup>

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INTRODUCTION: Imagined movements show several performance constraints found in physical ones, e.g., distancescaled movement times (MT) [1]. Thus, there is significant interest in using MI as a means of motor training and rehabilitation [2]. A key stage in locomotor rehabilitation is regaining sit-to-stand (STS) function, but age-related differences in MI of STS movements, and sensitivity of MI to attentional focus on different aspects of STS movements are not yet well understood. Here, we studied the effects of aging on self-reported MT of physical and imagined STS movements under changing conditions of attentional focus. We also measured the timing and stability of physical STS movements performed under these focus conditions. METHODS: 53 healthy young (18-30 yrs) and 34 older (65-80 yrs) adults performed physical and imagined STS movements under three attentional focus conditions - visual focus (on the change in viewpoint relative to a static target), muscular focus (on the load on thigh muscles), and somatosensory focus (on the pressure under feet). Self-reported MT was measured during MI and physical movement trials. MT and CoP path length were measured during physical movement trials using an AMTI force platform recording at 50Hz sampling rate. RESULTS: Both age groups reported shorter MT under visual than muscular or somatosensory attentional focus, in both imagined and physical movements. Young adults also had shorter MT and greater stability (shorter CoP path) during physical movements, but older adults' physical MT did not change with attentional focus, and their postural transition was actually more stable when focusing on muscular load. CONCLUSIONS: Attentional focus on body-external aspects of movement (e.g., our visual focus condition) tends to benefit balance and motor performance relative to body-internal focus (e.g., our muscular and somatosensory focus conditions) [3]. Young adults' self-report during movement imagery and execution was consistent with this. Older adults' self-report followed this pattern, but their performance showed an internal-focus benefit. Thus, older adults' motor planning during MI may not reflect their performance ability. These results suggest that attentional focus on muscular load may be more effective in MI-based training in older adults, but younger individuals would benefit more from focusing attention on body-external effects of movement. ACKNOWLEDGEMENTS: Supported by ESRC, UK and the Royal Thai Government. REFERENCES 1. Jeannerod M. Motor cognition. Oxford University Press, Oxford, 2006. 2. Guillot A, Collet C. Neurophysiological foundations of mental and motor imagery. Oxford University Press, Oxford, 2010. 3. Wulf, G. Attention and Motor Skill Learning. Human Kinetics, Champaign, IL, 2007

## P3-N-224 Cognitive decline is associated with impairments in mobility in healthy older adults: findings from a 5 year prospective study

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BACKGROUND AND AIM: In recent years, the understanding of the relationship between cognitive and motor function has brought about a shift in our perception of the mechanisms underlying functional decline in ageing. The aim of the current study was to further investigate this relationship in a longitudinal prospective study and to identify motor contributions to cognitive decline in healthy older adults over the course of 5 years. METHODS: Healthy older adults between the ages of 70-90 were recruited from the community. Assessments were performed at baseline and after 5 years. Subjects were included if they could walk independently and were free from neurological or orthopedic diseases likely to directly impact gait. Subjects were excluded if they had acute illness, history of brain surgery, major depression, or scored jU25 on the Mini Mental Status Examination (MMSE). The Berg Balance Scale (BBS), the Dynamic Gait Index (DGI), and the Timed Up and Go (TUG) evaluated balance and functional mobility. Subjects were divided into two groups based on their MMSE score in year 5. Those who had a decrease of >= 3 points were considered to have a significant cognitive decline (CD group) and were compared to the Non-CD group. Both groups were examined at baseline and slopes of deterioration over 5 years were determined. Linear regression analysis examined the contribution of motor parameters to cognitive decline. RESULTS: 182 subjects (76.0+/-4.4 yrs, 38.5% men) were reassessed in year 5. The CD group included 23 subjects (78.0+/-3.7yrs, 43.5% men) and the Non-CD group included 159 participants (75.8+/-4.5 yrs, 37.7% men). At baseline, the groups did not differ in MMSE scores (p=0.07). However, between groups differences were found at baseline for various motor measures including gait speed (p=0.006) and in the TUG (p<0.05). Time to perform the TUG increased (deteriorated) in both groups from baseline to year 5 (p<0.001). However this change was considerably larger (p=0.012) in the CD group, compared to the non-CD group. In the CD group, time to complete the TUG time increased by 42% (from 10.0+/-2.0 sec to 14.5+/-5.4 sec, p<0.001), passing the threshold of a heightened fall risk. In the Non-CD group, TUG increased by 20% (from 9.1+/-1.4 to 10.9+/-3.3 sec) in year 5. Similar patterns of deterioration between groups were also observed in the DGI (p=0.01) and the BBS (p=0.015). In multivariate analysis, the baseline TUG score was found to significantly predict cognitive decline after 5 years (p<0.001). CONCLUSIONS: These findings demonstrate a clear relation between clinically significant deterioration of motor and cognitive aspects. The fact that baseline motor parameters were associated with future cognitive decline further supports this link. Further, these findings suggest that performance-based measures of mobility may help to assess subtle changes in motor performance that are predictive of cognitive decline.

## P3-N-226 Dual tasking affects lateral trunk control in healthy younger and older adults

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BACKGROUND AND AIM: Assessing the effects of attention-demanding tasks on trunk movement provides useful insights into postural control while walking in an attention-split situation, such as occurs in daily life. The coefficient of attenuation of acceleration (CoA) at the trunk is a useful gait index to assess whole trunk movements. We investigated the effect of attention-demanding tasks on CoA to assess the role of attention on trunk control during walking. METHOD: Thirty healthy, community-dwelling older adults ( $70.1 \pm 5.6$  yrs) and 38 younger adults ( $22.1 \pm 3.4$  years) participated in this study. Participants walked 20 m at a self-selected speed (slow, normal, fast) and while performing an attention-demanding cognitive task. Trunk acceleration was measured using triaxial accelerometers attached to the lower (L3 spinous process) and upper (C7 spinous process) trunk and used to compute CoA (the reduction in acceleration from the lower to upper trunk). RESULTS: An attention-demanding task significantly decreased CoA in the medio-lateral (ML) direction in both age groups (p < 0.001), whereas it did not affect CoA in the vertical (VT) and anterior-posterior (AP) directions. CONCLUSIONS: Our findings suggest that the priority of whole trunk control in the ML direction may be higher than in other directions and be strongly associated with attention, whereas whole trunk control in the VT and AP directions may be passively regulated and require minimal attentional control.



Coefficient of attenuation of acceleration (CoA) at the trunk in the single-task and dual-task conditions. #: CoA was adjusted statistically by gait speed. VT, vertical; ML, medio-lateral; AP, anterior-posterior. Single-task = walking alone; dual-task = walking while counting down aloud from 100 by 7s. \*p < 0.0125, \*\*p < 0.001.

#### P3-N-228 Stepping accuracy of walking measured using a cancellation task

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BACKGROUND AND AIM: Stepping accuracy, which is critical where hazards or obstacles must be traversed, is presumably related with fall risk. Few studies have used neuropsychological tests to examine the accuracy with which humans can step on targets arranged irregularly on a walkway [1]. A cancellation task is a commonly used test for assessment of selective and directed attention [2]. This task requires an individual to place a mark through each occurrence of a specific target that appears many times along with non-targets. This study was conducted to investigate stepping accuracy using a cancellation task. METHODS: 19 young adults (10 women, M age =  $22.5 \pm 2.6$  years) participated. Participants performed cancellation tasks both by stepping (foot) and tapping (hand). In the stepping cancellation task, each participant was instructed to step on targets through a 5 m walkway while avoiding distracters. In the tapping cancellation task, each was instructed to tap targets placed on 50 cm sheet of paper with two hands. The target-to-distracter ratio differed for both tasks: 10 targets and 40 distracters (less-distractive condition) were used, as were 10 targets and 90 distracters (more-distractive condition). Across tasks, targets were the letter 'I'. Distracters were the letter 'L'. Two tasks and two conditions were counterbalanced among participants. RESULTS: Table 1 presents means and standard deviations of errors and performance times. Participants performed the tasks accurately. Errors were observed only for more distractive conditions in the stepping task. Analysis of performance times showed a main effect of response mode (F1, 18 = 26.43, p<0.0001), a main effect of the stimulus ratio (F1, 18 = 30.68, p<0.0001), and interaction between the response mode and stimulus ratio (F1, 18 = 4.48, p<0.05). The results demonstrated that the more-distractive condition is more difficult than the less-distractive condition, which is consistent with results of prior studies. Moreover, the stepping task is more difficult than the tapping task. It is noteworthy that significant interaction revealed that the more-distractive condition in the stepping task is particularly difficult. CONCLUSIONS: This study showed that a more-distractive stepping cancellation task is particularly challenging even for young adults. Future studies are expected to elucidate the potential factors related to the difficulty and to examine the utility of this task as a

clinical test for elderly people with fall risk. References 1. Alexander NB, Ashton-Miller JA, Giordani B, Guire K, & Schultz AB. J Gerontol Med Sci. 60:1558-1562, 2005. 2. Geldmacher DS. Brain Cognition 36:346-354, 1998.

		step	oping	tap	ping
		less distractive	more distractive	less distractive	more distractive
number of errors	М	0.0	0.4 <sup>a</sup>	0.0	0.0
	SD	0.0	0.7	0.0	0.0
performance time		8.0	11.0	6.7	8.3
(s)	М				
	SD	2.0	3.1	1.8	2.2

Table 1. Means and standard deviations of errors and performance times

<sup>a</sup> Five participants (26%) committed omission errors (failure to detect targets).

#### P3-N-230 Relationship between visual influence on path integration and landmark navigation ability

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Background and aim: Our spatial perception consists of three parts: allocentric representation, cognition based on absolute position information such as direction and distance; egocentric representation, cognition based on selfcentered relative position information such as front, back, right, and left; and path integration, one's own internal spatial perception. Egocentric representation mainly uses visual sense information, for which the parietal association area is mainly used. In order to construct egocentric representation as allocentric representation, which is an absolute spatial representation, experts believe that the functions of hippocampus and parahippocampal gyrus are necessary. We animals are constantly moving, so we need to perceive how we are moving and constantly update spatial cognition. This internal spatial cognition inside us is path integration. Animal experiments have reported that path integration is recognized through visual and olfactory information and vestibular stimulation. Of them, vestibular stimulation is considered to play a large role in path integration. This study investigated Landmark navigation, the ability to convert the function of path integration and egocentric spatial cognition to allocentric spatial information, and examined the association of these functions. Methods: 8 healthy adults without a history of vestibular or central disorder were reviewed for the following: 1) -1 Path integration (distance) a) walk 15 m with eyes closed, and return to the starting point with closed eyes; b) walk 15 m with eyes open, and return to the starting point with eyes closed. 1) -2 Path integration (angle) a) walk 1 m with closed eyes, rotate 60°, 90°, 120°, 240°, 270°, or 300°, walk 1 m again, and return to the starting point by following the last track with eyes closed; b) Move in the same manner with eyes open, and return to the starting point by following the last track with eyes closed; 2) Using a computer software on visual spatial cognition conversion ability on landmark navigation, the ability to convert egocentric spatial cognition to allocentric spatial cognition and vice versa were investigated. Results: 1) -1 Visual input helped improve path integration (distance). 1) -2 Visual input had no association with path integration (angle). 2) There was a tendency for visual input to improve path integration (distance) for good examples of landmark navigation. Conclusions: Landmark navigation ability and path integration improvement due to visual input may possibly be correlated.

