Correlation of the Functional Difficulties Questionnaire (FDQ-9) with dynamic balance using the SMART instrumented wobbleboard.

Clark C, Clark S, Dorey C and Williams J, Physical Therapy in Sport, 2016

Faculty of Health and Social Sciences, Bournemouth University

Abstract

Objectives : To investigate concurrent validity of the Functional Difficulties Questionnaire (FDQ-9) using balance tasks on the SMARTwobbleboard . Poor balance is associated with reduced physical activity which may impact on quality of life. There is a requirement to use simple tests to assess balance so that suitable interventions can be employed to ameliorate poor balance and enhance uptake of physical activity.

Design: Observational study employing 30 healthy volunteers who completed the FDQ-9 and undertook three balance tasks on the SMARTwobbleboard: double leg stance eyes open (DLSEO); double leg stance eyes closed (DLSEC) and single leg stance eyes open (SLSEO).

Results: There were moderate significant correlations between the FDQ-9 and DLSEO and SLSEO. There were significant between group differences in dynamic balance for participants with FDQ-9 ≤ 18 (indicative of no functional difficulties) and FDQ-9 ≥ 19 (indicative of one or more functional difficulties) for DLSEO and SLSEO.

Conclusions: Significant moderate correlations were recorded between the FDQ-9 and the SMARTwobbleboard in healthy adults indicating a relationship between dynamic balance and questionnaire scores (DLSEO and SLSEO). Initial findings contribute to the concurrent validity of the FDQ-9 which could also be used as a simple tool for assessing balance.

Key words Concurrent validity, balance tasks, functional tool

Introduction

Good dynamic balance is thought to be necessary to achieve appropriate levels of physical activity associated with a good quality of life [1,2] and a reduction in the health burden.[3,4,5]. Balance requires the integration of the sensory and motor systems and is reported to be more developed in high level athletes than low level athletes, with recognition that both vestibular and visual systems play an important role [6]. In addition, older adults with higher levels of physical fitness have been found to have better postural balance and function [7]. Evidence suggests that balance can be improved though participation in certain types of exercise [7].There is, therefore, a requirement to be able to assess balance and functional ability in adults in order to prescribe suitable interventions.

Various tools are available for objectively measuring balance; for example floor mounted force plates [8] and tri-axial accelerometers [9]. Wobbleboards are frequently used in the rehabilitation of balance in clinical practice and more recently an instrumented version has been validated as a reliable tool for quantifying balance [10]. However, use of the instrumented version in the clinical setting may not be possible as it is expensive, time consuming to use and may not be appropriate for those in pain. There is a requirement in for simple tests to assess balance for example a short questionnaire such as the Functional Difficulties Questionnaire (FDQ-9).

The FDQ-9 has been validated as a screening tool for adults with Dyspraxia, also known as developmental coordination disorder (DCD) [11]. Adults with dyspraxia/DCD are known to have functional difficulties including impairments in balance, obstacle avoidance, gross and fine motor control [12,13]. The aim of this study was to explore the concurrent validity of the FDQ-9 using wobbleboard performance as measured by the SMARTwobbleboard (ThetaMetrix ®, Waterlooville, Hampshire, UK) (WB). The secondary objectives were to investigate differences between participants who had FDQ-9 scores of ≤ 18 (indicative of no functional difficulties) and ≥ 19 (indicative of one or more functional difficulties with dynamic balance) [11].

Methods

Study participants

An observational study involving 30 healthy participants recruited from staff and students at Bournemouth University, U.K. in July 2014. All participants were volunteers and eligibility was defined as having no neurological, musculoskeletal or any other injury which might impair balance. Participants were required to answer questions pertaining to visual impairment, rheumatological condition and spinal and lower limb injury/surgery in the last 12 months to determine eligibility.

Participants who reported visual impairments not corrected by wearing glasses or any spinal or lower limb injury/surgery in the last 12 months were excluded from the study. Ethical approval for this study was granted by Bournemouth University ethics board and all participants were required to provide written consent before participating.

Instrumentation

i) Each participant's functional ability was assessed using the FDQ-9 a 9 item questionnaire (table 2) which encompasses the main areas of fine and gross motor coordination including balance. Participants were required to rate their abilities on a four-point Likert-type scale as: 'Very good' (1), 'Good' (2), 'Poor' (3), 'Very poor' (4), for each of the questions. Possible scores range from 9-36 with lower scores indicating greater functional ability. The questionnaire has a high internal reliability (0.81) with a mean inter-item correlation of 0.51 and good test-retest reliability (ICC 0.96 [95% CI 0.92 to 0.98]) [11].

ii) The SMARTwobbleboard instrumented wobbleboard (THETAmetrix ®, Waterlooville, Hampshire, UK) was used to quantify participant's WB performance for dynamic balance. The WB contains a wireless electronic tilt sensor which relays information on the tilt angle of the board at 15Hz to a PC with specifically constructed software (THETAmetrix ®, Waterlooville, Hampshire, UK). The SMARTwobbleboard demonstrates good test re-test reliability (ICC 0.71 [95% CI 0.67 to 0.76]) and an accuracy of <2% [10].

