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ASSESSMENT PROCEDURE

Rate of perceived stability as a measure of balance exercise intensity in people post-stroke

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ABSTRACT

Purpose: This study investigates the reproducibility and concurrent validity of the Rate of Perceived Stability (RPS) Scale in people with stroke.

Methods: On two separate days (2–10 days apart), participants provided their RPS ratings during clinical measures: 1)16 tasks from Community Balance and Mobility Scale (CB&M), 2)6-minute walk test (6MWT), and 3)self-paced gait speed. Intraclass correlations (ICCs) assessed between day test-retest reliability of RPS ratings. Standard error of measurement (SEM) and smallest detectable change (SDC) addressed level of between day agreement. Spearman rank correlations (r_s) quantified relationships between RPS, and general rating of perceived challenge, task-performance scores.

Results: Thirty participants with stroke (50% female) participated. ICC ranged from 0.46 to 0.93 across tasks with 12/19 tasks showing ICCs above 0.75 (good test-retest reliability). SEM was 1-point for each task and SDC ranged from 2 to 4 across tasks. Concurrent validity between RPS and ratings of perceived challenge was good-to-excellent (r_s ranged 0.78–0.94, $p < 0.01$). Higher RPS (indicative of feeling less stable) was associated with lower balance performance scores on CB&M tasks, negative relationships ranged in strength from fair to good-to-excellent in 10/16 tasks (r_s ranged -0.46 to -0.81, $p \leq 0.01$).

Conclusions: RPS shows promise as a measure of balance intensity in people with stroke.

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KEYWORDS
Stroke; walking balance; balance task intensity; self-rating; outcome assessment

➤ IMPLICATIONS FOR REHABILITATION

- The RPS is a reliable and valid measure of balance intensity in ambulatory people with stroke.
- The RPS scale may be a useful clinical tool to address the gap in practice of measuring balance intensity during rehabilitation of walking balance post-stroke.

Introduction

Following stroke, regaining safe independent walking is critical for reintegration into a person's community. Although over 80% of all people discharged from the hospital regain the ability to walk after stroke, independent walking is commonly impacted by impaired balance [1,2]. Low balance self-efficacy (confidence) post-stroke can further impact walking function and activity levels [3]. Post-stroke falls have been reported in as many as 73% of ambulatory people living in the community, and they commonly occur within the first few months of returning home from rehabilitation [1,2].

Functional retraining exercise programs during rehabilitation are the main interventions aimed at restoring walking function and balance post-stroke. It is recommended that exercises are prescribed using the "FITT" framework – Frequency, Intensity, Time and Type. With respect to exercise programs addressing walking balance, frequency, time and type are often straightforward to quantify; however, quantifying exercise intensity is more complex [4]. Although there are methods to measure exercise intensity for strength (e.g., percentage of 1 repetition max) and aerobic training (e.g., heart rate [HR], and rate of perceived exertion [RPE]), there is no analogous method for balance exercise intensity prescription [5].

A recent systematic review exploring walking balance interventions revealed that there is an absence of valid methodology for measuring balance exercise intensity in trials addressing walking balance in older adults following illness and injury including stroke [4]. This lack of measurement of balance intensity results in an inability to replicate experimental exercise approaches or, most importantly, translate the intervention to clinical practice [4]. Currently, the most common approach to addressing balance intensity is to prescribe tasks of increasing difficulty based on the treating clinician's perception of task difficulty or challenge. This is in contrast to measuring difficulty based on the participant's

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perception of challenge for a given balance task, as is required for optimal motor learning [6,7]. It is important to establish a measure that will allow for individualized prescription and progression of balance exercise intensity during rehabilitation of walking function post-stroke.

To address this exercise prescription gap in the rehabilitation of balance abilities, Espy et al. [8] developed the Rate of Perceived Stability scale (RPS) for self-rating the challenge of an activity that is specific to balance function. The scale follows the format of the RPE and uses ratings from 1-10 to ground clinically meaningful descriptions of stability in a numerical value (e.g., 1: Completely stable: *standing/sitting undisturbed on solid ground*, 4: Unsteady: *feels like work to keep balanced, but still do not need to step OR reach*, 10: About to fall: *extremely challenged, have to step AND/OR grab support to keep balance*) [8]. The RPS scale has been shown to be independent of heart rate response during exercise that challenges balance, suggesting it measures perceived exercise intensity related to balance rather than exertion during the task [8].