P3-N-232 Awareness of visual reliability significantly influences the relative sensory weight on motion perception under sensory conflict condition

## *Sue Park<sup>1</sup>,* Hyeob Choi<sup>1</sup> <sup>1</sup>KAIST

BACKGROUND AND AIM : The major topic of virtual reality technology attracting interest recently is how to increase a sense of immersion. The sense of immersion is affected significantly by reliability of visual information that is main stimulus in virtual reality, but there is not enough quantitative research focusing it. In this study, we examined how much the visual reliability affects the motion perception under sensory conflict condition by measuring direction of motion perception when subjects were either aware or not of possibility of false visual cues. METHODS : Eight male subjects answered their perception of direction of linear translation under sensory coherent/conflict conditions and being aware of possibility of false visual cues or not. The stimulus was one cycle of 0.22Hz sine shape acceleration and the magnitude was changed in each set. Each set consisted of forty trials except dummy trials. Because of two visual reliability conditions, five magnitudes of stimulus and randomly arrayed sensory coherent/conflict conditions, main experiment consisted of 10 sets. Subject wore HMD and stood on platform, and HMD showed virtual reality image to subject and platform gave vestibulo/somatosensation stimulus by real movement. Subject answered their perceived direction of motion by remote controller. RESULTS : When subjects did not know visual stimulus could be false, vision dominated the motion perception by having subjects report almost all the correct vs. incorrect detection of the direction of the motion. However, when they were aware of possibility of false visual cues, there was significant increase of percentage of correct answer under sensory conflict condition while there was no change for coherent condition. CONCLUSIONS : The results imply that sensory weights are most affected by reliability of vision and the effect becomes bigger when the stimulus is large enough to be sensed.





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BACKGROUND AND AIM: Proprioception is a sensory modality that provides feedback on the internal status of the body. Although several methods are available, a reliable tool for the assessment of proprioceptive acuity is the joint position matching task, in which individuals must replicate a reference target angle in the absence of vision. The proprioceptive matching task involves cognition and is not a simple reflection of proprioceptive signals from the periphery; a cognitive factor that may contribute to the proprioceptive matching task is dividing attention. However, it has not been clarified whether increased attentional demands influence the ankle proprioceptive target-matching task in young healthy individuals. In order to determine whether increased attentional demands influence the assessment of ankle joint proprioceptive ability, we used a dual-task paradigm to access the increasing attentional demand imposed by the primary joint matching task. We also examined whether position matching is more accurately enhanced when the position is encoded by active movement than by passive movement. METHODS: Eighteen young healthy adults participated in this study. Participants performed an ipsilateral ankle position matching task with and without a dual task (i.e., a computerized serial auditory subtraction task) during target angle encoding. Each blind-folded participant performed four conditions. (1) active×single task; (2) active×dual task; (3) passive×single task; and (4) passive×dual task. Joint matching errors (i.e., AE: Absolute Error, CE: Constant Error, and VE: Variable Error) were analyzed with a two-way ANOVA, 2 attention (single task, dual task) × 2 movement (active, passive), and showed a 0.05 level of significance. RESULTS: The significant main effect of attention revealed that participants in the dual-task conditions had higher AE than those in the single-task condition. This finding suggests that a cognitive factor (i.e., dividing attention) plays a role in the assessment of proprioceptive ability using a joint matching task. There was no significant interaction between attention and joint movement patterns, which indicates that the acuity of ankle proprioception (i.e., encoding the target joint angle) does not depend on the movement patterns for the joint angle matching task. CONCLUSIONS: The reduction in matching accuracy seen for participants with an attentionally demanding cognitive task suggests that allocation of attentional resources toward a second task can lead to compromised sensorimotor performance due to a limitation in resources available for concurrently coping with both tasks, even in young healthy adults.

## P3-N-236 The acute effects of transcranial direct current stimulation (tDCS) on balance and cerebral perfusion in young adults

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BACKGROUND AND AIM: Standing balance is regulated by a complex system that includes numerous brain networks and cognitive functions. Transcranial direct current stimulation (tDCS) is a safe and effective means of modulating brain activity and perfusion, and 20min of stimulation targeting the left prefrontal lobe induces acute improvements in sensorimotor and cognitive function. The aim of this study was to determine the acute effects of tDCS on standing balance, as well underlying cerebral perfusion, in young adults. METHODS: Ten healthy right-handed adults (age=22.6±1.07yrs; 5 men) completed four separate study visits. On Visits 1-2, subjects completed standing balance assessments immediately before and after 20min of either real or sham (i.e., control) tDCS targeting the left prefrontal brain region. tDCS was delivered with a battery-driven electrical stimulator and a pair of saline-soaked surface sponge electrodes placed over the C3 region of the 10-20 electrode placement system, as well as the contralateral orbit. Standing balance was assessed by measuring the area and speed of center-of-pressure (COP) fluctuations during 60sec trials of standing with eyes open, eyes closed, and eyes open while performing a cognitive task (i.e., serial subtractions). On Visits 3-4, continuous arterial spin labeling MRI was completed at 3 Tesla to quantify resting-state cerebral perfusion, before and after real or sham tDCS as described above. Anatomical imaging was also completed to enable regional perfusion analyses. In all cases, the real and sham tDCS conditions were randomized and double-blinded; i.e., subjects and testers were not aware of the condition, and tDCS was administered by a research assistant uninvolved in any other assessment procedure. RESULTS: tDCS did not affect COP area or speed when subjects stood normally with eyes open or closed. An interaction (p<0.05) between condition (real, sham) and time (before, after tDCS) was observed, however, for both COP area (Figure 1) and speed when standing and simultaneously performing a cognitive task. Both COP area and

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speed were significant less following real tDCS as compared to sham tDCS and both baseline assessments. Functional MRI studies revealed that as compared to sham tDCS, real tDCS targeting the left prefrontal lobe increased perfusion within the ipsilateral premotor cortex, bilateral somatosensory cortices (S1) and supplementary motor area (SMA), and decreased perfusion within the contralateral thalamus, cerebellar vermis, fusiform gynus, lingual gyrus and calarine (p<0.05). CONCLUSIONS: tDCS targeting the left prefrontal cortex improved the ability to adapt one's standing balance to a cognitive stressor, and significantly modulated underlying blood flow within the brain. Future studies are warranted to determine optimal tDCS parameters and placement, as well as the potential of repeated bouts of stimulation to induce long-term balance improvements.



Figure 1: The effects of tDCS on the area of center-ofpressure fluctuations during eyes-open standing with simultaneously performance of a serial-subtraction cognitive task. \* indicates a significant group by time interaction (p = 0.03).

## O - Modeling, robotics and biomechanics and implantable neuroprosthesis; Coordination of posture and gait

#### P3-O-238 Human Balance Control during Walking on Compliant Ground

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BACKGROUND AND AIM: Balance control is essential not only in human movements but also in biped robot movements. Our final goal is to develop a biped humanoid robot having an ability to walk on uneven surface including a compliant ground. Scientists suggest the ankle, hip and stepping strategies which are well known from researches on human balance control [1], but these strategies are devised by measuring human beings who are not "walking" but "standing" against external disturbances. In this work we aim to analyze human balance control during walking on a compliant ground, which is well modeled and can be implemented on humanoid robots. METHODS: Six healthy males (23.2±0.70 years) volunteered to participate in the study. Two types of urethane foams with a density of 150±30 kg/m<sup>3</sup> and 22±2 kg/m<sup>3</sup> were used as the compliant ground. They have 4.0 m length, 1.0 m width and 0.10 m depth. Full body 3-

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dimensional kinematic data were collected using an 8-camera Vicon system, and 39 reflective markers were placed on the body according to the Plug-in Gait kinematic model. Participants were asked to walk forward as naturally as possible on a rigid ground and two kinds of compliant grounds. Five trials were analyzed for each condition. Measuring items were step length, step width, step height and the CoM trajectory. RESULTS: There were no significant differences in step length and step width between a rigid ground and two kinds of compliant grounds, but step height tends to increase on compliant grounds as shown in Fig. 1 (a) (p<0.001). This represents that a larger safety margin are ensured between the feet and the compliant ground to prevent tripping during the swing phase. Similar increases in foot clearance were observed in MacLellan and Patla's work [2]. Regarding the CoM trajectory, the vertical CoM amplitude tends to increase on compliant grounds (p<0.01), but there are no significant differences between the lateral CoM trajectory on a rigid ground and that on compliant grounds (see Fig. 1 (b)). This suggests that the CoM motion is stabilized in the lateral direction on a compliant ground. One reason for the increase of the vertical CoM amplitude is the increase of the step height because the phase of the vertical CoM trajectory is coincident with that of the foot trajectory in the vertical direction. CONCLUSIONS: The findings suggest that humans walking on a compliant ground stabilize the lateral CoM by adjusting ground reaction forces because both the step width and the step length were not changed. Being inspired by the findings, we already developed a walking stabilization control to stabilize the lateral CoM motion, and a biped humanoid robot realized to walk on a compliant ground ACKNOWLEDGEMENTS: This research is partially supported by a European research project RoboSoM REFERENCES: 1. Horak FB, Nashner LM. J Neurophysiology. 55(6):1369-1381, 1986 2. MacLellan MJ, Patla AE. Experimental Brain Research. 173:521-5



#### P3-O-240 Structural analysis of trajectory variances in walking task with obstacles

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BACKGROUND AND AIM: the study of the trajectory geometry of a given locomotion task shows several invariant proprieties among the subjects. For example, the velocity decreases when the curvature increases, a property known as 2/3 power-law [Vieilledent et al. 2001, Hicheur et al. 2005]. Moreover, the trajectories are stereotyped, following the principle of the minimization of the jerk (third-order derivative of the position) that leads to maximizing the motion smoothness [Pham et al. 2007]. In the present study, the trajectories performed in a walking task with obstacles have been analyzed in order to demonstrate a common structure among the computed variances of the trajectory among repetitions. METHODS: 10 subjects participated in an experiment with an optoelectronic VICON motion-capture system

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(12 MX cameras at 120Hz), wearing a tight black suit with 48 light-reflective markers located on body landmarks following the VICON Plug-in Gait model. Translation of the body segments was calculated from the 3D Euclidian position of the markers according to a space-fixed reference frame. The Ys and Xs axes coincided to the long extension and short extension of the walking task, respectively. Participants were instructed to walk along the trajectory involving avoidance obstacle, step on and over a box. The trajectory condition was performed 10 times. The covered space size was about 5m x 4m. The trajectory was not drawn on the floor. The 2-D trajectories were normalized respect to the total time performed. Then, the variance was evaluated with respect to the distance of each trajectory from the mean, separately for each subject. Two methods were used to compare the variances: a Structural Error (SE) parameter (Fig.1) and a Regression Analysis (RA). Both for SE and RA, the vm is the mean of the other variances excluding vi (Standard Test ST). For each method, two other comparisons were computed: a randomized variance sequence with vm (RV) and a randomized variance sequence with randomized mean (RR). RESULTS: Fig.1 shows the trend of the mean of the variances of all subjects, showing similar low variance valleys and high variance peaks. The SE-ST is significantly lower respect to the other comparisons SE-RV and SE-RR (one-way ANOVA among 3 groups p<0.001). The RA is greater respect to the other comparison RA-RV and SE-RR (one-way ANOVA among 3 groups p<0.001). CONCLUSIONS: the variances of the performed trajectories show a similar constant structure. The similarity was evaluated with two different methods considering the comparison respect randomized sequences (RV and RR tests). The variance of each subject respects a common trend showing low variance points slightly before and after the obstacles and high variance peaks in correspondence with high curvatures in obstacle avoidance, thus demonstrating a dependency of the trajectory variance from the geometry. Acknowledgements: this research is partially supported by a EU research project RoboSoM (248366)



## P3-O-242 Squatting, a universal posture that minimizes instability: modelling and simulation of reaction to disturbance when squatting and standing