Protocol

i) On entering the testing room participants were asked to read through a participant information sheet and complete the FDQ-9 questionnaire with additional questions on the participant's age, sex, height and weight. Participants were also required to answer questions which assessed whether they suffered from any neurological, musculoskeletal or any other injury which might have impaired or affected their balance. Participants were exempt from testing if their answers indicated any of the later or if they were unhappy with any of the testing procedures. The height (cm) and weight (kg) of each participant were measured and recorded within the testing room.

ii) The WB was placed on a therapy mat (Airex Fitline Gym Mat) between two plinths. Participants were instructed to stand on the WB with the edge of their feet touching the rim of the board (See Figure 1). Three tasks were investigated and participants were allocated a warm up period of 30 seconds on each of these tasks before the testing period began. Participants were instructed to attempt to maintain the WB in a level state. On completion of the warmup the three tasks were undertaken for a period of 60 seconds each and included: (1) double leg stance eyes open (DLSEO), (2) double leg stance eyes closed (DLSEC), (3) single leg stance eyes open (SLSEO). The order in which the tasks were undertaken was randomised using an opaque envelope.

WB data were collected using the THETAmetrix software, which produces a performance report dividing the maximum tilt angle of the WB into thirds to provide the percentage time spent in each third (inner, middle, outer). In addition the software provides the number of edge contacts of the WB with the floor and the time spent with the edge in contact (see Figure 2). These percentages and the number of contacts made were recorded for each task and were then inputted into Excel along with the data from the questionnaire.

Insert figure 1 and 2 about here

Statistical analysis

Descriptive statistics for sex, handedness and education were reported numerically and in percentages. Data relating to age, height and weight were normally distributed and were reported as mean SD and range (table 1). Descriptive data relating to the two FDQ-9 groups (FDQ-9 ≥19 and FDQ-9 ≤ 18) were compared using Chi square test and the Fishers Exact test (where numbers were below 5). Since the data relating to the FDQ-9 and wobble board were not normally distributed (Kolmogorov-Smirnov), Spearman's rank correlations were used to test the strength of the relationship between the results for the FDQ-9 and the WB data and between group comparisons were reported using Mann Whitney-U test. Values of ≤ 0.35 were considered to represent low or weak correlations; 0.36 – 0.67 moderate and ≥ 0.67 strong [16]. Significance is reported with the coefficient of determination (R^2) which is the percent variation of the dependent variable value that can be explained by the independent variable value [17].

Statistical analyses were used to examine between group comparisons between the group who had FDQ-9 scores of ≤ 18 (n=19), indicative of no functional difficulties, and the group who had FDQ-9 scores of ≥ 19 (n=11), indicative of one or more functional difficulty [11]. Correlations were run using the total FDQ-9 score and the FDQ-9 score relating to gross motor activity including balance (questions 2,3,4,6,7 – see table 2) [11].

Results

Baseline participant characteristics are presented in Table 1.

Insert table 1. about here

Single Leg Stance Eyes Open (SLSEO)

There was a statistically significant moderate negative relationship between participants' total FDQ-9 scores and percentage time spent in the inner banding of the WB (R= -0.537, n=30, p <0.005). This indicated that participants who spent a lower percentage of time in the inner banding (increased balance difficulties) were correlated with a higher FDQ-9 score (indicating greater functional difficulties). There was also a positive correlation between FDQ-9 scores and the percentage time spent on the edge (R= 0.456, n=30, p<0.02) and the number of edge contacts (R= 0.393, n=30, p<0.05). The coefficient of determination (R^2) ranged from 0.11- 0.23 for this task (Figure 3).

Double Leg Stance Eyes Open (DLSEO)

There was a statistically significant moderate positive correlation between total FDQ-9 score and time spent in the outer banding for the task DLSEO (R= 0.387, n=30, p <0.05). The coefficient of determination (R^2) for this task was 0.23 (Figure 4). This indicated that participants who spent a higher percentage time in the outer banding (increased balance difficulties) had higher FDQ-9 scores (increased functional difficulties).

