Toronto Perturbation-Based Balance Training

Program Manual

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LIST OF ABBREVIATIONS

AFO = ankle-foot orthosis
BOS = base of support
BP = blood pressure
CMSA = Chedoke-McMaster Stroke Assessment
DF = dorsiflexion
EV = eversion
HR = heart rate
INV = inversion
Mini-BES = Mini Balance Evaluation Systems (test)
PBT = perturbation-based balance training
PF = plantarflexion
RPC = rating of perceived challenge
TUG = timed-up and go

INTRODUCTION

The **goal of PBT** is to improve reactive balance control in order to optimize safe independent mobility. The program requires that individuals repeatedly experience loss of balance (i.e., internal or manual postural perturbations) and are provided the opportunity to practice stepping reactions to regain balance following this instability. As participants adapt to the challenge and improve their balance control, the challenge should be increased. Challenge can be increased by increasing the magnitude of the manual perturbation, adding more challenging secondary movement and cognitive tasks, removing or altering sensory feedback, and changing the environment.

Note, for convenience and clarity of expression in this document, we use feminine pronouns to refer to the treating physiotherapist, and masculine pronouns to refer to the participant.

1. SCREENING AND ASSESSMENT

1.1 An initial assessment is required to inform and guide treatment, and ensure patient safety.

Information regarding significant medical history is obtained; specifically, does the participant:

- Have arthritis in the lower extremities or any other joint pain;
- Normally wear glasses or contact lenses;
- Normally use a cane, a rollator, or any other mobility aid;
- Normally wear an orthotic (brace) around the ankle and/or knee;
- Normally wear a sling around the arm/shoulder;
- Have diabetes;
- Take any medication on an "as needed" basis (i.e., PRN medication);
- Report any recent falls; and
- Have fear of falling?

Modifications to the manner in which the program is provided may be made based on responses to the questions above. For example, some activities might be avoided to prevent exacerbation of a previous injury.

The initial assessment includes:

- Assessment of reactive stepping using
    - Forward-fall lean-and-release perturbations under two conditions: usual response and encouraged use (5 trials per condition); and
    - Observation of reactions in the 'Reactive' component of the mini-Balance Evaluation Systems (mini-BES) test.
- Consideration of some of the contributors to impaired reactive stepping:
    - Stroke severity/stroke symptoms – e.g., using the National Institutes of Health Stroke Scale;
    - Stage of motor recovery – e.g., using the Chedoke McMaster Stroke Assessment (CMSA);
    - Balance confidence – e.g., using the Activity-specific Balance Confidence scale; and
    - Sensation (see Sections 1.4 and 1.5).

1.2 Lean and release assessment instructions.

Control of reactive stepping following a postural perturbation is assessed using a lean-and-release system. Participants wear a safety harness attached to an overhead support system. The harness is also connected at the back to a beam via a quick-release mechanism (i.e., a modified crossbow trigger). The participant must lean forward from the ankles far such that approximately 10% of his body weight supported by the cable. Once achieved, the cable is released creating a forward fall from which the participant needs to recover. He is instructed step as quickly as possible to regain balance and come to stable stance. If he cannot regain stability independently, then the assessor can aid in the recovery and prevent a 'fall' (i.e., being caught by the safety harness).

Two conditions are assessed and recorded on the score sheet (see Section 1.3) – the 'usual response' and the 'encouraged use'. The first five trials are completed as described above and the limb that

responds first to the release is recorded. This is the **'usual response'**. If the same limb responds ≥4/5 times, this is considered to be the 'preferred limb'. In the **'encouraged use'** condition, five trials are completed with the preferred limb blocked and the participant is instructed to attempt to react with the non-preferred limb. The blocking is accomplished with the hand or foot of the physiotherapist/assessor. If it appears that the participant is going to step with the blocked limb, the hand/foot can be removed quickly, but the participant is not told that the block will be removed. If there is no obvious preferred limb (i.e., participant stepped 3 times with one leg and 2 with the other), then the limb that is blocked should alternate 2 times for one limb and 3 for the other.