In this study we aimed to determine the reliability and validity of the RPS scale in people with stroke. Our first aim measured the test-retest reliability over two separate days. We hypothesised that the RPS scores for each walking and balance task performed would demonstrate good test-retest reliability and agreement. Our second aim measured the concurrent validity of the RPS scale by exploring the relationship between RPS and (1) perception of task challenge, and (2) walking and balance performance as measured with self-paced gait speed, the 6-min walk test (6MWT), and 16 items from the Community Balance and Mobility (CB&M) Scale. We hypothesised that the RPS would be strongly associated with the self-rating of perception of challenge (rate of perceived challenge; 0-rest to 10-maximal challenge) in walking tasks and with clinical measurement of performance.

It has been reported that recovery outcomes related to walking ability post-stroke are consistently poorer in women, despite adjustment for baseline differences in age, pre-stroke function, and comorbidities [9,10]. These stroke recovery outcomes suggest that it is important to consider if there are any between sex differences in use of self-report clinical measures that may be employed during stroke rehabilitation. Therefore, a secondary third aim of this study is to explore if there are differences between males and females post-stroke when using the RPS scale to score perception of balance challenge.

Materials and methods

Participants

Thirty people with stroke living in the community who had previously participated in research in our lab were invited to participate in this cohort study. Inclusion criteria included: hemiparesis post-stroke, the ability to walk at least 10 m with or without a walking aid, and being at least 1-year post-stroke. Participants with expressive aphasia were included with adaptations to verbal reporting of RPS scores as needed. Individuals were excluded if, in addition to stroke, they had any health conditions that could limit their involvement in regular walking activity (e.g., neurological conditions unrelated to stroke, severe arthritis, cardiac or respiratory conditions). Participants provided informed written consent before participation. This study was approved by the University of British Columbia Clinical Research Ethics Board.

Experimental protocol

Participant and clinical characteristics

Descriptive measures of participants included age, time since stroke, type of stroke, severity of lower extremity impairment as measured using the Chedoke McMaster Stroke Assessment (CMSA) [11] and balance confidence as measured using the Activities-specific Balance Confidence scale (ABC) [12].

The CMSA lower extremity stage of motor recovery was determined by physical assessment of each participant's leg (/7) and foot (/7) over a standardized series of motor control tasks evaluated by a licensed physiotherapist. Stage 1 is summarized as the presence of flaccid paralysis and a score of 7 is summarized as normal movement [11]. The ABC is a self- report questionnaire in which individuals rate their degree of confidence in their ability to perform common activities within their community. The ABC assesses balance confidence by asking participants to rate their confidence on a scale of 0% (no confidence) to 100% (extremely confident) [12]. Both scales have been shown to be valid and reliable in people with stroke [11,13].

Measurement of balance and walking function

The following measures were administered on two separate days (minimum number of 2 days in between) within the span of ten days. On each day, participants were asked to complete a series of tasks which included: three repetitions of self-paced gait speed, sixteen tasks from the Community Balance and Mobility Scale (CB&M), and the 6-min walk test (6MWT). Participants were provided standby supervision by a physiotherapist during the tasks. Participants were asked to rate their perceived stability and challenge after each task using the RPS and the rate of perceived challenge (RPC). The RPC scores range from 0-rest to 10-maximal challenge reflecting how technically challenging a skill/task is for an individual [14]. The RPC was chosen as it provides a generalized (non-task specific) measure of internal technical skill load (e.g., 1-Not very challenging, 4-Somewhat challenging, 8-Very challenging) which we hypothesized would show a strong correlation to the more task-specific scaling of perception stability of the RPS during tasks that challenge balance. Therefore, this measure facilitated exploration of the extent to which the RPS score is associated with perception of challenge post-stroke. To control for order effects, the first fifteen participants were asked to report their RPS scores before their RPC scores and the last fifteen participants were asked to report their RPC scores before their RPS scores. To avoid biasing the participant's self-report score on both scales, the clinician was not allowed to provide feedback regarding the participant's performance.

Walking function

The self-paced gait speed test is a reliable measure of walking speed in people post-stroke [15]. The self-paced gait speed (m/s) was determined when walking 5 m at a constant speed, on an 8 m long walkway [15]. Participants provided their RPS and RPC ratings following completion of the test. The self-paced gait speed test was included as a measure of baseline walking function.