There were no statistically significant correlations between total FDQ-9 score and time spent in inner banding (R=-0.325, n=30, p >0.05) middle (R=-0.273, n=30, p>0.05), on the edge (R=0.246, n=30, p >0.05) or the number of edge contacts (R=0.295, n=30, p >0.05.

Double Leg Stance Eyes Closed (DLSEC)

There were no statistically significant correlations between the total FDQ-9 score and percentage time spent in inner (R=0.024, n=30, p >0.05), middle(R=-0.092, n=30, p >0.05), or outer bandings (R=0.082, n=30, p >0.05), on the edge (R=-0.074, n=30, p >0.05), or the number of edge contacts (R=0.029, n=30, p >0.05).

Insert figures 3 and 4 about here

Single Leg Stance Eyes Open (SLSEO)

There was a moderate statistically significant negative relationship between the gross motor FDQ-9 scores and percentage time spent in the inner banding for the task SLSEO (R= -0.529, n=30, p <0.01). This indicated that participants who spent a lower percentage of time in the inner banding (increased balance difficulties) were correlated with higher gross motor FDQ-9 scores (indicating greater functional difficulties). There was a moderate statistically significant positive correlation between the gross motor scores and the time participants spent in the outer banding (R = 0.413, n=30, p<0.05) and on the edge (R= 0.409, n=30, p<0.05) of the WB on task SLSEO. The coefficient of determination (R^2) ranged from 0.07 – 0.31 for this task (Figure 5).

Double Leg Stance Eyes Open (DLSEO)

There were no statistically significant correlations between the gross motor FDQ-9 scores and percentage time spent in inner (R=-0.259, n=30, p >0.05), middle (R=-0.253, n=30, p >0.05), or outer (R=-0.326, n=30, p >0.05), bandings, on the edge (R=0.234, n=30, p >0.05), or the number of edge contacts (R=0.243, n=30, p >0.05).

Double Leg Stance Eyes Closed (DLSEC)

There were no statistically significant correlations between the gross motor FDQ-9 scores and percentage time spent in inner (R=0.199, n=30, p >0.05), middle (R=0.040, n=30, p >0.05), or outer (R=0.110, n=30, p >0.05), bandings, on the edge (R=-0.178, n=30, p >0.05), or the number of edge contacts (R=-0.0617, n=30, p >0.05).

Insert figure 5 about here

Functional Difficulties Questionnaire (FDQ-9) score

The FDQ-9 questions and the total number and percentage of participants who scored Good and Very Good (G-VG) and Poor and Very Poor (P-VP) for each question are presented in Table 2. The majority of participants reported being good or very good at all 9 items (see Table 2). The items that the greatest number of participants reported difficulties were catching a ball one handed as an adult and hand writing as a child. The item that participants reported the least difficulty was balance as an adult. All participants reported having good or very good balance. The median total scores of the two groups were significantly different, Mann Whitney U ($U=<0.01$, $Z=-4.524$ $n1=19$, $n2=11$, $P<0.001$) (Table 3.).

Insert table 2 about here

insert figure 6 about here

The mean percentage time (SD) for participants in SLSEO in the three bandings (inner, middle and outer) and on the edge were: 28.35 (32.15); 36.56 (11.76); 24.89 (9.42) and 15.84 (14.53) respectively. Participants spent the greatest percentage time in the inner and middle bands but there was a higher SD in the inner band indicating a greater variance between participants for this task. The least percentage time was spent with the edge in contact with the mat.

The mean percentage time (SD) for participants in DLSEO in the four bandings inner, middle, outer and edge was: 25.05 (10.44); 38.16 (7.44); 26.91 (8.97) and 9.86 (8.34) respectively. The smaller deviations indicated there was less variance between participants (Figure 6.).

The mean percentage time (SD) for participants DLSEC in the four bandings inner, middle, outer and edge was 8.89 (7.41); 17.52 (8.78); 29.5 (6.99) and 44.09 (17.45) respectively.

The results of the comparisons of WB performance for participants with low and high FDQ-9 scores are presented in Table 3. Participants involved in the DLSEC task spent the highest percentage of their time in the edge banding and had the highest number of contacts with the mat, while spending the lowest percentage of their time in the inner band.