The lean-and-release assessment is video-recorded and the video is reviewed later to observe any participant-specific impairments in reactive stepping (see also Section 4). While it might be possible to observe some obvious impairments in 'real time', often the reaction happens so quickly that this is not possible.

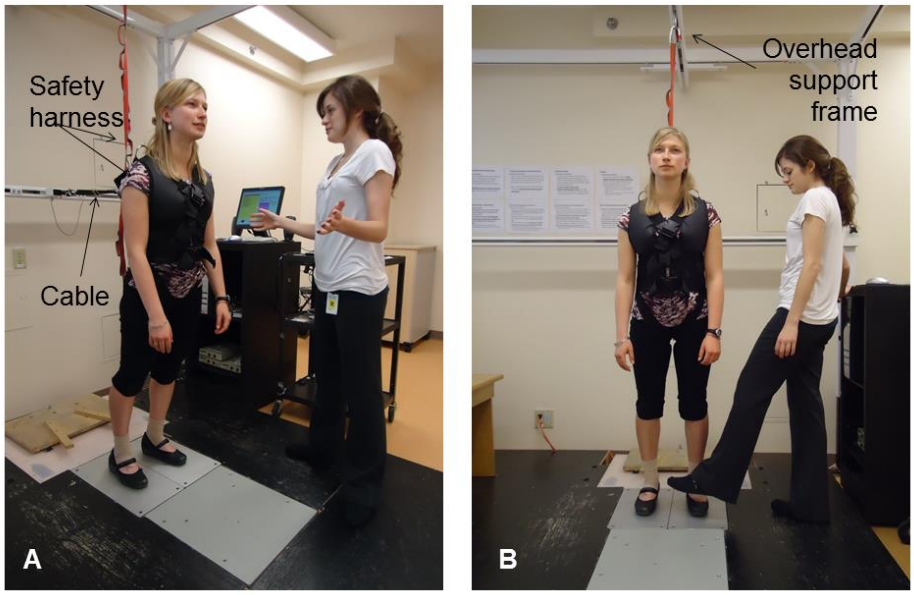

Figure 1.1: The lean-and-release system. Panel A (left) shows the usual response condition. Panel B (right) shows the encouraged-use condition. Figure taken from Mansfield et al., BMC Neurol. 2015;15:87

1.3 Lean and release collection sheet.

Usual response

- ❑ Participant wearing harness
- ❑ Aim for 10% body weight on the cable
- ❑ Random delay between 'ready' signal and perturbation
- ❑ Review video to determine preferred limb & assists (if not clear during testing)
- ❑ Record limb for first step

Test	Trial #	Comments	Limb	Assist
1			❑ Right ❑ Left	❑ No ❑ Yes
2			❑ Right ❑ Left	❑ No ❑ Yes
3			❑ Right ❑ Left	❑ No ❑ Yes
4			❑ Right ❑ Left	❑ No ❑ Yes
5			❑ Right ❑ Left	❑ No ❑ Yes

Preferred limb (initiated stepping in ≥4/5 trials with this limb):

- ❑ Right
- ❑ Left
- ❑ No clear preference

Encouraged use

- ❑ Block preferred limb with researchers hand/foot; if no limb preference do two trials blocking one limb and three blocking the other
- ❑ Aim for 10% body weight on the cable
- ❑ Random delay between 'ready' signal and perturbation
- ❑ Review video to determine preferred limb & assists (if not clear during testing)
- ❑ Record limb for first step

Test	Trial #	Comments	Limb	Assist
6			❑ Right ❑ Left	❑ No ❑ Yes
7			❑ Right ❑ Left	❑ No ❑ Yes
8			❑ Right ❑ Left	❑ No ❑ Yes
9			❑ Right ❑ Left	❑ No ❑ Yes
10			❑ Right ❑ Left	❑ No ❑ Yes

1.4 Sensation assessment instructions.

Exteroceptive and proprioceptive sensation are assessed in the affected foot and ankle. It is necessary to know if the participant appreciates light touch and movement of the ankle and foot. If these are absent or decreased, steps should be taken to accommodate the deficits in order to minimize potential injury due to PBT.