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BACKGROUND AND AIM: In many parts of the world, squatting is a typical posture in numerous daily activities be it work or rest. In this paper we propose to consider squatting as a bipedal posture which, compared to standing, is endowed with a critical adaptive benefit due to its overt stability. The aim of the study is twofold. A first part proposes a comparative analysis of the postural dynamics of both squatting and standing in a population of young adults having a wide experience in squatting. Subsequently, based on our experimental results we propose a biomechanical model associated to a model of control that allows for the simulation of the postural reaction when the posture is perturbed. PARABased on the experimental results, the second part put forwards a simulation of the reaction to disturbance in both postures modelled by a simple biomechanical system. To counterbalance the simplicity of the inverted pendulum model often proposed, the simulation is based on a geometrical model which is similar to but simpler than Havanan's model, and which takes into account the localisation of the centre of mass of the body segments. The inertia of the whole body is therefore taken into account. METHODS: The Centre of Pressure (CoP) of 22 participants (French and Japanese young adults) was recorded owing to a force platform (Technoconcept-France). Each participant was invited to perform four trials, twice squatting, twice standing, in a random order. RESULTS: Striking differences between the two postures were observed: when squatting body sway excursion has significantly lower amplitude in both directions (antero-posterior and lateral) compare with standing. The analysis of the CoP dynamics through diffusion analysis showed that there is no diffusion for squatting suggesting a different mode of control compare to standing. The results of the simulation confirm the experimental data: squatting is a very stable posture, hence providing a very suitable posture for work. CONCLUSIONS: We suggest that the commonality of squatting in a great number of cultural settings stems from a search for maximal stability. The standing posture corresponds to a multi articulated system, regulated through muscular activity. Squatting, on the opposite bears the properties of a perfect core posture. We may hypothesize that the squatting posture corresponds to a viscoelastic deformable system. That is why squatting should be considered as a bipedal posture sharing with standing an invaluable adaptive benefit for our species.

## P3-O-244 Differences in the fall responses of sedentary subjects versus contact and noncontact sportsmen due to tendon vibration at different sensory conditions

## Ozan Cinar<sup>1</sup>, Emre Akcay<sup>1</sup>, Ahmet Yildirim<sup>1</sup>, Senih Gurses<sup>1</sup>

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BACKGROUND AND AIM: Multisensory fusion enables re-weighting of vision and touch in different sensory conditions for maintaining balance in upright stance. Standing upright depends on the perception of verticality, where proprioception is essential in supplying information about the "self" with respect to gravity vertical. On the other hand tendon vibration technique is known to cause corruptions in the proprioceptive information recruited in a given postural task as well as subject's reactions to the illusions of the movement produced by vibration depending on the given task. We aimed to study the differences at the fall response of the sedentary subjects compared to contact and non-contact sportsmen due to tendon vibration at different visual and somatosensory conditions. METHODS: Three groups; sedentary subjects, handball players (contact) and swimmers (noncontact) each consisting of 4 healthy male subjects received 80 Hz vibration to Achilles tendon twice (in-between 50th to 60th and 120th to 130th sec) while standing still for 180-sec on a force platform. Each subject was tested at four conditions; eyes open (EO) and eyes closed (EC) without (T-) and with (T+) somatosensory cue (Touch) respectively. Somatosensory cue to the subject was defined as standing while 1-2% of the subject's weight being suspended by a harness fixed to the ceiling. Center of pressure antero-posterior

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coordinate (CoPx) was computed and demeaned in each of four successive trials. A 3rd order ARX model was fit to CoPx time series where the input was defined as the 10-sec long tendon vibration. Magnitude of the backward fall as a result of the tendon stimulus was computed from the model output. Furthermore an error term was defined as the difference between the recorded CoPx time series and the output of the ARX model. Average of the error terms for each 10-sec long window was then computed. RESULTS: Groups were found to be different in their fall responses (p=0.018). Swimmers' fall magnitude was the maximum (-21.64 mm). On the other hand, fall at EC condition and T- was significantly larger than EO and T+ (p=0.001 and p=0.000, respectively). Furthermore, we found an interaction between Groups and Eyes condition (p = 0.051). Difference in swimmers' backward fall magnitude between EC and EO condition was the largest (-12.5 mm) among the groups. Furthermore the error terms computed for the two successive falls in a trial were significantly different (p=0.013). CONCLUSION: The linear model fit to data revealed fall magnitude differences due to groups and sensory conditions but couldn't discriminate in between the two successive falls. One reason of the fall patterns observed being complex was the individual quiet stance characteristics superposed to postural perturbations. Further research is going on in order to identify physiological fall mechanisms and individual fall characteristics.



P3-O-246 Efficacy of the robot suit HAL in a hemiplegic client

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BACKGROUND AND AIM: The Hybrid Assistive Limb (HAL) is a robot suit that provides active motion support by using the bioelectric signals based in the Cybernics Voluntary Control system. HAL is used not only for active motion support but also for gait training for those with impaired motion function. In this report, we present a case of a hemiplegic client whose standing balance and walking ability were improved through training wearing HAL. METHODS: The participant was a 70-year-old male who had a cerebral hemorrhage 142 days prior to initiation of the study. He had severe right

hemiplegia, severe sensory disturbance, aphasia and apraxia. He required much assistance when attempting to walk as he needed excessive effort on the non-paretic side. The A-B-A treatment-withdrawal single-subject design was used. The measurements are as follows; Functional Ambulation Categories Classification (FAC), 10 meter maximum walking speed (MWS), Berg Balance Scale (BBS), Leg Weight Bearing Rate on paretic side (WBR). The client was evaluated with those measurements regularly; baseline phase (A1), treatment phase (B), and treatment-withdrawal phase (A2). He underwent stand-up exercises, standing balance exercises and gait exercises in each phase every two weeks. RESULTS: The result is shown in table1. <1>FAC score increased after the phase B. <2>MWS and BBS showed marked improvement after the phase B, moreover they improved after the phase A2 as well. <3>Although WBR showed small improvement after the phase B, it did not show significant difference in each phase. DISCUSSION:For this case, HAL reduced excessive effort of the non-paretic side, which made it possible to stand and keep one leg standing without the support of his upper limbs. One of the functions of HAL is to support flexion of hip joint on the paretic side. This function made it possible to swing the paretic leg without effort of the non-paretic side, which allowed the client to participate in the gait exercise more often. This positive cycle enabled him to improve his dynamic balance when standing. After the HAL program was over, these effects continued at least two more weeks, which caused more effect at the end of A2 period. CONCLUSIONS:HAL training was performed on a severe hemiplegic client who needed much assistance for walking in the beginning. After the HAL training, he achieved better motion ability since the excessive effort was reduced on the non-paretic side. That seems one of the effects of HAL training to such client.

TableT	1 41151 1 1 01		IICAI UALAS UI E		
	Befo	re phase A1	Before phase	B After phase B	After phase A2
FAC		1	1	2	2
MWS(m/mir	ו)	_*	_*	3.98	6.85
BBS		7	9	26	30
WBR (%)		32. 77	27.31	38.46	36.34

Table1 Transition of the clinical datas of each phase

\*: The datas were not available because the client could not walk through ten meters without assistance.

## P3-O-248 Contact force on the medial knee joint and knee function in the elderly: An inverse simulation analysis of gait

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BACKGROUND AND AIM: Excessive contact force on the knee joint is thought to lead to the progression of osteoarthritis (OA). However, it is not possible to measure the joint contact force in a non-invasive manner. The measurement of external knee adduction moment has been used as a parameter to indicate the load on the medial knee compartment. Although previous studies have shown that patients with early OA generate excessive knee adduction moment during gait, few studies have examined the knee contact force during gait. Recent simulation analysis has enabled prediction of knee contact force using body motion captured in a non-invasive manner. The aim of this study was 2-fold: to examine the joint contact force at the medial knee compartment during gait in the context of an inverse dynamics analysis based on a musculoskeletal simulation model, and to determine the relationship between contact force on the knee joint and knee function. METHODS: One-hundred twenty-two elderly volunteer subjects (mean age, 73.8  $\pm$  6.3 years) participated in this study. Written informed consent was obtained from each subject. The study was approved by the Ethical Review Board. Subjects were divided into 2 groups, the pain group and the non-pain group, according to the existence of knee pain of at least 3 months duration. Knee function of the pain group subjects was measured using the Japanese Knee Osteoarthritis Measure (JKOM). Three-dimensional kinetics and kinematics data were measured for level-ground

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walking at self-selected speeds using 19 reflective markers attached to bony landmarks on individual subjects. The simulation model consisted of 4 link segments, 3 joints, and 42 Hill model muscles as used in previous studies, and was used to calculate muscle activation patterns during the stance phase from joint moments and joint angles. Joint contact force at the medial knee compartment was subsequently determined from the external force calculated by force plate data and muscle force generated by the muscle activation. The affected knee was analyzed for the pain group and both knees were analyzed for the non-pain group. Student's t-test and Spearman's correlation was used. RESULTS: There were 43 subjects (7 male and 36 female) in the pain group and 79 subjects (24 male and 55 female) in the non-pain group. Maximum joint contact force at the medial knee compartment was  $3.05 \pm 0.90$  BW for the pain group and  $2.92 \pm 0.81$  BW for the non-pain group, with no statistical difference between the groups. The JKOM score of the pain group was  $10.3 \pm 8.4$  and was significantly correlated with the knee joint contact force (r = 0.33, p < 0.05). CONCLUSIONS: The existence of knee pain was not related to excessive joint contact force. However, maximum joint contact force at the medial knee function for knee pain subjects.





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BACKGROUND AND AIM: Center of pressure (COP) data is an important measure to understand the dynamics of human posture. Perturbed stance experiments help us to identify postural control system parameters for the given task. Aim of the study is to propose a method for identifying different postural control strategies from a given dynamic posturographic data. METHODS: CoPx signal during a tilt platform experiment is caused by two different mechanical effects. The first effect is due to the weight of a stationary mass on the tilting platform, which creates a moment signal.

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On the other hand, the position of the center of mass of the human can actively be changed (second effect). CoPx (m/s) is the data measured (raw signal) at antero-posterior tilt, which has been decomposed according to following equation; CoPx (m/s)=CoPx (m/fp)±CoPx (fp/s) where, CoPx (fp/s) is created by the moments caused by the human's and forceplate's stationary masses with respect to (wrt) force plate and a constant moment created due to the initial position of the subject. On the other hand, CoPx\_(m/fp) is caused by the moment signal created by the subject's own movement. Thus, CoPx (m/fp) reflects the relative motion of the human wrt force plate. We tried to verify the results of decomposition method by using another independent kinematic signal, angular displacement of center of mass (CM). CM (h/s)=CM  $(h/fp)\pm CM$  (fp/s). In previous equation, CM (fp/s) is the absolute displacement of CM of the human caused by the tilting platform, whereas CM\_(h/fp) is the relative displacement of the center of mass of the human wrt the platform. CM (h/s) is the absolute displacement of CM of the human observed from the inertial frame of reference (ground). RESULTS: CM\_(h/s) and CoPx\_(m/s), CM\_(h/fp) and CoPx\_(m/fp) signals are shown in Figure top and bottom respectively. As CoPx (m/s) is driving CM (h/s), the latter signal reflects the mean behaviour of the former while CM (h/fp) is highly correlated with CoPx (m/fp) signal. This is because of the fact that the stationary mass effect of the human (CoPx\_(fp/s)) on the tilting platform masks to reveal the relative motion effect (CoPx\_(m/fp)) of the subject. CONCLUSIONS: The signal decomposition method suggests a way to understand actual human movements on the tilted force plate as it compensates for dynamical effects of the stationary (wrt platform) masses of the force plate and subjects. We propose that in order to identify postural control strategies of a human on a tilting platform, measured CoPx signal (CoPx (m/s)) needs to be "decomposed" because stationary mass effect and relative motion of the human on the platform tends to cancel each other (first eqn) resulting in a signal (CoPx\_(m/s)) which reflects the mean behaviour of the control system only.