Insert table 3 about here

There were statistically significant ($p<0.05$) between group differences for participants with an FDQ-9 score ≥ 19 or an FDQ-9 score ≤ 18 in all bandings of the WB for the stance DLSEO task. The FDQ-9 ≤ 18 group spent more time in the inner band (28.6%) compared with the FDQ-9 ≥ 19 (12.9%). In relation to the number of times the WB made contact with the mat the FDQ-9 ≤ 18 had significantly less edge contacts (25) compared with the FDQ-9 ≥ 19 (70). There were statistically significant ($p<0.05$) between group differences for participants with an FDQ-9 score ≥ 19 or an FDQ-9 score ≤ 18 in all bandings except the outer banding of the WB for the stance SLSEO task. The FDQ-9 ≤ 18 group spent more time in the inner band (28.5%) compared with the FDQ-9 ≥ 19 (12%). There was no significant difference in WB performance between participants with FDQ-9 ≥ 19 and FDQ-9 ≤ 18 for the DLSEC task. The median total scores of the two groups were significantly different, Mann Whitney U (U=<0.01, Z=-4.524 n1=19, n2=11, P<0.001) (Table 3).

Discussion

This is the first study to explore the concurrent validity of the FDQ-9 Questionnaire using WB performance by investigating the relationship between these two tools. Indicators of better balance on the WB correspond to increased time spent in the inner and middle bandings while better balance in the FDQ-9 corresponds to lower scores.

The primary objective was to investigate the correlation between scores of the FDQ-9 with measurements of dynamic balance taken from the WB in a group of health adults. In summary there were significant moderate correlations relating to balance ability on the WB for all bandings and number of edge contacts and scores of the FDQ-9 questionnaire in SLSEO task. This suggested there was a relationship between balance and functional ability scores for this task. There was only one correlation between WB banding and the scores of the FDQ-9 for the DLSEO. This might suggest that the DLSEO task presented as a limited balance challenge and lacked the sensitivity to detect subtle balance abilities in this healthy adult population. These results would appear to echo the findings of a systematic review [6] which found DLSEO on a solid surface was not a challenging enough task to detect balance differences between participants of sports such as; Tai Chi, gymnastics etc. There were no significant correlations between any of the bandings or the number of edge contacts of the WB in DLSEC for either the gross or total FDQ-9 scores. Balance control depends on the integration of proprioceptive, vestibular and visual input [6]. It is possible that the lack of visual input made this dynamic balance activity too challenging in this population, resulting in no relationship being found between the two measures. It is possible that the DLSEC task would be a more appropriate balance challenge for in high level athletes, who generally have better balance than low level athletes [6].

The secondary objective explored between group differences in the dynamic balance of those who reported FDQ-9 scores of ≤ 18, with those who reported scores ≥ 19. (FDQ-9 scores of ≤ 18 are indicative of no functional difficulties where as FDQ-9 scores ≥ 19 are indicative of one or more functional difficulties [11]). There were significant differences between the groups (FDQ-9 score ≤ 18 and FDQ-9 score ≥ 19) in relation to time spent in each banding or number of edge contacts for the DLSEO and SLSEO tasks. Participants with FDQ-9 ≤ 18 spent significantly more time in the inner and middle bandings of the WB than participants with FDQ-9 score ≥ 19. Participants with FDQ-9 score ≥ 19 spent a greater percentage of time in the outer banding and had significantly more edge contacts than participants with FDQ-9 ≤ 18 for the SLSEO task. This suggests a relationship between those with one or more functional difficulties reporting a greater balance challenge than those with no functional difficulties for the SLSEO task. There were no significant differences between the groups for the DLSEC task indicating no relationship between the groups for this task.

There was no statistically significant difference between groups for the DLSEC task which is similar to the findings above. It is suggested that the DLSEC task was not discriminatory because the challenge exceeded the abilities of the participants in this study. It is interesting to note that both DLSEO and DLSEC activities on a flat surface have been found to be discriminatory between professional and amateur football players as professionals relied less on visual input for balance [18,19]. In a review in which Kiers and colleagues [6] reported on the balance of many different sports, they found sports practitioners tended to have better balance. It might be suggested that DLSEC on a WB will be more discriminatory amongst professional sports practitioners.

It is acknowledged that the current study has limitations. Firstly, the study was carried out in a group of adults who reported good or very good balance, whose FDQ-9 scores covered a small range and within whom the percentage reporting functional difficulties were few. Secondly, the study was carried out with a small sample size which limits the generalizability of the findings from this study. Thirdly, although moderate significant correlations were noted, the percentage variable that could be explained by the independent variable was small.

Poor balance has been associated with increased mortality [20] and good balance is a requirement for appropriate levels of physical activity to be achieved [1]. There is a requirement to use simple inexpensive tests like the FDQ-9 to assess physical capability, in particular balance. Suitable interventions could then be employed to ameliorate poor balance and enhance the uptake of physical activity. Initial findings suggest that the FDQ-9 may be used to assess balance, but that this may be limited to certain tasks. Further research is required to repeat the observations reported in this current study in: adults who report having balance difficulties, in adults who report a range of functional difficulties and in a study with a larger population. This would establish whether the FDQ-9 is a suitable tool for assessing balance in adults with a range of balance and functional abilities.