The 6MWT is a reliable and valid measure of endurance in people post-stroke [16]. During the 6MWT participants were instructed to walk as far as possible around a 24-m course over 6 min. At the three-minute mark, participants were asked to provide their RPS and RPC ratings (in counterbalance order) according to what they experienced at that moment. At the six-minute mark they were again asked to provide their RPS and RPC ratings which represented their perception at the end of the walk test. The total distance walked (metres) and the average walking speed (m/s) were calculated.

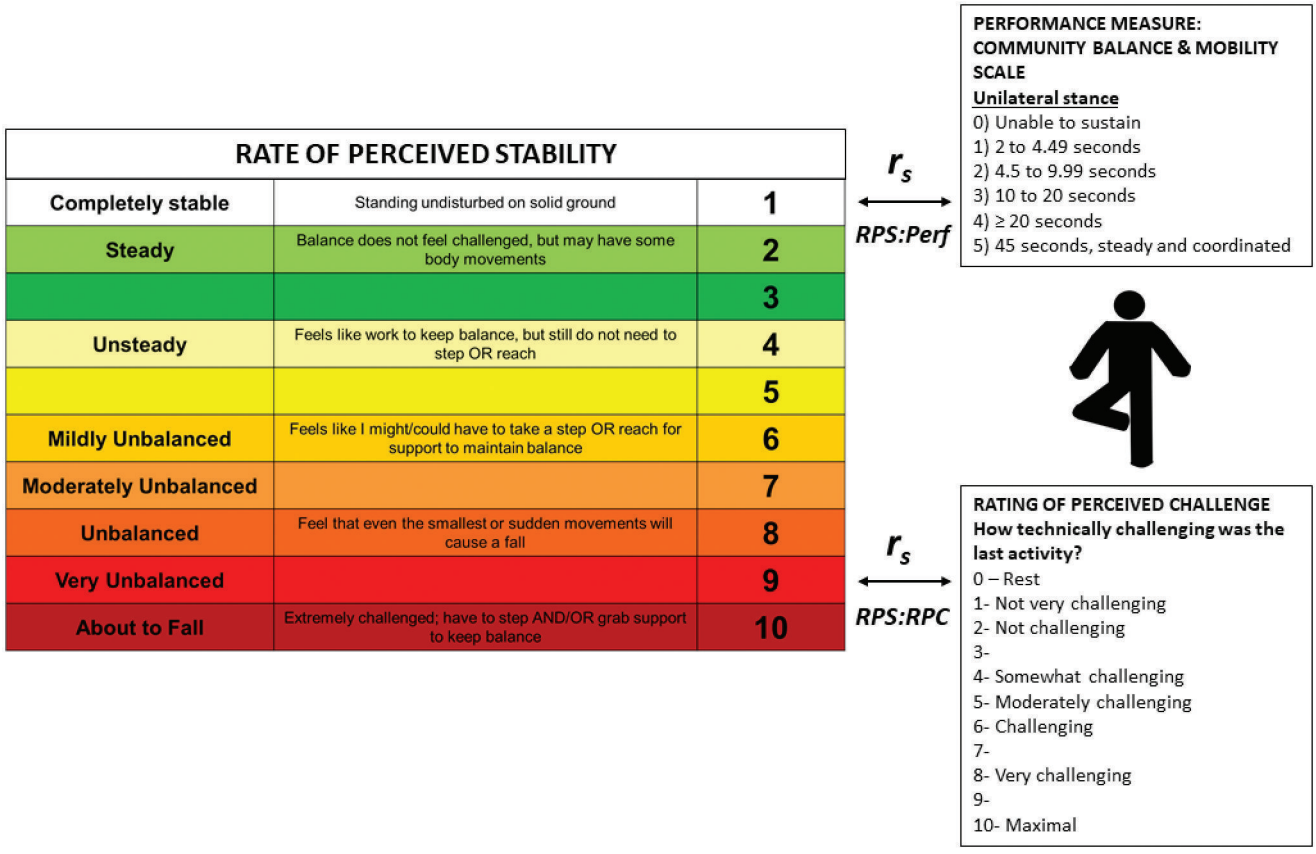

Figure 1. Relationships between rate of perceived stability [10] (RPS) and rating of perceived challenge [14] (RPS:RPC), measure of performance (RPS:Perf). Spearman correlation coefficients (r_s) were calculated between RPS and the individual task scoring on each of the CB&M tasks (example of unilateral stance task provided), 6MWT (distance walked) and self-selected gait speed to explore associations between RPS and task performance (RPS:Perf). Spearman correlation coefficients (r_s) were calculated between self-reported ratings on the RPS and RPC to explore the relationships between perception of stability and generalized challenge while performing balance and mobility tasks (RPS:RPC).