*You-Hua Su*<sup>1</sup>, **Po-Tsun Chen**<sup>1</sup>, **Li-Chieh Kuo**<sup>1</sup>, **Fong-Chin Su**<sup>1</sup> <sup>1</sup>National Cheng Kung University Background and Aim: There have been many studies investigating digits forces when holding a cylindrical object by grasping constrainedly on the same plane. However, due to the hand anatomy, the digits position was different among subjects during natural grasp. In previous studies, the pattern of digits force changed with different thumb positions. Nevertheless, there was no study to address the differences in force patterns during natural grasp and constrained grasp. Therefore, the objective of this study is to compare the digits force pattern between cylindrical grasp in natural grasp (NG) and constrained grasp (CG). Methods: 4 healthy subjects were recruited in this study (2 males and 2 females, aged 25.8). A custom cylindrical simulator with five force transducers (ATI Industrial Automation, Apex, NC, USA) was designed to record the digits forces. In NG, the positions of transducers on simulator were adjusted according to the natural grasp position of each subject. In CG, the positions of all transducers were aligned on the same plane. A videographic motion capture system (Motion Analysis System, USA) was used to collect the trajectories of three markers attached on the top plate of the simulator to determine the movement events of holding task that was divided into four events and one phase (Figure 1). Several pair t tests were conducted to examine the difference between two grasp conditions. The following variables were discussed: "radial force (Fr)" and "resultant force (F)". Also, the "force contribution ratio (Fcr)", defined as the resultant forces of each digit normalized by the sum of resultant forces of five digits, was analyzed in all events. Results: During holding phase, thumb and index finger generated larger Fr in CG than that in NG. At all the events, thumb generated larger Fr in CG. At H3, index created larger Fr in CG. Thumb generated larger F in CG than that in NG during whole holding task. The phenomenon may be due to the muscle length tension that CG did not fit in with hand anatomy. The reason may make the palm muscles of subject to be shortened, and then exerted larger force in CG. In addition, thumb and index finger showed larger Fcr, whereas ring and little fingers showed smaller Fcr in both conditions, which demonstrated that ring and little fingers did not have to make too much effort during whole holding task. In both conditions, subjects grasped with larger index and middle fingers Fcr than other two fingers, which was different from the results in previous studies. The possible reason was that the natural position of thumb was set approximately between the location of index and middle finger across subjects. Conclusions: It was found that the digits, especially thumb, would exert larger digit force in the condition of CG, which may be due to the mechanical disadvantages of CG posture. The contributions of finger force were mainly exerted by index and middle fingers rather than middle and ring fingers in NG.



Fig 1: Schematic display of four movement events of holding task (the lifting phase: H1 to H2, the holding phase: H2 to H3 and the lowering phase: H3 to H4), identified by a marker attached on the top of cylinder.<sup>4</sup>

## P - Habilitation and rehabilitation; Coordination of posture and gait

## P3-P -254 Immediate beneficial effects of a mental rotation of foot stimuli for upright postural control in young healthy participants

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INTRODUCTION: Recent studies indicated that effectiveness of imagining the ankle joint movement on postural stability [1]. We have previously found a significant correlation between the ability to mentally rotating pictured foot stimuli as quickly as possible (i.e., ability of imagining the ankle joint movement) and to maintain upright posture as stable as possible. To extend this finding, the present study was designed to investigate whether an intervention involving the mental rotation of foot stimuli would contribute to improve stability of upright posture as measured immediately after the intervention. METHODS: Sixteen healthy young volunteers participated. Testing was approved by the Ethics Committee of the Tokyo Metropolitan University. Written informed consent was obtained according to the Declaration of Helsinki. The experiment consisted of a two-day session (at least a week apart). In each day, the participants performed the mental rotation of either foot or car stimuli for 10minutes. The order of the stimuli presented on a first day was counterbalanced. In the mental rotation task, a single stimulus appeared with one of four orientations on PC screen. The participants judged whether the feet were left or right, or whether the patch was on the left or the right headlight from a driver's view. Pre- immediately post measurements of postural stability during the unipedal and bipedal standing were made using a force plate for each intervention. RESULTS AND CONCLUSION: Postural sway during unipedal standing, but not bipedal standing, decreased significantly after intervention when the foot stimuli were used for the mental rotation. Such effect was not observed when the car stimuli were used for the mental rotation. These results suggest the beneficial effects of the intervention using mental rotation of foot stimuli in healthy subjects. Because mental rotation is a cognitive task and, thus, impose no physical load, the intervention using mental rotation of soot stimuli may be applied for fragile elderly individuals. REFERENCE: [1]Kazuhiro Yasuda et al. (2012) Journal of Novel Physiotherapies .2(6), 118,.

## P3-P -256 Positive and negative effects of support by upper limbs on performance accuracy of lateral body weightshifting

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BACKGROUND AND AIM: A lateral body weight-shifting task is often used in therapeutic programs to improve abilities of orthopedic patients in normal standing/gait. In this task, participants (i.e., patients) are required to stand on the unaffected lower limb and then shift a part of the body weight as a target load toward the affected lower limb, while adjusting the loads between the lower limbs. They usually perform this task with the support by both upper limbs placed on a pair of horizontal parallel bars. However, there is no study which investigated whether the support by upper limbs would contribute (or not contribute) to accurate performance of the task. We therefore compared performance accuracy of the task between two groups of with and without support by upper limbs. METHODS: Forty right-footed and -handed healthy adults were assigned to either group of with and without support by upper limbs. They were asked to perform a lateral body weight-shifting task under four conditions: two target loads (one- and two-thirds of the body weight) in two directions (left and right) of body weight-shifting. The load on each limb was measured with two force plates for lower limbs and two load cells for upper limbs. Performance accuracy for target loads and the intra-trial variability were calculated in terms of constant error (CE) and coefficient of variation (CV). RESULTS: One-sample t-tests showed that the mean CE scores for the with support group revealed significant undershooting for the leftward shift (t = -2.86, p < 0.05) but not for the rightward shift (t = -0.94, p > 0.05) at the one-third target load condition and for both the

leftward (t = -3.82, p < 0.05) and rightward (t = -3.95, p < 0.05) shift at the two-thirds target load condition. In contrast, the without support group showed neither significant undershooting nor overshooting for any condition (p > 0.05). A 3-way ANOVA on CV scores showed a significant main effect for group (F1, 38 = 79.48, p < 0.05), with the mean CV for the with support group being significantly smaller than that for the without support group. CONCLUSIONS: Our results indicated that the support by upper limbs in lateral body weight-shifting caused undershooting (in CE) for both the one-and two-thirds target load conditions, except the condition of rightward shift at one-third target load, although task performance was significantly stable (in CV) with the upper limb support. Such an undershooting occurring with upper limb support may impede a full recovery from imbalance standing/gait caused by injury, particularly in the late recovery stage in rehabilitation, which needs a heavy weight to be loaded on the affected lower limb and should not suffer any undershooting.

## P3-P -258 Aftereffect of gait exercise using functional electrical stimulation in hemiplegic patients

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BACKGROUND AND AIM: The re-acquisition of walking ability in hemiplegic patients is essential for their return to normal life. In most patients, a decrease in ankle dorsiflexion torque as a result of paralysis is an issue. We have investigated the use of functional electrical stimulation (FES) in these patients to enable sufficient dorsiflexion of the ankle. An additional approach might be to make use of the consolidation of motor learning in the central nervous system by repetitive motion as identified by Ping-bo et al. Thus, repetitive exercise methods may offer an important remedial therapy. In a preliminary trial based on these reports, healthy subjects with a dorsiflexion block affecting the left ankle underwent gait exercise of 1000 steps (500 steps each leg). We found that the angle of ankle dorsiflexion was decreased at one hour after exercise. Here, we extended this preliminary trial to determine through a kinematic analysis whether there is a motor learning effect in hemiplegic patients after gait exercise of 1000 steps using FES. METHODS: Four hemiplegic patients were involved in this study. The subjects were able to walk independently using ankle-foot orthotics. We used the NESS L300(Bioness Inc) for the FES treatment. Subjects walked at their maximum speeds under four conditions: barefoot walking before exercise; FES during gait exercise of 1000 steps; barefoot walking immediately after exercise; and, barefoot walking one hour after exercise. The subjects were instrumented with 10 markers on anatomical landmarks bilaterally. Three-dimensional kinematic data were collected using a 4-camera motion analysis system (DKH Inc: Frame-DIAS4) at 60 Hz. The angles of flexion and extension of the hip and knee joints, and the angles of the ankle joint at dorsiflexion and plantar flexion were calculated. We compared gait patterns among the four conditions. RESULTS: After FES during gait exercise of 1000 steps, we found that the angles of the ankle joint at dorsiflexion in subjects 1, 2 and 3 during barefoot walking immediately after exercise and during barefoot walking one hour after exercise were increased at the initial swing phase compared to barefoot walking before exercise. By contrast, subject 4 showed no change after exercise. CONCLUSIONS: The results from subjects 1, 2 and 3 indicated that gait exercise of 1000 steps prompted consolidation in the brain and led to a motor learning effect. We also found in one case, subject 4, that there was no motor learning effect for the small variation in the angle of ankle dorsiflexion from toe off to mid swing. The latter results indicate that the variation in angle of ankle dorsiflexion is also important in addition to repetitive exercise. We conclude that there is a motor learning effect in hemiplegic patients after gait exercise of 1000 steps using FES.

## P3-P -260 Balance and cognitive reactivation for patients with atactic disorder during recovery stroke period

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## P3-P -262 Assessment of the balance and gait functions in patients with the syndrome of central hemiparesis after stroke

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BACKGROUND AND AIM: The stroke is the main cause of the disability in Russia. There are stride length increasing, shifting the center of mass on the healthily limb, and the standing and gait energy costs increasing characteristically for the central hemiparesis syndrome gait stereotype changes. We assessed the efficacy of the force platforms with visual biofeedback training on balance and gait in post-stroke patients with central hemiparesis syndrome. METHODS: 120 patients were randomized in three groups. In the I (n=39) group patients received traditional neurorehabilitation methods: proprioceptive correction, massage, physiotherapy. In II group patients had complex treatment (traditional neurorehabilitation methods and balance training with visual biofeedback). In the II group (n=40) patients got only biofeedback training on the force platform. In the 2nd and 3rd groups MBN «Biomechanic» force platform was used for the biofeedback training. Duration of each training was 20-30 minutes. The aim of the trainings was shifting the COP on to the paretic side - approaching real COP to the "ideal". For assessment these methods we used the neurological status assessment, clinical balance assessment by the Berg Balance scale, gait function scoring (Gait dynamic index) and functional independence (D. Barthel). Also, all patients were assessed by computerized stabilometry. For definition of movement disorders severity it is necessary an objective method of the gait analysis. It is necessary to define gait

parameters such as: length, duration, uniformity and asymmetry of a patient step. It is known that infringement of quantitative parameters of walking is interconnected with the patient falls risk. We have offered a gait research method by laser range finder using. RESULTS: In the first group patients had significant improvement by the stabilometry and Berg Balance Scale data (Wilcoxon nonparametric test: p<0,05). Fall risk in this group stayed high after the treatment course. In groups 2 and 3 we obtained significant improvement in gait and balance by the scales score and decreasing of fall risk. The marked decrease of the spatial (p<0,01) and temporal asymmetry (p<0,01) was observed in the second group. The data obtained by new diagnostic method with a laser rangefinder using. CONCLUSIONS: results of this research confirmed the high fall risk in post-stroke patients with central hemiparesis syndrome. Isolate using of the visual biofeedback COP shifting method or with traditional neurorehabilitation complex (proprioceptive correction in suite, massage, physiotherapy and etc.) can decrease risk of falls and improve gait and balance in those patients. Method allows estimate relative length and duration of a step, spatial and time asymmetry of a step. The proposed method can be used in neurological practice, as a complex for the objective gait parameters screening.