Conclusions

This was the first time dynamic balance- as measured by the SMARTwobbleboard-had been correlated with the FDQ-9. This study shows statistically significant moderate correlations between the total FDQ-9 scores and dynamic balance measured using a WB for the SLSEO and DLSEO tasks in healthy adults. There were no correlations with the DLSEC, and it is suggested this was due to the balance challenge being too great to be discriminatory for the participants in this study. Concurrent validity measures how well a particular test correlates with a previously validated measure. In this study we report moderate correlations between the WB and FDQ-9 using a number of tasks. This would suggest there is evidence of concurrent validity between the FDQ-9 and WB.

References:

[1] Hayashi D, Gonçalves CG, Parreira PB, et al. Postural balance and physical activity in daily life (PADL) in physically independent older adults with different levels of aerobic exercise capacity. Arch Gerontol Geriatr 2012;55:480-485.

[2] Tiedemann A, Sherrington C, Lord SR. The roll of exercise in fall prevention in older age. Motriz 2013;19:541-547.

[3] Wannamethee SG, Ebtahim S, Papacosta O, Shaper AG. From a postal questionnaire of older men, healthy lifestyle factors reduced the onset of and may have increased recovery from mobility limitation. J Clin Epidemiol 2005;58:831-840.

[4] Allender S, Foster C, Scarborough P, Rayner M. The burden of physical activity-related ill health in the UK. J Epidemiol Community Health 2007;61:344–348.

[5] Health Survey for England – 2008: Physical Activity and Fitness. Health and Social Care Information Centre, 2009. www.hscic.gov.uk/pubs/hse08physicalactivity

[6] Kiers H, van Dieen J, Dekkers H, Wittink H, Vahees L. A systematic review of the relationship between physical activities in sports or daily life and postural sway in upright stance. Sports med. 2013;43:1171-1189.

[7] Howe, T.E., Rochester, L., Neil, F. et al., Exercise for improving balance in older people *Cochrane Database of Syst Rev* 2011 2007;(4)CD004963.

[8] Mancini, M., Salarian, A., Carlson-Kuhta, P., Zampieri, C., King, L., Chiari, L., Horak, F.B. (2012). ISway: a sensitive, valid and reliable measure of postural control. Journal of NeuroEngineering and Rehabilitation, 9: 59.

[9] Eguchi R and Takada S. Usefulness of the tri-axial accelerometer for assessing balance function in children. Pediatrics International 2014. 10.1111/ped.12370.

[10] Williams J and Bentman S. An investigation into the reliability and variability of wobble board performance in a healthy population using the SMARTwobble instrumented wobble board. Phys Ther Sport 2014;15:143-147.

[11] Clark CJ, Thomas S, Khattab AD, et al. Development and psychometric properties of a screening tool for assessing Developmental Coordination Disorder in adults. Int J Phys Med Rehabil 2013;1:145.

[12] Cousins M and Smyth MM. Developmental coordination impairments in adulthood. Hum Movement Sci 2003;22:433-459.

[13] Clark CJ, Khattab AD, Carr ECJ. Chronic widespread pain and neurophysiological symptoms in Joint Hypermobility Syndrome (JHS). Int J Ther Rehabil 2014;21:60-67.

[14] Blair W-N, Barela JA, Whitall J, Jeka JJ and Clark SE. Children with Developmental Coordination Disorder benefit from using vision in combination with touch information for quiet standing. Gait and Posture 2011;34:183-190.

[15] Tal-Saban M, Zarka S, Grotto I, Ornoy A, Parush S. The functional profile of young adults with suspected Developmental Coordination Disorder (DCD). Res Dev Disibil 2012;33:2193-2202.

[16] Taylor, R. Interpretation of the correlation coefficient: A basic review. Journal of diagnostic medical sonography 1990;6:35-39.

[17] Mason RO, Lind DA, Marchal WG: Statistics: An Introduction. New York: Harcourt Brace Jovanovich, Inc, 1983;368-383.

[18] Paillard T. and Noe´ F. Effect of expertise and visual contribution on postural control in soccer. Scand J Med Sci Sports 2006;16:345–8.

[19] Paillard T, Bizid R, Dupui P. Do sensorial manipulations affect subjects differently depending on their postural abilities? Br J Sports Med 2007;41:435–8.