Balance function

The CB&M is valid and sensitive to assess changes in functional balance and mobility in ambulatory people post-stroke who have moderate to mild neurological impairments [17]. This scale includes tasks with a range of levels of difficulty and does not demonstrate a ceiling effect in people with stroke [17,18], (allowing us to see how RPS scores vary as task difficulty changes). All but two of the typically administered tasks of the CB&M were included. The two excluded tasks were, "Walk, Look and Carry" (walking while looking to the side and carrying weighted bags in both hands) and "Descending Stairs," which were excluded due to unfeasible equipment requirements. Upon completion of each task the participants were asked to rate their perceived stability during the task using RPS and perceived challenge using the RPC. Each task from the CB&M contributed to the data as an independent observation, and each single leg task was counted as an individual task for each leg separately (e.g., CBM1: Unilateral Stance, was split into two tasks, one performed on the non-paretic and the other performed on the paretic). Participants were scored on their performance for each task using the standardized CB&M scoring guidelines (0–5 for each task, total score for the modified scale/80).

Statistical analysis

Descriptive statistics were examined for all variables measured. A MANOVA was used to examine between-sex differences in participant and clinical characteristics (age, time since stroke, ABC, CMSA foot and leg) and clinical performance measures (CB&M total score, self-selected walking speed, 6MWT distance walked). For aim 1, test-retest reliability of the RPS was assessed between days with intraclass correlations (ICCs) using a two-way random-effects model with absolute agreement [19]. Additionally, the standard error of measurement (SEM), a measure of agreement and the smallest detectable change (SDC), defined as the smallest within-person change in score that, with $p = 0.05$, can be interpreted as a "real" change in an individual beyond measurement error, were calculated [20,21]. The SEM was calculated using the equation, $\text{s.d.} \times \sqrt{1 - \text{r}}$, where s.d. is the pooled standard deviation of task RPS scores over both days and r is the test–retest reliability coefficient of the measurement set [20,21]. The SDC was calculated using the equation, $1.96 \times \text{SEM} \times \sqrt{2}$ [20,21].

For aim 2, Spearman rank correlations quantified the relationship between: (1) RPS and RPC (RPS:RPC) during 19 tasks (16 tasks of the CB&M, self-paced gait speed, and minute number 3 and 6 of the 6MWT) and, (2) RPS and measures of task performance during 18 tasks (16 tasks of the CB&M, self-paced gait speed, and distance walked by minute number 6 of the 6MWT; Figure 1). Correlation coefficients were classified as; 0.25–0.50 fair relationship, 0.50–0.75 moderate-to-good relationship and, above 0.75 good-to-excellent relationship [22]. To explore the secondary aim of the study, a two-way ANOVA was used to test whether sex (between subject variable) and task (within subject variable) had effects on self-reported score RPS (dependent variable) and specifically test whether there was an interaction such that sex had effects on tasks scores. Statistical analyses were performed with

Table 1. Clinical characteristics.

Participant characteristics	Females	Males
Age (year, mean (SD)	65.5 (9.7)	65.1 (10.2)
Time since stroke (years, mean (SD)	7.6 (5.9)	9.4 (4.7)
Type of stroke (Ischaemic/haemorrhagic/unknown)	9/4/1	10/4
Hemiparetic side (right/left)	7R/7L	6R/8L
Use of Walking Aid (none/cane or pole/walker)	8/4/2	5/9/0
Ankle-foot orthosis (none/fixed/flexible)	9/1/4	10/2/2
Clinical measures[a]		
ABC (/100)	66.3 (20.8)	81.9 (13.6)
CMSA (foot/leg)	4.5 (2)/5.8 (1.3)	4.3 (2)/5.2 (1.6)
Self-paced gait speed (m/s)	0.7 (0.3)	0.8 (0.2)
6MWT distance walked (m)	283.2 (109.6)	329.3 (129.4)
Modified CB&M total score (/80)	26.8 (12.8)	25.7 (1.5)

[a]All clinical measures results presented as mean (SD).