## P3-P -264 The effect of gait speed on gait variability and asymmetry in children and adolescents with Cerebral Palsy

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BACKGROUND AND AIM: Compared to typically developing peers, the gait pattern of children and adolescents with Cerebral Palsy (CP) is often characterized by increased variability (1) and asymmetry (2). This may lead to postural instability and possible development of secondary symptoms. A relevant clinical question with respect to treatment decision making and evaluation is therefore how gait variability can be decreased and gait symmetry increased in persons with CP. Several studies have reported positive results on gait quality by increasing walking speed in patients with osteoarthritis (3) and stroke (4). The main objective of the current study was to investigate whether increased walking speed likewise has a positive effect on gait variability and asymmetry in children and adolescents with CP. METHODS: Twenty three children/adolescents (9-17 yrs, 7 female and 16 male) with unilateral (16) or bilateral (7) CP were included in this retrospective study. Mean age was  $12.3 \pm 3.2$  yrs, with level I (n=16) or level II (n=7) according to the Gross Motor Function Classification System. All participants had been referred to 3D gait analysis as part of their follow-up program at the local hospital. They walked several trials at preferred speed and fast speed. Data were captured by a Vicon MX-13 motion capture system and the following variables calculated: Walking Speed, Step Length (SL), Step Time (ST), Single support (SS), and duration of Stance Phase (SP). SS and SP were normalized to % of gait cycle. Asymmetry was calculated as the absolute value of the Symmetry Index (SI) as defined by (5). All variables were normally distributed. One-sample t-tests were used to test whether absolute SI was different from 0, and pairedsamples t-tests to test the effect of walking speed. RESULTS AND DISCUSSION: While walking at preferred speed, both participants with unilateral and with bilateral CP showed a significant asymmetry between the two limbs in SL, ST, SS, and SP (all p's  $\leq$  .029). There was a significant increase in walking speed from preferred (1.07 m/s) to fast speed (1.52 m/s, t(22) = -12.4, p < .001), indicating that children/adolescents with CP manage to walk considerably faster than their normally preferred speed. However, gait did not become more regular with increased speed, while effects of speed on gait asymmetry were variable across participants and gait variables, with some participants showing less asymmetry with higher walking speed and others more asymmetry. Further analyses will focus on these individual differences and investigate possible relationship with bilateral versus unilateral CP. REFERENCES: 1. Prosser et al. Gait Posture 2010;31(4):522-6 2. O'Sullivan et al. Gait Posture 2007;25(3):425-431 3. Bejek et al. Knee Surg Sports Traumatol Arthrosc 2006;14(7):612-22 4. Lamontagne et al. 2004;35(11):2543-8 5. Sadeghi et al. Gait Posture 2000;12(1):34-45

## P3-P -266 Effects of Clock-Turning Pattern on Gait Performance in People with Parkinson Disease

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BACKGROUND AND AIM: Turning is difficult for many people with advanced Parkinson's disease (PD), and leads to imbalance and gait abnormality. Cognitive movement strategies for improving turning performance have been proposed, despite the evidences are scarce. Therefore, the purpose of this study is to test the effect of cognitive movement strategies, in specific, the "clock-turning" pattern on gait parameters during turning. METHODS: Sixteen PD patients (age: 72.6±5.2 years old, Hoehn-Yahr stage: 2.8±0.3) were enrolled. Participants were randomly assigned to experimental and control groups, and conducted the timed Up-and-Go (TUG) test during their medication "OFF" period. The experimental group conducted the TUG test using the "clock-turning" pattern, and the control group using their selfselect pattern. Gait parameters including foot clearance, stride time and stance/swing ratio were measured by 3D motion capture system (Vicon, Oxford, UK). Turning performance was measured by turning time and number of turning steps. We also measured the duration and frequency of freezing-of-gait (FOG) by reviewing the video recording. Independent t test was employed to examine the difference in gait parameters, turning performance and FOG severity. RESULTS: Both groups completed TUG test with comparable turning time (experimental: 4.26±3.75 s, control: 5.78±4.29 s) and turning steps (experimental: 10.2±5.3, control: 12.2±4.7). It is found the experimental group showed greater foot clearance (experimental: 5.6±2.2 cm, control: 3.2±1.7 cm, p<.01) and lower stance/swing ratio (experimental: 2.21±0.37, control: 2.84±0.46, p<.05) than the control. In addition, the experimental group showed lower FOG frequency during turning (experimental: 0.22 FOG per trial, control: 0.65 FOG per trial). CONCLUSIONS: The clock-turning pattern helped patients to turn with improved gait pattern and reduce the frequency of FOG. Patients are suggested learning the skill to cope with turning in narrow space.

### P3-P -268 The process of brake reaction time and knee functional test for patients with total knee arthroplasty

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BACKGROUND AND AIM: Total knee arthroplasty (TKA) is a worldwide treatment to decrease pain, improve knee function, and provide joint stability. The goal was to establish the timeframe for return to driving, as determined by attainment of preoperative braking levels. METHODS: 14 severe right knee osteoarthritis patients (4 male and 10 female, mean ages was 63.14±6.62) with normal visual field were recruited in this study. The driving simulator and Monitored Rehab Systems were used to measure the brake response and knee function. The driving task is to drive a virtual car using the accelerator and brake pedals at a driving speed of 50, 70 and 90 km/hr. The knee functional tests included maximum force, reaction time and proprioception. The brake reaction time was divided into three parts: gasoff time, transition time, pressing time. The deficit (%) was calculated as the result of proprioception between with visual and non-visual feedback. All of the tests were measured at preoperative, 2 weeks and 4 weeks postoperative. RESULTS: The result of knee joint functional tests and brake response were showed in Figure 1 and Table 1. It showed that 4 weeks postoperative would show significantly improving than 2 weeks postoperative in knee proprioception and knee reaction time and it could achieve the level of preoperative. The maximum isometric force for knee extension was also improving than 2 weeks postoperative, but it did not achieve the level of preoperative. For brake reaction time test, it showed that transition time and pressing time was significantly faster at 4 weeks postoperative than 2 weeks postoperative in low and moderate driving speed condition. CONCLUSIONS: Failure of quadriceps femoris muscle may play an important role in the cause of the decreased force production in patients following TKA. Therefore, the knee function test performance of proprioception and knee reaction time test decreased at 2 weeks postoperative and following the quadriceps femoris muscle recory that showed significant improving than 2 weeks postoperative. For brake reaction time, the transition time and pressing time were also showed similar results since that also have to use

quadriceps femoris muscle as quick as possible. Summary, if patients following TKA requirements for driving, surgeons may consider allowing patients treated with contemporary right TKAs to drive 4 weeks after surgery.

## **Q** - Cognitive impairments; Aging

# P3-Q-272 Further evidence for the co-dependence of cognitive function and mobility in aging: findings from a 5 year prospective study

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BACKGROUND AND AIMS: Gait speed is a predictor of many outcomes among older adults. It has been related to future morbidity and mortality, provides a good overall measure of balance and lower extremity function, and has even been related to cognitive function. A gait speed of 1 m/sec has been identified as the threshold for the transition between normal and abnormal walking speed. The aim of the present study was to compare the motor and cognitive characteristics of community-living older adults who were above the threshold to those below it and to investigate the transition from normal to abnormal gait in a prospective longitudinal study. METHODS: 184 community-living older adults (age: 76±4.4 yrs; 61% women), free from dementia and who had good mobility at study entry were followed in a prospective study over 5 years. At baseline and 5 years later, participants were tested using a computerized cognitive battery. The Timed Up & Go (TUG) assessed balance and mobility. Gait was assessed during single and dual task (DT) conditions (i.e., subtracting serial 3s). Based on gait speed in year 5, the performance of subjects transitioned to an 'abnormal' gait speed (T) was compared to that of subjects who continued to walk with a normal gait speed (N). Students T-tests and paired T-tests were used to compare groups and to evaluate the effects of aging over 5 years. Multivariate logistic regression models determined the predictive value of relevant measures. RESULTS: 36 subjects transitioned to the abnormal gait category in the course of 5 years. No differences were observed between the groups in MMSE scores (p=0.96) at baseline. However, subjects who transitioned to an abnormal gait speed had lower scores on the global cognitive score (p=0.01), EF (p=0.01) and attention indicies (p=0.02). During the follow-up period, the T group demonstrated significantly larger decline than the N group in the time to perform the TUG (45% vs 9%; p<0.001) and a higher increase in gait variability during usual and DT conditions (103.6% vs 18.0%; p=0.01 and 47.7% vs 17.4%; p=0.009 respectively). Cognitive measures for both groups deteriorated in both groups, but these differences were more pronounced in the T group than in the N group for the Executive function index (T: 97.0±10.6 to 93.5±11.5 vs. N: 102.1±10.3 to 100.8±11.9, p=0.133), Attention index (T: 95.49±14.4 to 90.75±16.7 vs. N: 101.4±10.2 to 101.1±11.9, p=0.08), Memory index (T: 99.24±12.2 to 91.1±20.7 vs. N: 102.24±10.1 to 102.35±13.5, p=0.009), and Global Cognitive Score index (T: 97.42±9.1 to 93.39±10.4 vs. N: 101.29±7.3 to 100.79±8.4, p=0.007). DISCUSSION: The present findings further emphasize the relationship between gait and cognitive function. Individuals with lower congitive function had a more pronounced and significant deterioration in physical and motor abilities than those with better cognitive function suggesting that gait and mobility is highly dependent on cognition.

# P3-Q-274 Disability in Instrumental Activities of daily living in elderly patients with Mild Cognitive Impairment or Alzheimers disease

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Background and aim: assessing instrumental activities of daily living (I-ADL) in elderly persons experiencing cognitive impairment may be useful in addition to commonly used cognitive tests for earlier, accurate diagnosis of Mild Cognitive

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Impairment (MCI) and dementia. The aim of the study was to examine I-ADL disability in elderly persons with MCI compared to elderly persons with Alzheimer's disease (AD), and to identify the items of I-ADL which separate the two conditions best. Secondly gender differences were explored. Methods: The design is cross sectional. 729 patients ≥65 years from outpatient memory clinics diagnosed with MCI (n=394) or AD (n=335) were included. All patients were included after an initial examination regarding cognitive impairment and possible dementia at a memory clinic, assessed and diagnosed in accordance to a standard examination protocol. Logistic regression analysis with the Lawton and Brody I-ADL scale as the dependent variable and diagnosis, MCI and AD, as the independent variable, was used. Results: I-ADL sum score revealed that 34% of patients with MCI and 10% of patients with AD were independent in I-ADL. Disability was shown in the items shopping, food preparation and responsibility for own medication. The men showed a higher proportion of disability in the item managing laundry than women. Results from logistic regression analysis show a significant association between I-ADL and MCI and AD. Conclusions: Patients with MCI diagnosis show I-ADL disability, but fewer problems than patients with AD. Regarding the items shopping, food preparation and responsibility for own medication, 35-48% of the patients with MCI reported in some degree difficulties which may be interesting information regarding malnutrition and compliance in medication. Updated tools with good psychometric properties for assessing I-ADL should be developed.