[20] Cooper R, Strand BH, Hardy R, Patel KV, Kuh D. Physical capability in mid-life and survival over 13 years of follow-up: British birth cohort study. Br Med J 2014

Ethical Approval

Ethical approval was granted by Bournemouth University Research Ethics Committee

Funding

This study was supported by Seed Corn funding from the School of Health and Social Care, Bournemouth University, UK.

Tables and Figures

Table 1. Baseline patient characteristics (n=30). Frequency and association of Functional Difficulties Questionnaire (FDQ-9) scores FDQ-9 ≤ 18 and FDQ- 9 ≥19 with sex, handedness and education (Secondary: GCSE/GCE, AS/A2 level, Baccalaureate, BTech. Tertiary: Certificate, Diploma, Degree, Masters, Doctorate). Mean, standard deviation (SD) and range of participant's age, height and weight.

	Frequency N (%)	Total N=30	FDQ ≤ 18 N (%)	FDQ ≥19 N(%)	Chi sq	*p*
Sex					0.2153	>0.05
Male	12 (40)		7 (58)	5 (42)		
Female	18 (60)		12 (67)	6 (33)		
Handed					0.6111	>0.05*
Left	4 (13.3)		2 (50)	2 (50)		
Right	26 (86.7)		17 (65)	9 (35)		
Education					0.0318	>0.05
Secondary	12 (40)		8 (62)	5 (38)		
Tertiary	18 (60)		11 (65)	6 (35)		
Age –years Mean (SD) [range]		28.77 (8.72) [19-53]	29.6 (8.42) [20-49]	27.4 (9.47) [21-53]	83.500	>0.05**
Height cm Mean (SD) [range]		170.57 (9.79) [150-193]	169.1 (9.83) [150-193]	173.1 (9.64) [157.5-186]	82.000	>0.05**
Weight Kg Mean (SD) [range]		73.43 (15.3) [50-115]	69.8 (12.60) [53-95]	79.7 (18.07) [50-115]	65.500	>0.05**
*Fishers Exact ** Mann-Whitney U						

Figure 1 Assessing dynamic balance on the SMARTwobble board.

Figure 2 Diagrammatic example of the percentage time spent in inner, middle and outer range and on the edge for the wobble board.

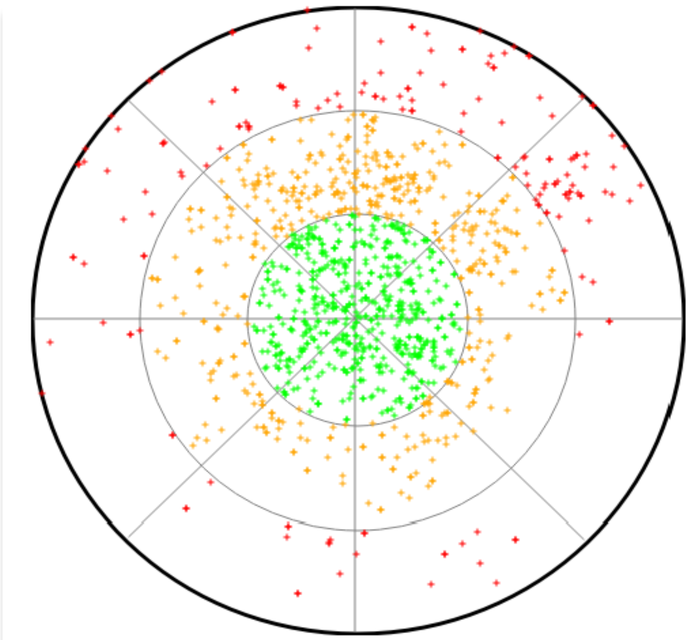

Figure 3. Correlation between total FDQ score and percentage time spent in the inner band (a), on the edge (b) and the number of edge contacts (c) of the WB during task SLSEO with the coefficient of determination (R^2).