SPSS version 24 (IBM corporation). Significance level was set at $p < 0.05$ and Benjamini-Hochberg tests were applied to control for multiple comparisons.

Results

Participants

Thirty participants (15 males and 15 females) with chronic stroke consented to participate. Participant characteristics are presented in Table 1. The participants' average Foot-CMSA and Leg-CMSA stage was 4–5/7. This represents a moderate level of impairment of the foot and leg post-stroke. The mean self-selected gait speed of 0.7 m/s for women and 0.8 m/s for men is demonstrative of limitations in abilities to ambulate at the level of unrestricted community ambulation [23].

There was no significant difference between males and females in age ($p = 0.96$), years since stroke ($p = 0.24$) or level of motor impairment as measured with the CMSA (foot, $p = 0.80$, leg, $p = 0.26$; Table 1). Balance confidence as measured with the ABC scale was significantly lower in female participants compared to males ($p = 0.03$; Table 1). Two males and two female participants had expressive aphasia and used both strategies of verbal reporting and pointing to report RPS and RPC values. Two participants (one male and one female) were not able to complete the walking measures on day 1 and therefore did not return for day 2. Data from these participants were not included for analysis ($n = 28$).

Clinical measures of walking function and balance are presented in Table 1. There was no significant difference between men and women in CB&M total score ($p = 0.73$), self-selected gait speed ($p = 0.18$) or 6MWT distance walked ($p = 0.32$). There were few instances where participants did not attempt a task due to participant/clinician perceived safety concerns (6 participants did not attempt step-ups leading with paretic leg without handrails, 2 participants did not attempt to hop on their paretic leg and 1 participant did not attempt to perform lateral foot scooting standing on the paretic leg). In these instances, participants did not grade their perception of stability.

Aim 1: reproducibility of the rate of perceived stability (RPS)

RPS scores for each task on each day are shown in Table 2. The ICC ranged from 0.46 to 0.93 across tasks with 12/19 tasks resulting in ICCs above 0.75 indicative of good test-retest reliability [22]. The tasks of Forward to Backward Walking and Self-selected Gait Speed demonstrated the lowest ICCs of 0.46 and 0.56 respectively. The remaining five tasks demonstrated ICCs between 0.61 and 0.69. The SEM was consistently one across all 19 tasks scored using the RPS. The SDC ranged from 2 to 4 across the 19 tasks (SDC of $2-8$ tasks, SDC of $3-8$ tasks and, SDC of $4-3$ tasks).

Aim 2: concurrent validity of rate of perceived stability (RPS)

Table 3 shows the Spearman's rho between the RPS and the RPC for balance task performed on day 1. Participants showed good-to-excellent relationship between RPS and RPC (RPS:RPC, r_s ranged from 0.78 to 0.94, $p < 0.01$) for each balance-specific task (CB&M tasks, 16/16 tasks). The lateral dodging task showed the strongest correlation ($r_s = 0.94$, $p < 0.01$) among all tasks, and the unilateral stance task on the non-paretic leg showed the weakest correlation ($r_s = 0.78$, $p < 0.01$). Walking tasks measuring self-paced gait speed ($r_s = 0.53$, $p = 0.003$) and the 3-min mark of the 6MWT ($r_s = 0.74$, $p < 0.01$) were the only 2 tasks to show a moderate-to-good RPS:RPC relationship.

The relationship between balance performance scores and RPS was consistently negative (Table 3). As participants reported higher RPS ratings (indicative of feeling less stable), they scored lower balance performance scores on the tasks of the CB&M. These negative relationships ranged in strength from fair to good-to-excellent in 10/16 tasks (r_s ranged from -0.46 to -0.81, $p \leq 0.01$). The relationship between RPS and self-paced gait speed (m/s) was not significant. The negative relationship between the final RPS score and the 6MWT distance walked was moderate-to-good ($r_s = -0.55$, $p = 0.003$). Higher ratings on the RPS (indicative of feeling less stable) were associated with decreased distance walked.