Sensation is assessed with the participant sitting on a raised plinth, feet dangling, with shoes and socks removed. Demonstration of the test should be done with the participant's eyes open and administered to the less-affected foot/ankle. The actual test should be administered to the more-affected foot/ankle following the demonstration with the participant's eyes closed.

Light touch is assessed using a cotton ball; the cotton ball should lightly touch but not brush the sole of the participant's foot. The foot is touched 5 times and the participant is instructed to respond when the touch is felt. Responses are recorded on the score sheet (see Section 1.5). If there is no response (and you are certain that the participant understood the instructions) this is recorded as a negative response.

The **perception of joint movement** is assessed in the ankle (dorsiflexion and plantar flexion) and in the foot (inversion and eversion). The participant's foot is held in two places: the bony prominences of the first and fifth meta-tarsal phalangeal joints and at the medial and lateral malleoli. Movements of the ankle should be demonstrated on the less-affected side as "up" for dorsiflexion and "down" for plantar flexion and, of the foot, as "in" for inversion and "out" for eversion. Care should be taken not to change the pressure of the hold during the movement. When being tested, movements should be through small ranges and time should be allowed for the participant to respond. If the participant is unsure of the direction of the movement, the range should be increased. If the participant is still unsure, then this is a negative response for the test. Five movements should be tested at the ankle and five at the foot.

Each correct, incorrect, or absent response is recorded on the score sheet (Section 1.5). If the participant scores <4/5 for light touch appreciation, and/or <8/10 for joint movement perception, then consideration is made for use of an Aircast Airsport Ankle Brace during training.

1.5 Sensation assessment collection sheet.

Position recognition

Position	Correct response?
Dorsiflexion	❑ Yes ❑ No
Plantarflexion	❑ Yes ❑ No
Dorsiflexion	❑ Yes ❑ No
Dorsiflexion	❑ Yes ❑ No
Plantarflexion	❑ Yes ❑ No
Number correct	

Position	Correct response?
Inversion	❑ Yes ❑ No
Eversion	❑ Yes ❑ No
Inversion	❑ Yes ❑ No
Eversion	❑ Yes ❑ No
Eversion	❑ Yes ❑ No
Number correct	

If number correct is <8/10, an AirSport ankle brace should be used to prevent injury during PBT.

Light touch sensation

Trial	Correct response?
Trial 1	❑ Yes ❑ No
Trial 2	❑ Yes ❑ No
Trial 3	❑ Yes ❑ No
Trial 4	❑ Yes ❑ No
Trial 5	❑ Yes ❑ No
Number correct	

If number correct is <4/5, an AirSport ankle brace should be used to prevent injury during PBT.

2. PLANNING THE PROGRAM

2.1 The program is individualized to the participant's specific impairments in reactive balance control

In order to create an effective training program, consideration is made of the participant's unique areas of dyscontrol (identified on initial assessment; see Section 1). Section 4 (Perturbation Training Log) outlines areas of dyscontrol and suggested treatment approaches for each problem. The principle of individual differences considers an individual's response to exercise. Therefore, progression should be gradual and systematic and occur at the individual participant's rate of improvement. Task difficulty is not absolute and could vary from participant-to-participant depending on specific control problems and other deficits.

2.2 List of equipment

The following equipment is required for this specific program:

- Overhead harness support track;
- Fall-arrest approved safety harness;
- Equipment for task-specific activities:
    - Thin foam mat (e.g., thickness of yoga mat or 2.5 cm gym mat);
    - Thick foam pad (dense blue foam);
    - Hand ball (2 sizes; e.g., 10 cm diameter and tennis ball);
    - Soccer ball;
    - Steps (10 cm and 20 cm high);
    - Stop watch;
    - Unstable 'step' (if an unstable step is not available, place a regular step on a thin foam mat);
    - Cross marked out in tape on the floor (2 pieces of tape each at least 60 cm long placed to intersect at right angles (see Figure 6.24);
    - Set of 6 – 23 cm diameter multi-colored Agility Dots;
    - Foam obstacles (e.g., pool noodles or half-round foam rollers); and
- Participant-specific equipment (e.g., walking aid, ankle brace/orthosis, helmet, arm sling).