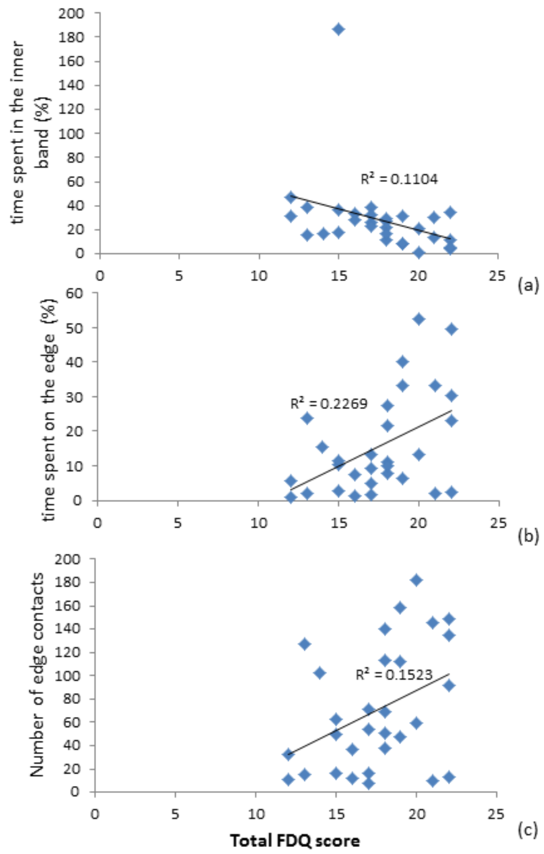

Figure 4. Correlation between total FDQ score and percentage time spent in the outer band of the WB during task DLSEO with the coefficient of determination (R^2).

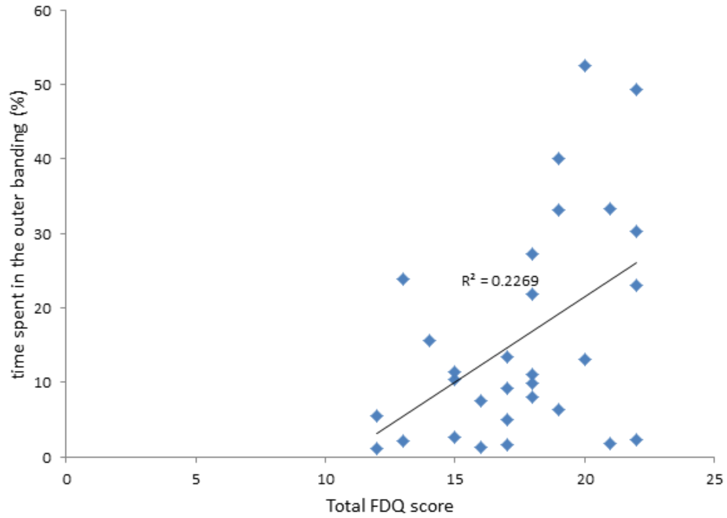

Figure 5. Correlation between FDQ gross motor score and percentage time spent in the inner (a) and outer (b) bands, and on the edge (c) of the WB during task SLSEO with the coefficient of determination (R^2).

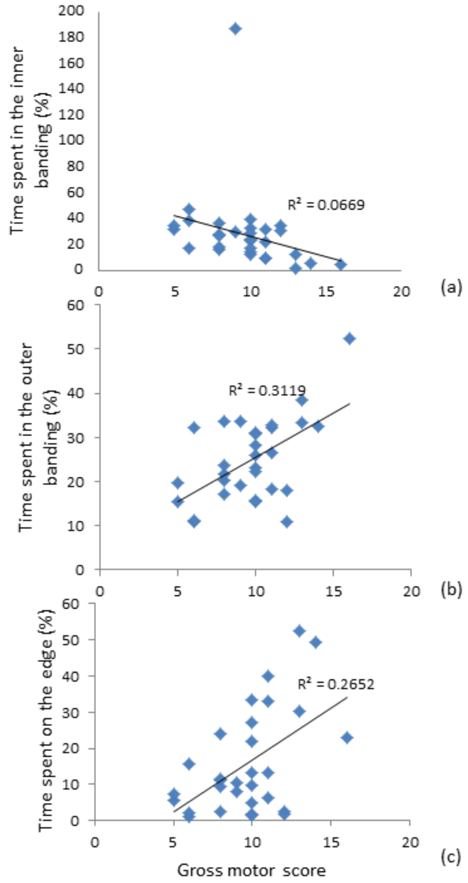

Figure 6. Mean (sd) percentage time participants spent in each bandings (inner, middle and outer) and on the edge of the wobble board in each stance: DLSEO; double leg stance eyes open, DLSEC; double leg stance eyes closed, SLSEO; single leg stance eyes open.