Aim 3: effect of sex and task on the rate of perceived stability (RPS)

Regarding the secondary aim of the study, examination revealed a statistically significant main effect for task ($F(18,482) = 22.22$, $p < 0.001$) but no significant main effect for sex ($F(1, 482) = 0.97$, $p = 0.33$) on RPS scores reported. There was no interaction effect between sex and task ($F(18, 482) = 0.72$, $p = 0.79$). This suggests that although RPS scores reported were significantly different between tasks, sex did not influence the RPS scores reported during walking function and balance tasks.

Discussion

Measurement of balance intensity during rehabilitation has been identified as a critical missing piece in the effective prescription and progression of exercise aimed at retraining of walking balance [6,7]. In this study we challenged the walking function and balance of participants with chronic stroke to examine the

Table 2. Rate of perceived stability (RPS) for each task (mean (SD) for day 1 and 2, and between day intraclass correlations (ICC), standard error of measurement (SEM (% mean) and smallest detectable change (SDC (% mean).

Task	RPS Day 1	RPS Day 2	ICC[a]	95% CI	*p*-Value	SEM[b]	SDC[b]
CB&M tasks							
Unilateral Stance Non-Paretic	6 (2)	5 (2)	0.64	0.23–0.84	0.002	1 (18%)	4 (73%)
Unilateral Stance Paretic	8 (2)	7 (2)	0.80	0.56–0.90	<0.001	1 (13%)	3 (40%)
Tandem Walking	7 (2)	6 (2)	0.80	0.55–0.91	<0.001	1 (15%)	3 (46%)
180 Tandem Pivot	7 (2)	7 (2)	0.69	0.34–0.86	0.001	1 (14%)	3 (43%)
Lateral Foot Scooting Non-Paretic	8 (2)	7 (2)	0.84	0.64–0.93	<0.001	1 (13%)	2 (27%)
Lateral Foot Scooting Paretic	9 (2)	9 (1)	0.77	0.47–0.90	<0.001	1 (11%)	2 (22%)
Hopping Forward Non-Paretic	8 (2)	7 (2)	0.91	0.80–0.96	<0.001	1 (13%)	2 (27%)
Hopping Forward Paretic	9 (2)	9 (2)	0.87	0.71–0.94	<0.001	1 (11%)	2 (22%)
Crouch and Walk (pick up objects from floor)	4 (2)	4 (2)	0.62	0.19–0.82	0.003	1 (25%)	3 (75%)
Lateral Dodging (cross-over steps)	7 (3)	6 (3)	0.92	0.82–0.97	<0.001	1 (15%)	2 (29%)
Walking and Looking Right	4 (2)	4 (2)	0.61	0.15–0.82	0.009	1 (25%)	4 (100%)
Walking and Looking Left	4 (2)	4 (2)	0.63	0.17–0.83	0.008	1 (25%)	3 (75%)
Running with Controlled Stop	4 (2)	4 (2)	0.86	0.69–0.93	<0.001	1 (25%)	2 (50%)
Forward to Backward Walking	*4 (2)*	*4 (2)*	*0.46*	*−0.20–0.75*	*0.064*	1 (25%)	4 (100%)
Step ups Non-Paretic	6 (3)	6 (3)	0.93	0.84–0.97	<0.001	1 (17%)	2 (33%)
Step ups Paretic	6 (3)	6 (2)	0.87	0.69–0.95	<0.001	1 (17%)	3 (50%)
Measures of walking ability							
Self-selected Gait Speed Test	3 (2)	2 (1)	0.56	0.09–0.79	0.009	1 (40%)	3 (100%)
6MWT at 3-minute mark	3 (2)	3 (2)	0.84	0.65–0.93	<0.001	1 (33%)	2 (67%)
6MWT at 6-minute mark	3 (2)	3 (2)	0.77	0.49–0.90	<0.001	1 (33%)	3 (100%)

[a]Non-significant task ICC results are italicized.
[b]SEM and SDC presented with percentage of mean score calculated from RPS Day 1 and 2 scores.

Table 3. Correlation coefficients between rate of perceived stability (RPS) and rating of perceived challenge (RPS:RPC), measure of performance (RPS:Perf).