			ALL			Mei	n		Wom	en
I-ADL- s % indep	scores endent	MCI <sup>a</sup>	ADb	P-value <sup>c</sup>	MCIa	ADb	P-value <sup>c</sup>	MCIa	ADb	P-value <sup>c</sup>
A.	Ability to Use Telephone	98	97	0.638	96	97	0.604	100	97	0.118
B.	Shopping	52	30	<0.001	46	35	0.049	58	28	<0.001
C.	Food Preparation	58	37	<0.001	52	38	0.019	64	36	<0.001
D.	Housekeeping	96	94	0.304	94	91	0.445	98	96	0.157
E.	Laundry	86	78	0.006	76	58	0.002	95	89	0.037
F.	Mode of Transportation	83	67	<0.001	88	72	0.001	80	64	0.001
G.	Responsibility for Own Medications	66	41	<0.001	64	41	<0.001	67	41	<0.001
H.	Ability to Handle Finances	96	82	<0.001	97	84	0.001	95	81	<0.001

#### I-ADL scores by Lawton and Brody, presenting the eight items

<sup>a</sup>Mild Cognitive Impairment. <sup>b</sup>Alzheimer's disease. <sup>c</sup>Differences between patient groups analysed with chi-square test (Linear- by

linear association).

## P3-Q-276 Quantitative gait parameter changes in good and poor Trail Making Test performers under challenging single and dual tasking conditions: Cross-sectional analysis in 673 elderly

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BACKGROUND: Effective supraspinal control of gait is increasingly perceived as a relevant contributor to healthy ageing, and is regularly affected in neurodegenerative disorders. The function of supraspinal control mechanisms depends - at least partly - on executive function, and can be assessed with challenging single and dual task paradigms. Still, it is not

entirely clear which are the most promising paradigms and parameters to test this system, although measures of gait variability seem most often affected. METHODS: In the frame of the TREND study (www.trend-studie.de), quantitative gait parameters were evaluated in a cohort of 673 non-demented individuals aged 50 to 80 years. All participants performed 20 meter walks at maximum speed, with and without simultaneously checking boxes on a clipboard or subtracting serial 7s. Gait parameters were assessed with a sensor at the lower back (Dynaport<sup>®</sup>, McRoberts). The Trail Making Test (Delta TMT) as a measure of executive function was used to divide the cohort in those with low, and those with high probability for suffering from supraspinal control deficits. RESULTS: From the assessments, walking when subtracting 7s was most effective to delineate gait differences between good and poor TMT performers, followed by the walking when checking boxes task and the walking task. Among the parameters analysed, gait speed (p<0.0001) and step frequency (p=0.001) differentiated best between subgroups. In addition, the poor - but not the good - TMT performers had lower step time variability in the walking while subtracting condition than in the walking only condition (p=0.005 versus 0.37). Vice versa, good but not poor TMT performers had lower step time variability in the walking while checking boxes situation compared to the walking while subtracting condition (p=0.019 versus 0.37). CONCLUSION: This large cohort study confirms results from previous studies with smaller cohorts showing that assessments of challenging single and dual tasking paradigms with a single sensor can indeed detect subtle gait changes between good and poor TMT performers. Moreover, distinct step time variability changes among the subcohorts suggest that good and poor TMT performers use different walking strategies when performing challenging secondary tasks.

## P3-Q-278 Long-term effects of concussion on a collision avoidance task

## *Carmen Baker<sup>1</sup>,* Michael Cinelli<sup>1</sup>

<sup>1</sup>Wilfrid Laurier University

BACKGROUND AND AIM: Previously concussed athletes (PCA) have been identified as having perception-action integration dysfunctions up to 30 days post-concussion during a static balancing task (1). It is unknown whether this dysfunction will continue for longer time periods following a concussion during tasks that challenge dynamic rather than static stability. Changes in action strategies during obstacle avoidance tasks have been shown to be dependent on changes in dynamic stability (2). The purpose of the current study was to determine if action strategies of PCA (30-110 days post injury) will differ from non-concussed individuals (NCI) previously collected (3) when avoiding two obstacles placed along a travel path in unconfined space. METHODS: Participants (N=6) were asked to walk toward a goal along a 10m path and to avoid two stationary obstacles placed 5m from their start position. The obstacles created a horizontal aperture, ranging from 0.6 to 1.8 times the participant's shoulder width (by increments of 0.2), which they could circumvent or pass through. RESULTS: Although the maximum relative aperture width that the PCA required in order to pass through the aperture rather than around was similar to NCI (i.e. 1.4), a trend is emerging to suggest that maximum aperture width is negatively correlated to the time since one's concussion (rs(4)=-0.61, p=0.196). CONCLUSIONS: The current findings indicate that by increasing the cognitive demands of a task through a complex, dynamic stability paradigm, perception-action integration dysfunctions can be identified in PCA for a greater time period post-injury than previously suggested. REFERENCES: 1. Slobounov, S. et al. (2006). Cyberpsychology & Behaviour, 9(2), 188-191. 2. Hackney, AL & Cinelli, ME. (2012). Gait & Posture, 37(1):93-7 3. Hackney, AL. et al. (2012). QJEP, DOI: 10.1080/17470218.2012.730532

## R - Development of posture and gait; Coordination of posture and gait

P3-R-280 Effect of icing lower-leg muscle during walking on irregular surface

## Akira Obara<sup>1</sup>, Shiina Takayuki<sup>1</sup>, Takemura Hiroshi<sup>1</sup>, Mizoguchi Hiroshi<sup>1</sup>

<sup>1</sup>Tokyo University of Science

Walking is one of basic motion of human. However, walking has risk of falling accident. Falling accident is large problem for elderly people. One of the causes of falling for elderly people is reduced sensation. The purpose of this study was to investigate difference of walking on irregular surface made from some blocks between health and reduced muscle spindle functional condition. 3 healthy young adult males (age: 22.0 ± 1.41 year) were recruited in this research. Normal and high-speed walking motion ware measured on two surfaces: an even surface and an uneven surface. Healthy and reduced muscle spindle function conditions were compared. The ice immersion approach was applied on the lower-leg muscles as a method of reducing muscle spindle function. To create an irregular surface, a thin cloth carpet was modified by many blocks beneath a carpet. During high-speed walking on even surface, the step length was significantly decreased by icing (p<0.01). During normal walking on even surface, the step length was significantly decreased (p<0.01). During normal walking on even and uneven surface, the step width was significantly increased by icing (p<0.01). In addition, during normal and high-speed walking on even surface, walking velocity was significantly decreased by icing (p<0.01). These results suggest that the walking becomes a conservative walk by reduced muscle spindle function. During normal walking in healthy condition, the rate of acceleration was significantly increased by uneven surface (p<0.01). This increased acceleration means that the walking becomes unstable due to uneven surface. During normal and high-speed walking in healthy condition, the walking velocity and step length were significantly decreased by the uneven surface (p<0.03). These results mean that the walking adapted to uneven surface. On the other hand, during normal and high-speed walking in reduced muscle spindle functional condition, the walking velocity was increased by uneven surface (p<0.01). In addition, during normal walking in reduced muscle spindle functional, the step length was increased by uneven surface (p<0.01). These increased parameters suggest that the muscle spindle function is important to adjust forward-bent posture while an uneven surface walking. During normal and high-speed walking on even and uneven surface, the rate of acceleration was decreased by reduced muscle spindle function (p<0.01). The decreased acceleration suggests that the walking becomes stable due to the change to stabilize walking. These changes in walking suggest that the muscle spindle function is related to walking. Standard deviations for all walking parameters were not significantly difference between not only even and uneven surface, but also between healthy and reduced muscle spindle functional condition. Standard deviations did not distinguish in all conditions. The obtained results suggest that muscle spindle function is not important to walk on the irregular surface.

## P3-R-282 Development of postural control in children involves functional freezing of degrees of freedom

## Akio Yamamoto<sup>1</sup>, Shun Sasagawa<sup>1</sup>, Naoko Oba<sup>1</sup>, Kimitaka Nakazawa<sup>1</sup>

## <sup>1</sup>University of Tokyo

BACKGROUND: The central issue of motor control is to organize multiple degrees of freedom (DOFs) to achieve optimal motor performances. The human body during quiet standing behaves more or less like an inverted pendulum rotating around the ankle joint. By doing so, the central nervous system can simplify the control and/or estimation problems. In this study, we hypothesized that developmental process of postural control in children involves functional freezing of the DOFs for efficient control of balance during quiet standing. METHODS: Eighteen healthy children between 4 (two boys & seven girls) and 5 (three boys & six girls) years old and nine healthy males (27.0 ± 2.0 years old) participated in this study. The subjects were asked to stand quietly for 30 seconds with eyes open and closed conditions (three trials each). The three dimensional positions of spherical markers placed on the lateral malleolus, caput fibulae, great trencher, acrominal process, and vertex were measured by a motion capture system and sampled at 100 Hz. We simulated behavior of an ideal inverted pendulum model in the sagittal plane, in which the translational displacements of individual body positions are exactly proportional to the angular displacement of ankle joint. By subtracting the simulated translational displacement of each reference point (hip, shoulder, and head) from corresponding translational

displacements measured in the experiment, we derived residual errors (REhip, REshoulder, and REhead) at all data samples. The residual errors were normalized by the distances from the ankle joint to each reference point. From histograms of the normalized residual errors, standard deviations (SDs), modes, and frequencies at the modes were calculated. RESULTS: In all age groups and all reference points, the modes of the normalized residual errors were observed at close to RE = 0. However, frequencies at the modes in adults were greater than those in children approximately by six times for REhip, by four times for REshoulder, and by three times for REhead on averages. In the eyes open condition, SDs of the residual errors in both 4 and 5 years old groups were significantly larger than those in the adult group for the all reference points (all P < 0.05). By contrast, in the eyes closed condition, although SDs in the 4 years old group were significantly larger than those in the adult group for the all reference points (P < 0.05), those in the 5 years old group were not statistically different from those in the adult group (P > 0.05). CONCLUSIONS: This study revealed, during quiet standing, adults behaved more like an ideal inverted pendulum as compared to children. This supported our hypothesis that the development of postural control involves a process of functional freezing of the DOFs. It was also revealed children of 5 years old behave more like adults in the case of no visual input, suggesting sensorimotor integration for postural control is achieved at 5-6 years old.

## P3-R-284 Task-specificity of postural control in patients recovering from stroke

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BACKGROUND AND AIM: Postural control is embedded in a variety of contexts. Balasubramaniam et al. (2000) investigated the postural activity when healthy individuals were performing a precision aiming task. They found that the postural sway in the body's anterior-posterior (AP) and medio-lateral (ML) axes were modulated in a task-specific manner. Recently, the characteristics of the postural control while standing in patients with stroke have been identified. Yet, the understanding of the nature of postural control in patients with stroke in functional, naturalistic contexts is at present poor. We investigated the task-specificity of postural control in a precision aiming task in patients recovering from stroke. METHODS: Six inpatients with stroke participated in this study (mean age, 70.8 y  $\pm$  9.1; mean time poststroke, 62.2 days ± 30.0). Participants stood without assistance with arms by the side holding a laser pointer in the nonparetic hand. The hand was held against the thigh. Participants were asked to point to the target and to keep the beam within the target. Each combination of two target directions (front and side) and two target distances (1m and 3m) was tested twice. Each trial lasted 30 seconds. The same assessment was repeated 2 and 4 weeks later. We monitored movement of the head, seventh cervical vertebra (C7), and fifth lumbar vertebra (L5) using a magnetic tracking system. For the AP and ML axes in each body segment, we analyzed the magnitude of the sway (the standard deviation of position, SD; the root mean square of velocity, VRMS) and the dynamics of the sway (percent recurrence, %REC; percent determinism, %DET) using recurrence quantification analysis. A linear mixed-model analysis (with period of assessment and target direction, target distance as fixed effects and participants as a random effect) was conducted for each axis in each body segment. RESULTS: We found that the postural sway was influenced by the target direction, especially in the L5 (Figure 1). In the AP axis, SD and %REC of the L5, and %DET of the head and C7 were greater in the front target than those in the side target. In the ML axis, SD of each body segment, VRMS of the head and L5, and %REC of the L5 were greater in side target than those in the front target. These results are consistent with the previous findings in healthy individuals. In addition, in the ML axis, SD and %REC of the head, and %REC of L5 were greater in the far target than those in the near target. In general, the magnitude of sway tended to decrease over the course of 4 weeks. There was no interaction effect between the factors for each axis in each body segment. CONCLUSIONS: These results suggest that, despite the difference in the postural-sway characteristics, patients with stroke in the recovery phase still have the flexibility to meet the functional demands of the situation. REFERENCES: Balasubramaniam, R. et al. Gait Posture 11: 12-24, 2000.