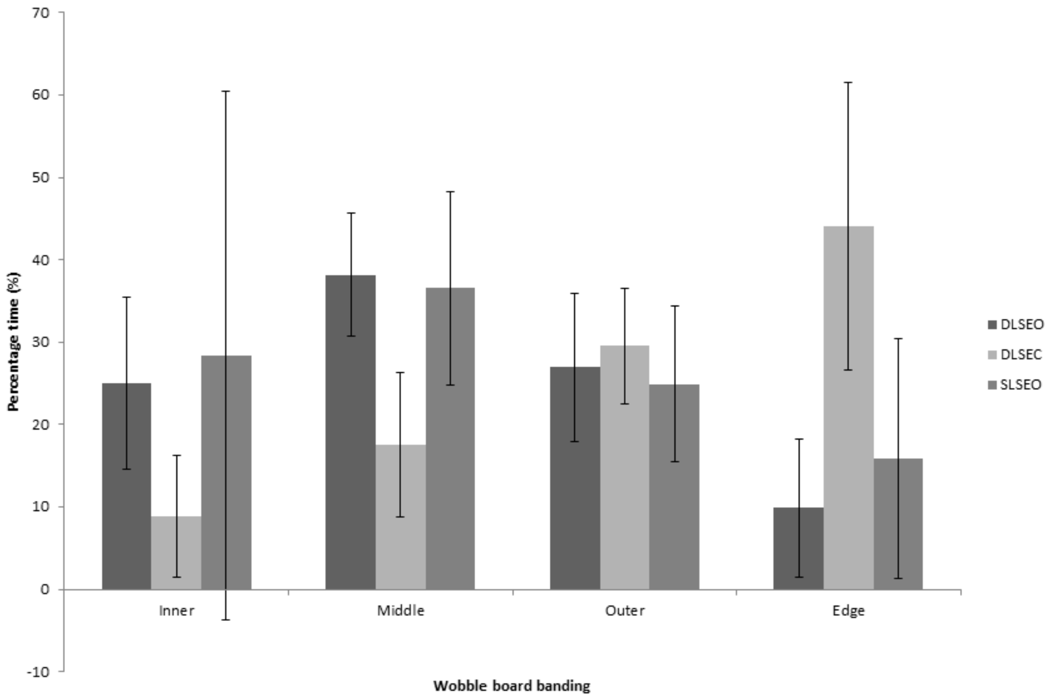

Table 2. Total number and percentage (%) of participants scoring Good and Very good (G-VG) and Poor and Very poor (P-VP) for each question on the Functional Difficulties Questionnaire (FDQ-9) (n=30).

Question		Total G-VG N (%)	Total P-VP N (%)
1	**AS A CHILD,** how good was your hand writing?	20 (67)	10 (33)
2	**AS A CHILD,** were you good at team games that involved balls? i.e. football, netball, basketball	24 (80)	6 (20)
3	**AS A CHILD,** how did others rate your coordination?	24 (80)	6 (20)
4	**AS AN ADULT,** how good are you at avoiding obstacles, like bumping into doors?	25 (83)	5 (17)
5	**AS AN ADULT,** how good are you at organizing yourself? i.e. getting ready for work or for a meeting	28 (93)	2 (7)
6	**AS AN ADULT,** how good are you at catching a ball one handed?	21 (70)	9 (30)
7	**AS AN ADULT,** how good are you at balancing on a bike, in a bus or train, or on skis?	30 (100)	0 (0)
8	**AS AN ADULT,** how good are you at using your hands i.e. to do jobs around the home, DIY, sewing or using scissors?	28 (93)	2 (7)
9	**AS AN ADULT,** how good is your hand writing now?	24 (80)	6 (20)

Table 3. Comparison of participant's WB performance with a total FDQ-9 score of ≤ 18 (n=19) and ≥ 19 (n=11) with the Mann Whitney U statistic (U); p (two tailed); the Z statistic (Z) and the number of participants with a FDQ-9 score of ≤ 18 (n=19) and ≥ 19 (n=11) categories. Significance * < 0.05; ** <0.001

		U	P (two tailed)	Z	FDQ-9 ≤18 Median (n=19)	FDQ-9 ≥19 Median (n=11)
Total FDQ score		<0.01	0.008**	-4.524	16	21
DLSEO						
	Inner	66	0.010**	-1.657	28.6	12.9
	Middle	54	0.046*	-2.175	41	31
	Outer	57	0.037*	-2.044	23.8	32.7
	Edge	53	0.048*	-2.217	6.6	17.9
	Contacts	40.5	0.002**	-2.756	25	70
DLSEC						
	Inner	92.5	0.441	-0.517	6.9	5.3
	Middle	93.5	0.258	-0.473	16.7	15.4
	Outer	92.5	0.339	-0.516	27.8	26.2
	Edge	98.5	1.306	-0.258	44.9	51
	Contacts	84	2.214	-0.883	120	135
SLSEO						
	Inner	43	0.006**	-2.647	28.5	12
	Middle	57	0.041*	-2.044	42.7	24.8
	Outer	63	0.349	-1.786	21.6	32.3
	Edge	50	0.012*	-2.345	9.3	30.3
	Contacts	59	0.004*	-1.958	50	112