Task	RPS:RPC (*rs*)	*p*-Value	RPS:Perf (*rs*)[a]	*p*-Value
CB&M tasks				
Unilateral Stance Non-Paretic	0.78	<0.001	−0.58	0.001
Unilateral Stance Paretic	0.83	<0.001	−0.46	0.010
Tandem Walking	0.87	<0.001	*−0.36*	*0.058*
180 Tandem Pivot	0.83	<0.001	*−0.36*	*0.061*
Lateral Foot Scooting Non-Paretic	0.81	<0.001	−0.53	0.004
Lateral Foot Scooting Paretic	0.85	<0.001	−0.53	0.005
Hopping Forward Non-Paretic	0.85	<0.001	−0.51	0.006
Hopping Forward Paretic	0.91	<0.001	−0.57	0.003
Crouch and Walk (pick up objects from floor)	0.82	<0.001	*−0.16*	*0.425*
Lateral Dodging (cross-over steps)	0.94	<0.001	−0.81	<0.001
Walking and Looking Right	0.81	<0.001	*−0.32*	*0.099*
Walking and Looking Left	0.88	<0.001	*−0.27*	*0.169*
Running with Controlled Stop	0.92	<0.001	−0.49	0.008
Forward to Backward Walking	0.89	<0.001	*−0.35*	*0.069*
Step ups Non-Paretic	0.92	<0.001	−0.72	<0.001
Step ups Paretic	0.90	<0.001	−0.61	0.002
Measures of walking ability				
Self-selected Gait Speed Test	0.53	0.003	*−0.26*[b]	*0.179*
6MWT at 3-minute mark	0.74	<0.001	na	na
6MWT at 6-minute mark	0.84	<0.001	−0.55[c]	0.003

[a]Non-significant association between RPS and performance scores are italicized.
[b]Association between RPS and walking speed during the self-paced gait speed test (m/s).
[c]Association between RPS and distance walked during the 6MWT (m).

reliability and validity of the RPS scale, a self-rating balance exercise intensity scale. The RPS showed generally good test-retest reliability between days and a 1-point SEM. Self-reported RPS scores reflected use of the full scale from 1 to 10 and scores were significantly different between tasks. Task specific RPS scores were not significantly different between males and females. Validation of the RPS with respect to both perception of general task challenge and task performance measurement was promising. In general, findings of lower levels of reliability of RPS scores and weaker relationships between the RPS scores and perception of task challenge or task performance tended to be present during tasks that were rated with a score of 4 or less on the RPS scale.

Our first aim established the test-retest reliability and agreement for RPS scores across 19 different tasks that challenge balance and mobility. Good levels of agreement between test days were noted with an SEM of 1-point across all tasks and RPS scores of 16/19 tasks showing measures of SDCs of 2–3. Reliability was good (i.e., ICC >0.75) [22] in 12/19 tasks. The remaining 7 tasks demonstrated ICC of 0.46–0.69. Interestingly, the majority of these tasks (5/7) were rated at an average RPS score of 3 or 4, whereas the majority of the 12 tasks with ICC greater than 0.75 were rated at higher RPS scores (>4) by participants with stroke. In line with this finding, four of the seven tasks of the CB&M that did not demonstrate an ICC >0.75 have previously been found to be the four easiest tasks in a Rasch analysis of the use of the CB&M in community-dwelling ambulatory adults with stroke [18]. The fifth of these tasks was the self-paced gait speed test that can be considered baseline walking function and simply asks the participant to walk as they typically would walk, therefore, providing little challenge. Taken together, this suggests that the RPS may be

considered most reliable when people with stroke rate their perception of stability above a 4: Unsteady: *feels like work to keep balanced, but still do not need to step OR reach*. Future research could explore this aspect of measurement specifically, including scaling of the lower ratings of 1–4.

One other scale has been created to measure participant rating of intensity during balance training. Farlie et al. [24] created the Balance Intensity Scale for Exercisers (BIS-E)– a tool enabling patient rating of balance exercise intensity for use in physiotherapy practice with mixed patient populations (5-point rating scale, "no effort at all" to "maximal effort"). Examination of this tool in a clinical setting demonstrated that reliability of the BIS-E was poor and the tool was unable to statistically distinguish between levels of balance intensity [24]. It was anticipated that this finding was somewhat impacted by a low level of difficulty of the tasks performed during therapy in the clinical setting during the study [24].