2.3 Ensuring safety during training

2.3.1 Safety harness

Participants wear a safety harness attached to an overhead track at all times to prevent a fall to the ground. However, the harness system should be used as a back-up; the supervising physiotherapist still intervenes and provides physical assistance to 'brake the fall' when she feels the individual will not be able to recover balance. (Note, to allow participants the opportunity to practice stepping reactions, the physiotherapist ***only*** provides hands-on assistance if the participant is unable to regain stability alone.) The harness can prevent a fall to the floor but cannot prevent all possible injuries. Appropriate selection of participants, consideration of their underlying impairments, and appropriate supervision is still required. For example, it is possible that an individual could experience an ankle sprain while stepping in response to a perturbation (see Section 2.3.2). It is also possible that a frail individual who falls completely into the harness will experience an injury (e.g., bruise) because he is caught by the safety harness; a fracture could also be possible with a participant who has very low

bone mineral density. Participants should not be left 'dangling' in the safety harness as the straps can restrict circulation.

2.3.2 Protective equipment for ankle

An ankle-foot orthosis (AFO; if prescribed) or an Aircast AirSport Ankle Brace is used during PBT if the participant meets one or more of the following criteria:

- Participant typically uses an AFO during home and/or community walking;
- CMSA foot score is stage 3 or lower;
- Ankle joint position sense score is <8/10 (see Section 1.4 and 1.5);
- Light touch sensation of the plantar surface of the foot score is <4/5 (see Section 1.4 and 1.5); and/or
- The treating physiotherapist feels this is necessary to preserve stability of the ankle joint and prevent injury.

Use of the AirSport Ankle Brace, AFO, or any other assistive devices should be documented in the Perturbation Training Log (Section 4).

2.3.3 Monitoring heart rate and blood pressure

Heart rate (HR) and blood pressure (BP) are taken from the less affected arm using an automatic BP cuff. The less-affected arm is repositioned in an extended position resting on a table slightly below the level of the heart. If BP and/or HR fall outside of an 'acceptable' range (systolic BP is outside 90-140 mmHg; diastolic BP is outside 60-90 mmHg; or, HR is outside 60-100 bpm), a second measure is obtained. If the values continue to be outside of the range, the participant is asked to sit quietly for 5 minutes and perhaps, take a few deep breaths or drink a glass of water, before taking a third measurement. Participants with HR/BP measurements outside of the acceptable range are also questioned regarding recent medications (what they have taken and when, or if they have not taken their usual medications), when they last had something to eat/drink, and if the recently took caffeine, exercised, or smoked. The decision to continue or terminate the session is made by the physiotherapist considering factors such as the participants' usual resting HR/BP, how far the measured values are outside of the acceptable range, the participants' usual medication (e.g., beta-blockers), and the participants' perception of how they are feeling. If the visit is terminated, the physiotherapist may advise that the participant follow-up with his primary care physician. If the visit continues, the physiotherapist may choose to monitor HR and BP regularly throughout the visit and observe cardiovascular responses to exercise.

3. THE PROGRAM

3.1 Overview

The PBT program involves 12 1-hour training sessions provided 2 times per week for 6 weeks. Each session is 60 minutes in length and is provided in a one-to-one format. This core program is modified to fit with delivery of in-patient rehabilitation to allow for evaluation among individuals with sub-acute stroke.