#### P3-R-286 Assessment of Ankle Joint Stiffness along Various Frequency of Translation Perturbation

#### Aizreena Azaman<sup>1</sup>, Shin-ichiroh Yamamoto<sup>1</sup>

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Background and Aim: Human postural strategy is a flexible system where it will use mechanisms that fit a body condition and not necessarily apply the same strategy for the same disturbance. Degeneration of balance ability especially due to ageing is related to degeneration of muscle properties and nerve system, thus, weaken the cognitive system. These degeneration symptoms can be seen through limb stiffness. Previous research by M. Cenciarini et al. (2012), stated that mean of ankle joint stiffness of healthy elderly is larger than young adult during quiet standing. Ho and Bendrups (2002) also found the 'elderly fallers' have large stiffness compared with the 'non-fallers'. It can be conclude that, joints' stiffness of joint is much related to the activation of surround muscles. Simultaneous contraction of both agonist and antagonist muscle around joints occur to maintain the joints' position and sway. However, adaptation of joint stiffness under longer period of perturbation is still unclear. In this study, the characteristics of ankle joint stiffness under repetitive translation perturbation at four different frequencies will be discussed. Methodology: Six healthy young subjects were participated in five trial sessions with different frequencies of translation perturbation (0.2, 0.4, 0.6 and 0.8 Hz) with 80 mm displacement. Each session are recorded by using motion analysis system, and force plate. Result and Discussion: The result shows the ankle joint stiffness and ankle sway at four different frequencies. Ankle joint stiffness followed the perturbation sway at 0.2 Hz but not at higher frequency (jÝ0.4Hz). This might be due to the central nervous system (CNS) that stiffed the ankle to counter the increase of force at high frequency. Ankle joint stiffness also reduced with increasing in number of perturbation cycles. At early five cycles, higher amplitude of stiffness can be observed but then, it reduced through sixth cycle. The decrease of stiffness amplitude may indicate an energy minimization strategy by nervous system. The posture adaptation strategy also might depend on the ankle sway magnitude as it increased with the number of cycles. Here, stiffness at other joints (knee and hip) is expecting to be increased. Forward and backward platform movement induced ankle plantar flexion and dorsiflexion respectively. This ankle plantar flexion can be seen at a wide range of ankle sway during forward movement and dorsiflexion at limited sway during backward movement. Furthermore, stiffness of ankle joint during forward movement was higher at low

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frequency, but, during backward movement stiffness higher at high frequency. These happen may due to movement of ground reaction force towards or away of the ankle. Conclusion: Further investigation on stiffness at hip joint and muscle activation was warranted in order to provide clear understand









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Fig. 2. Ankle joint stiffness and ankle sway at four different translation perturbation, (a) 0.2 Hz, (b) 0.4 Hz, (c) 0.6 Hz and (d) 0.8 Hz.

### P3-R-288 Characteristics of gait in adults with intellectual and developmental disabilities

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BACKGROUND AND AIM: Step length (SL), step rate (SR), and walking velocity (WV) are important indexes of gait [1]. This study was undertaken to investigate gait characteristics during preferred and maximum walking in adults with intellectual and developmental disabilities (IDD) in comparison with adults with no disability. METHODS: Subjects were 54 adults with no disability (controls) (34 women, 20 men; mean age = 20.94±1.85 years), and 38 adults with IDD (27 women, 11 men; mean age = 33.89±10.48 years; mean IQ = 25.38±10.08, range 12-52), including 3 individuals with Down syndrome and 11 with autism. Informed consent was obtained; all were willing participants. The subject walked on a straight walkway at preferred and maximum walking speeds. SL (m), SR (step/s), and WV (m/s) were measured. RESULTS: Table 1 presents means and standard deviations of SL, SR, and WV. Two-way ANOVA of SL showed main effects of group (F1, 90 = 72.23, p<.001) and walking conditions (F1, 90 = 130.23, p<.001). The interaction was also significant (F1, 90 = 27.48, p<.001). Two-way ANOVA of SR showed main effects of group (F1, 90 = 56.70, p<.001) and walking condition (F1, 90 = 151.20, p<.001). The interaction was also significant (F1, 90 = 74.63, p<.001). Two-way ANOVA of WV showed main effects of group (F1, 90 = 109.80, p<.001) and walking condition (F1, 90 = 205.13, p<.001). The interaction was also significant (F1, 90 =88.54, p<.001). CONCLUSIONS: Although SL was narrow, and SR was small, WV in adults with IDD was lower than in adults with no disability. Differences between preferred and maximum velocity are not clear in adults with IDD. Results suggest that changing of the walking pattern as the need arises is difficult for adults with IDD. REFERENCES 1. Sekiya N. & Nagasaki H. Gait Posture. 7:225-227, 1998.

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Table 1	Means and	l standard	deviations	in	SL.	SR.	and W	IV
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	SL (m)		SR (s	tep/s)	WV (m/s)		
	Pr	Max	Pr	Max	Pr	Max	
IDD	0.59±0.10	0.64±0.10	1.86±0.24	1.97±0.31	1.11±0.27	1.27±0.33	
Controls	0.70±0.08	0.84±0.10	1.97±0.18	2.61±0.35	1.38±0.17	2.19±0.42	

*Note.* Pr = preferred, Max = maximum.

#### P3-R-290 Motor function in children with Autism Spectrum Disorder: a cross-sectional longitudinal study

## *Nicoleta Bugnariu<sup>1</sup>,* Rita Patterson<sup>1</sup>, Dan Popa<sup>2</sup>, Carolyn Garver<sup>3</sup>

<sup>1</sup>UNT Health Science Center, <sup>2</sup>University of Texas at Arlington, <sup>3</sup>Autism Treatment Center

BACKGROUND AND AIM: Individuals with autism spectrum disorders (ASD) experience coordination and gait difficulties, slower speed in timed movements, reduced balance and postural stability. However, the timing of when motor abilities diverge from typical development is not known. During development children learn through imitation. Children with ASD have difficulties initiating and engaging in imitation behavior and available clinical tests that evaluate imitation rely on observation and categorical data of "yes" or "no". The aims of this research were to: i) assess the development of motor function in children with ASD and ii) guantify deficits in imitation behavior in children with ASD. METHODS: A crosssectional longitudinal design was used to investigate the development of motor function in children with ASD between 2 and 12 years old. Evaluations of motor functions were conducted guarterly over a period of one year and compared with those of age- and gender-matched healthy typically developing children. Ten pairs of ASD-Control children participated. Children performed dynamic daily tasks, such as pointing and reaching, balance and walking. A realistic-looking, agile robot Zeno performed movements such as "waving hello/goodbye", and "good job fist bump" and encouraged children to imitate it. Kinematic data of the human-robot interaction and a Dynamic Time Warping algorithm was used to quantify imitation behavior. RESULTS: Children with ASD had significant higher variability of Centre of Pressure compared to controls at all ages. Children with ASD consistently have significant lower Froude numbers than agematched controls. The Froude number (Fr) is directly proportional to the ratio between the kinetic energy and the gravitational potential energy needed during movement and is given by Fr = V\*V/gL, where V is the average speed of locomotion, g the acceleration of gravity, and L the leg length. These results suggest that development of an adult-like walking pattern characterized by an optimal energy transfer from cycle to cycle takes places at a slower rate in children with ASD. Children with ASD use significantly longer time to successfully point and reach a target resulting in longer "time per target" values (p<0.5). This suggests that the coordination of eye-arm movement in order to reach and point to target is delayed in children with ASD. The results of Dynamic Time Warping algorithm showed that children with ASD have poorer imitation behavior (higher discrepancy values of imitation based on weighted joint angle contributions) during the dynamic task compared to control group. CONCLUSIONS: Although improvements in motor function are evident in both groups with increasing age, the trajectories for development of balance, walking and reaching have a different slope (slower rate) compared to controls. During early childhood, specific motor and imitation impairments can serve as markers for screening/diagnosis of ASD.

#### P3-R-292 Investigating balance in persons with Down Syndrome: A focus on vision

*Lisa Bunn<sup>1</sup>*, Jonathan Waddington<sup>1</sup>, Chris Harris<sup>1</sup>, Heather Skirton<sup>1</sup>, Jonathan Marsden<sup>1</sup> <sup>1</sup>Plymouth University BACKGROUND AND AIM: People with Down Syndrome (pwDS) exhibit poor balance and incoordination1, both features which have been linked to cerebellar disease pathology, peripheral and central sensory processing abnormalities, problems with tone and co-contraction and cognitive limitations2-4. This study explored the effects of visual and proprioceptive stimulation and increased cognitive load on balance in DS. METHODS: 12 pwDS and 12 matched typically developed healthy controls (TDhc) were tested whilst standing under 5 conditions: c1. Eyes open, c2. Eyes closed, c3. Eyes closed with enhanced under-foot texture, c4. Eyes open with a dual task (button press when a visual target changed colour), c5. Eyes open with optokinetic stimuli (OKS) back-projected onto a 3x2.5 metres screen. In all conditions projected fixation points standardised the pre-trial visual environment. Motion analysis (Codamotion) recorded postural sway (C7 vertebral level). Mean sway speeds were averaged over trial repeats and normalised to subject height. For conditions 1-4 mean sway over two 40 s collection trials were measured. In condition 5, ten 20s OKS trials induced balance perturbations and sway response speeds were calculated from 0.2-2s following stimuli onset. Responses under different sensory/cognitive conditions were normalised to the relevant baseline sway condition (quotients). Results were analysed using unpaired t-tests (SPSS version 7). RESULTS: PwDS swayed faster than TDhcs in all standing conditions and in response to OKS (figure 1). Quotients (Vision: c2/c1, texture: c3/c2, cognitive load: c4/c1 and OKS: c5/c1) were not statistically significant between groups (figure 1B). In pwDS response magnitude following OKS was significantly correlated with baseline sway speeds with eyes open (r=0.703, p=0.011). TDhcs OKS responses did not correlate with baseline sway. CONCLUSIONS: The tendency for sway to be similar under eyes open and closed conditions in pwDS suggests impaired use of vision for the stabilisation of balance. However, the lack of group differences with the quotients and the correlation between response size and baseline sway in DS suggests that greater instability under many sensory and cognitive conditions may be related to increased baseline sway rather than specific sensory processing deficits or problems with cognitive loading. 1. Shumway-Cook & Woollacott (1985) Dynamics of postural control in the child with Down syndrome. PhysTher 65, 1315-22. 2. Costa (2011) An assessment of optokinetic nystagmus (OKN) in persons with Down syndrome. Exp Brain Res. 214, 381-91. 3. Carvalho & Almeida (2009) Assessment of postural adjustments in persons with intellectual disability during balance on the seesaw. J Int Dis Res 53, 389-395. 4. Vuillerme et al. (2001) Assessment of Static Postural Control in Teenagers With Down Syndrome. Adapt Phys Act Quart 18, 417-433.