Our second aim found a good-to-excellent relationship between the RPS and the self-reported general level of task challenge, indicating that perception of stability while performing the task is associated with perception of how challenging the task is to perform for people with stroke. In the current study, the average RPS ratings for tasks performed ranged from 2 to 9. This data indicates that participants used the full range of the scale and that these scores are reflective of a range of perceptions of task challenge, critical to measurement of balance intensity. Interestingly, the self-paced gait task, was the only task to demonstrate a relationship between RPS and task challenge that fell outside of the good-to-excellent range ($r_s = 0.53$, moderate-to-good association). This task represents the least challenging task of all tasks performed in this study, as it simply asks the participant to walk as they normally would, with no additional challenge. The 6MWT has been shown to be a better method of assessing home and community walking activity than self-paced gait speed [16]. Importantly, previous studies have shown that balance was the strongest predictor of distance walked in the 6MWT in people post-stroke [25,26]. This relationship likely underpins our findings of a stronger relationship between RPS and perceived task challenge during the 6MWT compared to the self-paced gait speed task.

Validation of a participant's perception of balance intensity is challenged by not having a psychometrically sound tool that can measure how much a person's balance was actually challenged [6]. We addressed this challenge of validation by examining the relationship between the RPS and previously established functional performance scores of outcome measures of walking balance and walking performance. Tasks of the CB&M which were rated with higher levels of perception of instability on the RPS, were associated with lower scores of balance performance. Similar to the above noted findings describing test-retest reliability of RPS scores across tasks, four of the six tasks of the CB&M that did not demonstrate a significant relationship between performance measurement and the RPS rating have previously been found to be the four easiest tasks in a Rasch analysis of the use of the CB&M in community-dwelling ambulatory adults with stroke [18].

Taken together, examination of reliability and the relationship between RPS scores and measurement of task performance, in both tasks of the CB&M and walking performance measures, suggests that both reliability and concurrent validity of the RPS with performance is stronger in tasks that present a greater challenge to walking balance (e.g., beyond *4 – Unsteady, requires work to keep balance but does not need to take a step to maintain balance*). This is in-line with recent findings that patient ratings of task challenge during walking and balance tasks may lack valid representation of perception when the patients are not adequately challenged [24]. Clinically, the reliability and concurrent validity of the RPS with task challenge at levels greater than a RPS rating of 4 remains an important finding. It is likely that walking balance tasks employed during rehabilitation need to challenge people beyond this level of perceived stability to optimize rehabilitation of motor skills associated with walking balance.

Importantly, our third aim found no difference between males and females with respect to rating of RPS in each task. This is promising for future use of the scale in both males and females post-stroke. However, in contrast to this finding, females reported lower balance confidence measured with the ABC. Although this between group difference was not reflected in between group differences in RPS scores, future research should explore the potential impact of high vs low balance confidence on RPS scores reported (e.g., do people with lower balance confidence simply rate all tasks performed as more challenging to stability). Another important observation in the present study was that all four participants with expressive aphasia were able to use both verbal and pointing forms of communication to express their RPS score. However, this aspect of clinical utility also requires further study.

A limitation of the current study is that findings can only be generalized among the chronic stroke population. It is important to understand perception of balance exercise intensity in people with acute and sub-acute stroke as this is a time period of significant change in walking abilities [27]. Future studies should explore the use of the RPS in people actively undergoing rehabilitation of walking, including the transition to independent walking post-stroke. Inclusion of participants with a broader range of walking abilities in the sub-acute phase post-stroke would also benefit from a larger sample size to explore the use of the RPS during active rehabilitation. Finally, the RPC has not been specifically validated in use with people post-stroke, however, due to the generalizability of the 0–10 scale and its anchors (e.g., very challenging, moderately challenging, not very challenging) it is unlikely that this lack of validation would impact current findings.

Conclusion

Our findings suggest that the RPS shows promise as a reliable and valid (concurrent validity) measure of balance intensity in ambulatory people with stroke. Numerical ratings of perceived stability are grounded in meaningful descriptions of levels of stability to assist the individual in being able to capture their perception of task challenge as it relates to balance intensity. Importantly, these descriptors are also clinically meaningful and provide the clinician with valuable insight into the person with stroke's perception of their own abilities when their balance is challenged. This insight of intensity specific to balance can inform an individualized approach to exercise prescription and progression when retraining walking and walking balance post-stroke. The RPS scale may address the gap in practice of measuring balance intensity during rehabilitation of walking balance post-stroke.

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