Sessions begin with a 10-minute warm-up and end with a 10-minute cool-down following the warm-up and cool-down from the Keep Moving with Stroke program. Each session involves a minimum of ten 'voluntary' tasks that are each practiced for about 2 minutes. Once the participant is comfortable doing the task, the physiotherapist provides a manual perturbation to cause the participant to lose balance with the intent of evoking a reactive step (see Section 3.3). Six external perturbations are provided per task such that there are 60 external perturbations per session; however, fewer perturbations may be performed if participant tolerance is low. Participants might also experience a loss of balance (i.e., internal perturbation) due to failure to properly control balance during the voluntary task. Intensity of the session is determined by participant response; the participant should successfully regain stability with 1 or 2 steps and no assistance from the physiotherapist or safety harness 50% of the time. If the participant is too 'successful', the level of challenge is increased, or vice versa.

3.2 Voluntary Tasks

Each session involves 'voluntary' tasks that progress along a mobility continuum to evoke internal perturbations (i.e., loss of balance or self-destabilization):

a) 'Stable' – the voluntary task is to maintain a static base of support;
b) 'Quasi-mobile' – the voluntary task is to move the feet (e.g., stepping forward with alternate feet); however, the participant remains in place;
c) 'Mobile' – the voluntary task is to move from one location to another (e.g., walking, side-stepping); and
d) 'Unpredictably mobile' – the voluntary task is to move from one location to another in an unpredictable manner (e.g., kicking a soccer ball).

The challenge of each voluntary task can be influenced by manipulating other factors, such as:

a) The sensory condition (e.g., firm to compliant surfaces, eyes open to eyes closed).
b) The cognitive requirements (e.g. single task to multi-task, counting backwards, moving on cue).
c) The environment (e.g., walking on even surface to walking over obstacles).

See "Description of Voluntary Tasks" in Section 5 for further information.

3.3 Methods of Perturbation

Internal perturbations are evoked when the participant attempts to perform a task that causes instability. Various voluntary tasks, including rapid 'agility' tasks (e.g., rapid step-ups) are used to evoke internal perturbations. A task that appears as easy as standing with eyes closed may cause an internal perturbation for a participant with poor balance control. However, some participants do not put themselves in situations causing a loss of balance or necessitating a stepping reaction (i.e., they will

perform agility tasks slowly); therefore, external perturbations are also included in every session to ensure a sufficient training dose.

External perturbations are caused by a force outside of the participant's control. Small-magnitude external perturbations may be used with participants who have lower functional abilities. It is usually easiest to start with perturbations that cause a fall towards the physiotherapist (i.e., pull or lean-and-release) so that the physiotherapist can control the outcome and alleviate participants' anxiety and facilitate participants' perceptions of safety. There are three methods for evoking external perturbations: 1) lean-and-release (predictable direction/magnitude; 2) push/pull (can be unpredictable in terms of direction and magnitude; or 3) trip during walking (see Section 5 for details).

3.4 Measurement

Measures are taken throughout the training to ensure: 1) focus on participant-specific problems; 2) ongoing progression; and 3) participant safety. The Perturbation Training Log (Section 4) is used to document the following:

- Performance on reactive stepping linked to key areas of focus (e.g., if a goal is to reduce frequency of multiple stepping then frequency of multiple stepping should be documented);
- Number of repetitions (i.e., number of times the participant experiences a loss of balance): '0' = balance recovered using 2 steps or fewer; '1' = balance recovered using more than 2 steps; and, 'X' = assistance provided by the safety harness or physiotherapist to recover balance;
- Additional tasks/conditions;
- Number of rest breaks;
- 'Rating of perceived challenge' (RPC) (Section 6);
- HR and/or BP (if indicated);

3.5 Format of training session

1) Participant arrives.
2) HR and BP are taken.
3) Warm-up is completed.
4) Harness is donned.
5) Tasks, as outlined in the Perturbation Training Log (Section 4), are performed for that particular session. Detailed descriptions of each task can be found in Section 5.
6) Documentation about and scoring of each task are completed before moving on to the next task.
7) Rest is taken as required, or after each task.
8) Cool-down and stretching are completed.