Figure 1: Mean sway speeds (+/-sem) under sensory conditions, c1-5 (A) and sensory quotients (B)

## S - Effect of medication on posture and gait; Neurological diseases

# P3-S-294 Next -day residual effects of Zolpidem and Triazolam, Rilmazafone Hydrochloride administered at bedtime: a randomized double-blind study in elderly subjects

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BACKGROUND AND AIM: A common problem with current hypnotic agents is their potential to cause next-day residual ("hangover") effects. These effects may be particularly pronounced in older adults, although relatively few studies have investigated residual effects in this population. The purpose of this study was to evaluate potential residual effects in early morning and the following day with Zolpidem and Triazolam, Rilmazafone hydrochloride in healthy elderly people on the physical and cognitive functions. METHODS: Healthy women (n=11) and men (n=3) aged 60-70 years received a single bedtime (23:00 h) dose of Zolpidem 5mg and Triazolam 0.125mg, Rilmazafone hydrochloride 1mg, and placebo in a randomized, double-blind, crossover study. Measures of objective parameters and psychomotor performances (Timed up and Go test, Functional reach test, body sway pass, critical flicker fusion test, simply discriminatory reaction test), memory (short-term memory), as well as subjective ratings (Stanford Sleepiness scale, Visual analog scales), were obtained at 04:00 h, 07:00 h, and the following day. Adverse events were recorded. RESULTS: Rilmazafone hydrochloride did showed next-day impairments versus placebo on TUG and memory, but showed significantly improvements on body sway pass. Zolpidem showed improvements versus placebo on CFF. Rilmazafone hydrochloride showed impairments versus placebo on subjective rating of next-day alertness. All hypnotics were generally well tolerated; there were no serious adverse experiences and no subjects discontinued due to an adverse experience. CONCLUSIONS: A single oral bedtime dose of Zolpidem 5mg and Triazolam 0.125mg did not have next-day residual effects in healthy elderly subjects, (as measured by a range of pharmacodynamic assessments,) in contrast to the clear impairments produced by Rilmazafone hydrochloride 1mg. Residual effects appear to be related to compound half-life and dose

## P3-S-296 Dual task costs of gait in advanced Parkinson?s disease improve with L-Dopa but not with deep brain stimulation

*Markus Hobert*<sup>1</sup>, Lara Paulig<sup>1</sup>, Rejko Krüger<sup>1</sup>, Daniel Weiss<sup>1</sup>, Walter Maetzler<sup>1</sup> <sup>1</sup>Center of Neurology, University of Tuebingen

BACKGROUND: Patients with Parkinson?s disease (PD) primarily experience problems with mobility, however cognition is also often affected. Both treatment with L-Dopa and deep brain stimulation (Dbs) improve motor symptoms, but their impact on cognitive symptoms is less clear. This is of particular relevance as cognitive deficits can directly influence gait and balance, for example during dual tasking situations. We therefore used two different dual task paradigms to evaluate the influence of Dbs and L-Dopa on gait parameters during a secondary motor and cognitive task, respectively. METHODS: Fourteen advanced non-demented PD patients with DBS of the subthalamic nucleus (6 females, mean age 66 years, mean disease duration 18 years, mean MMSE 28.4, mean UPDRS motor score in DbsON/MedON condition 29 points) were examined. The patients performed ?as fast as possible? walks along a 20m walkway under single and dual tasking conditions. We used subtracting serial 7s and checking boxes as secondary tasks, again under ?as fast as possible? conditions. Quantitative gait parameters were measured with a tri-axial accelerometer (DynaPort Hybrid, McRoberts/ Netherlands), fixed at the lower back with an elastic belt. Dual task costs of gait parameters as well as speeds of the secondary tasks between DbsOFF/MedON and DbsON/MedON (for Dbs) and DbsON/MedOFF and DbsON/MedON were intra-individually compared. RESULTS: Dual task costs of step frequency when checking boxes

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were lower in the DbsON/MedON than in the DbsON/MedOFF condition (p=0.006). The parameters step time variability (p=0.10) and phase coordination index (p=0.06) approached significance. Comparably, dual task costs of step frequency when subtracting serial 7s were lower in the DbsON/MedON than in the DbsON/MedOFF condition (p=0.04). When comparing the DbsON/MedON with the DbsOFF/MedON condition, only dual task costs of step frequency when checking boxes were significantly different (p=0.03). Dual task costs of the cognitive tasks did not add relevant information. CONCLUSION: Our results argue for a relevant influence of L-Dopa on walking performance during dual tasking in advanced PD patients with Dbs. Dbs itself does not seem to have a major impact on the supraspinal motor control system. More pronounced effects in the secondary motor than in the secondary cognitive tasks may be best explained by a ?bottleneck? in the basal ganglia during simultaneous performance of two motor tasks.

## T - Ergonomics; Tools and methods for posture and gait analysis

### P3-T-298 Is strategy a matter of age?

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BACKGROUND AND AIM: Exploring how a movement is executed is often done by analysing measuring variables independently without looking at the global effect. Therefore it has become difficult to understand the body motion as a whole. The aim of this project was to have a different look at our data on workers' motions by asking if it is possible to identify different strategies for doing the same task. METHODS: 67 Workers split into three age groups (juniors: 30 to 35, medians: 45 to 50 and seniors: 60 to 65 years old) did a repetitive assembling task during two periods of 20 minutes work with two different rhythms (comfortable and a rapid). The task was to squat down, to grab spare parts and then to stand up to put all the parts together on a mounting table. Motion kinematics was recorded with a Vicon system <sup>®</sup> and dynamics with two force plates: one on the ground and the other one on the table. Joint centres were computed through the Hanavan model based on 37 markers and 70 anthropometric measures. Euler angle from ankles, knees and hips was computed as recommended by the Internal Society of Biomechanics. RESULTS: First we analysed workers' motion by the classical way of comparing dynamics, kinematic and Euler angles variables independently. Most of these variables showed statistical differences as a function of age and as a function of work rhythm. Then by putting all variables together and analysing them as a whole, it was possible to identify 7 different manners to realise the task. In comfortable condition, 5% of juniors, 30% of medians and 44% of seniors used only one kind of strategy during the whole experiment. 45% of juniors, 40% of medians and 26% of seniors used equivalently two kinds of strategies that they switch regularly. 50% of juniors, 30% of medians and 30% of seniors used three or more kinds of strategies. In rapid condition, all subjects' groups used less kind of strategies but still with more strategies variability observed for younger. CONCLUSIONS: A number of statistical differences observed between the groups when they were compared independently. These differences clearly showed where some limits could appear for the senior to realise the task. Then by looking at all variables together, we identified what we call some strategies. We did not observe that the senior workers used different strategies from the other groups. However, we observed that they used fewer strategies compared to the other groups. One of the ergonomics current (Mathiassen, 2006) postulated that if workers can change the way of doing a repetitive task, that could help to decrease the number of musculoskeletal disorders. Knowing that older workers are less able to change strategy could be a help in prevention against working diseases. BIBLIOGRAPHY: Hanavan EP, A.F. Base Ohio, (1964). ISB recommendation, Journal of Biomechanics 35 (2002) 543-548 Mathiassen SE, Applied Ergonomics (2006) 37, 419-427

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BACKGROUND AND AIM: Cross-legged sitting is extremely common for men and women of all ages, but has been reported as a high risk of spinal deformy. The purpose of this study was to investigate kinematic and kinetic changes that may occur in the pelvic and spine regions during cross-legged sitting postures. METHODS: 3D-motion analyses were performed on 26 healthy subjects. Data were collected while the subjects sat in four different postures: the control posture (without crossed legs) of sitting upright on the chair; the knee-on-knee (KoK) posture (the right knee on the left knee), the ankle-on-knee (AoK) posture (the right ankle on the left knee) and the ankle-on-ankle (AoA) posture (the right ankle on the left ankle). Joint angles were measured using VICON system with 6 infra-red cameras. Buttock pressure was measured using Tekscan pressure sensor. EMG signals were also collected for abdominal muscles using Delsys Trigno wireless EMG system. Repeated one-way analysis of variance (ANOVA) and the Bonferroni?s post hoc test were used for statistical analyses. RESULTS: Cross-legged sitting postures showed significantly greater kyphotic curves in lumbar and thoracic spines when compared with uncross-legged sitting posture. Pelvic posterior tilting was also greater in crosslegged sitting postures. In cross-legged sitting postures, right scoliosis was occurred in the thoracic spine, even though there was no significant difference (p>.05). Lumbar scoliosis angle showed significant differences in the AoA posture among the cross-legged sitting postures (p<.05), but thoracic spine scoliosis angles did not change significantly. Comparing with the control posture, pressure on the right buttock area was greater in AoK posture, and the pressure on the left buttock area was greater in KoK posture. Smaller scoliosis angle in AoA posture indicates that AoA posture has the least effect on the body. Cross-legged sitting postures showed significantly greater external oblique muscle activities. CONCLUSIONS: The present study suggested that asymmetric changes in the pelvic and spine region secondary to the prolonged cross-legged sitting postures might cause lower back pain and deformities in the spine structures. ACKNOWLEDGEMENTS: This research was financially supported by MKE and KIAT through RDRI (70011192), and ISTDP (10032055) funded by the MKE.

## U - Psychiatric disorders; Vestibular function and disorders

## P3-U-302 Neuro-otological findings in psychiatric patients with nystagmus

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BACKGROUND AND AIM: We previously reported Nystagmus (Nys) was observed in 56 of 227 psychiatric (Psy) patients using video-oculography (VOG) in the gaze, positional and positioning Nys tests. 1). Nys was observed 20% in schizophrenia, 22% in organic Psy disorders (D), 59% in alcoholism, 20% in excited mental retardation. There is a significant difference to the control group. To evaluate whether neuro-otological tests have clinical significance in Psy patients with Nys who have inner ear and/or brain dysfunction, we performed neuro-otological tests. METHODS: The subjects were 56 Psy patients (38 men, 18 women) (age range, 40-97; mean age ?} SD 61.6 ?} 10.5 years) with Nys in the gaze, positional and positioning Nys tests. Patients were classified according to the underlying diseases: schizophrenia (25 cases), organic Psy disorders (D) (14 cases), alcoholism (16 cases), excited mental retardation (1 case). The tests included caloric tests, vestibular ocular reflex (VOR) tests in rotation, eye tracking tests (ETT), visual suppression (VS) tests, pure tone audiometry (PTA) and stabilometry tests. RESULTS: Caloric test results showed a normal response in 30 (75%) cases, right canal paresis (CP) in 4 (10%), left CP in 4 (10%) and bilateral CP in 2 (5%). Therefore, 10 (25%) cases had CP. VOR test results showed a normal response in 40 (78.4%) cases, CP in 11 (21.6%). The results of the ETT were sorted into 5 categories: 4 (8.2%) cases smooth (normal), 8 (16.3%) slightly saccadic, 28 (57.1%) saccadic, 8 (16.3%)

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ataxic, and 1 (2%) no tracking ability. Therefore, 45 (91.8%) cases had abnormal ETT results. PTA showed normal hearing in 24 (47.1%) cases, hearing loss (HL) in 27 (52.9%) cases. The patients were classified as organic or functional groups. In ETT there was a significant difference between these 2 groups (Table). CONCLUSIONS: These results indicate that Psy patients may have nystagmus, CP or HL, therefore, neuro-otological and Nys tests with VOG should be useful not to detect vestibular D, but to detect possible organic brain diseases. REFERENCES: 1. Kiyomizu K. et al. Eur Arch Otorhinolaryngol 266: 1167-74, 2009 2. Kiyomizu K. et al. Eur Arch Otorhinolaryngol 268: 1713-19, 2011

psychiatric	ETT				
disease	normal	abnormal			
organic	0	25			
functional	4	20			

P=0.0332