4. PERTURBATION TRAINING LOG

Participant ID: _____

Affected side of body: _____ **Does HR &/or BP need monitoring through session?** Y N

Harness size: _____ **Participant Equipment:** AFO AirsSport Arm Sling Other

Participant Goal(s):

_____

_____

Highlights of Assessment Findings:

CMSA stage (/7): Leg _____ Foot _____

Position Recognition (#correct/5): DF/PF _____ INV/EV _____

Light touch (#correct/5): _____

Berg balance scale (/56): _____

Mini-BES - Reactive Postural Control (/12): _____

TUG (sec): _____

Lean & Release – Preferred trials (#): Right _____ Left _____

Lean & Release – Encouraged use trials (#): Right _____ Left _____

Comments:

_____

Participant ID: _____ Date: _____

Treatment planning:

Area of dyscontrol	Treatment suggestions	Additional treatment strategies/comments
❑ Requires external assist to regain stability	❑ Start with low-magnitude perturbation, increase magnitude as tolerated ❑ Consider other problems that contribute, like delayed stepping or no stepping	
❑ Does not step when magnitude of perturbation requires a step	❑ Instruct participant to step when s/he feels unstable ❑ Start with low-magnitude perturbations ❑ Start with predictable time/direction of perturbation ❑ Practice the step prior to perturbation ❑ Consider other problems that contribute, like unwillingness to step with paretic limb	
❑ Has low foot clearance during step: foot 'slides', or shuffles	❑ Use obstacles to 'force' a step-over	
❑ Demonstrates delayed stepping reaction	❑ Instruct participant to step as quickly as possible ❑ Start with predictable time/direction of perturbation ❑ If delay is with non-paretic limb, have participant weight-shift to paretic limb prior to perturbation	

Area of dyscontrol	Treatment suggestions	Additional treatment strategies/comments
❑ Is unwilling to step with paretic limb	❑ Block the non-paretic limb with obstacles, or hand/ foot of physiotherapist ❑ Instruct participant to step with paretic limb ❑ Start with predictable time/direction of perturbation ❑ Time perturbation to coincide with paretic leg/foot being un-weighted	
❑ Demonstrates multi-step reactions	❑ Instruct participant to take as few steps as possible ❑ Instruct participant to take long(er) steps	
❑ Stands asymmetrically prior to perturbation	❑ Instruct participant to increase loading on the less-loaded limb ❑ Consider using video or feedback of stance symmetry	
❑ Takes short steps	❑ Instruct participant to take longer steps ❑ Step to targets ❑ Step over obstacles	
❑ Attempts to use upper extremity to regain stability	❑ Physiotherapist should stand as far away as safely possible ❑ Instruct to not use reach-to-grasp reactions ❑ Have participant hold object to prevent grasping	

Area of dyscontrol	Treatment suggestions	Additional treatment strategies/comments
❑ Falls laterally on step termination	❑ Instruct participant to take as few steps as possible ❑ Start with low-magnitude perturbation ❑ Try forward/backward perturbations initially with a narrow base of support	
❑ Uses 'crossover' steps to respond to lateral perturbations	❑ Instruct participant to use side-stepping strategy ❑ Place large obstacles in front and behind participant to deter cross-overs	
❑ Is unable to step equally well in all directions	❑ Use multi-directional perturbations ❑ Do more perturbations in the most challenging direction	

'Stable' tasks*: *session 1

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Standing still with feet hip-width apart	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, eyes closed	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, on a thin foam mat	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, on a thick foam pad	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, turning head left and right	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, looking up and down	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing with feet hip-width apart, counting backwards by 3's	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				

Voluntary task	Adaptation to reduce difficulty	Adaptation to increase difficulty	Perturbation	Outcome (0=≤2 steps, 1=multi step, X=loss of balance)	RPC	# Rests during task	Rest after task (Y/N)
Standing with feet hip-width apart, eyes closed & counting backwards by 3's	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing with feet hip-width apart, rapid weight-shifting left and right	❑ Wide BOS	❑ Feet together	6 multi-directional push/pull				
Standing with feet hip-width apart, or in stride position, rapid weight-shifting forward and backward	❑ Wide BOS	❑ Feet together	6 multi-directional push/pull				
Standing with feet hip-width apart, throwing & catching a ball	❑ Wide BOS	❑ Feet together	internal				
Standing with feet hip-width apart, rapid arm raises forward and to the sides	❑ Wide BOS	❑ Feet together	internal				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

_____

_____

_____

'Stable' tasks*: *Session 2

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Standing still with feet hip-width apart	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, eyes closed	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, on a thin foam mat	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, on a thick foam pad	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, turning head left and right	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing still with feet hip-width apart, looking up and down	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing with feet hip-width apart, counting backwards by 3's	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing with feet hip-width apart, eyes closed & counting backwards by 3's	❑ Wide BOS	❑ Feet together	6 multi-directional lean-and-release				
Standing with feet hip-width apart, rapid weight-shifting left and right	❑ Wide BOS	❑ Feet together	6 multi-directional push/pull				

Voluntary task	Adaptation to reduce difficulty	Adaptation to increase difficulty	Perturbation	Outcome (0=≤2 steps, 1=multi step, X=loss of balance)	RPC	# Rests During task	Rest After task (Y/N)
Standing with feet hip-width apart, or in stride position, rapid weight-shifting forward and backward	❑ Wide BOS	❑ Feet together	6 multi-directional push/pull				
Standing with feet hip-width apart, throwing & catching a ball	❑ Wide BOS	❑ Feet together	internal				
Standing with feet hip-width apart, rapid arm raises forward and to the sides	❑ Wide BOS	❑ Feet together	internal				
Rapid stepping forward with alternate feet	❑ Short steps	❑ Long steps	internal				
Rapid stepping backward with alternate feet	❑ Short steps	❑ Long steps	internal				
Rapid stepping to the right (right foot)	❑ Short steps	❑ Long steps	internal				
Rapid stepping to the left (left foot)	❑ Short steps	❑ Long steps	internal				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

_____

_____

_____

'Quasi-mobile' tasks: Session 3

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid stepping forward with alternate feet	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping backward with alternate feet	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping to alternate sides	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid tap-ups forward with alternate feet	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Walking in place	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				
Rapid stepping forward with alternate feet, on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping backward with alternate feet, on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid stepping to alternate sides, on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid tap-ups forward with alternate feet, on a thin foam mat	❑ Low step Step Height: ____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Walking in place, on a thin foam mat	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Quasi-mobile' tasks: Session 4

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid stepping forward and backward with right foot	❑ Short steps; rest in stance	❑ Long steps	6 multi-directional push/pull				
Rapid stepping forward and backward with left foot	❑ Short steps; rest in stance	❑ Long steps	6 multi-directional push/pull				
Rapid tap-ups forward with alternate feet	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Rapid step-ups with alternate feet	❑ Low step Step Height: _____	❑ Unstable surface (e.g. dense foam)	6 multi-directional push/pull				
Rapid tap-ups to alternate sides	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Rapid stepping forward and backward with right foot, on a thin foam mat	❑ Short steps; rest in stance	❑ Long steps	6 multi-directional push/pull				
Rapid stepping forward and backward with left foot, on a thin foam mat	❑ Short steps; rest in stance	❑ Long steps	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid tap-ups forward with alternate feet, on a thin foam mat	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Rapid step-ups with alternate feet, on a thin foam mat	❑ Low step Step Height: _____	❑ Unstable surface (e.g. dense foam)	6 multi-directional push/pull				
Rapid tap-ups to alternate sides, on a thin foam mat	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Quasi-mobile' tasks: Session 5

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid stepping forward and backward with right foot	❑ Short steps; rest in stance	❑ Long steps	6 multi-directional push/pull				
Rapid stepping forward and backward with left foot	❑ Short steps; rest in stance	❑ Long steps	6 multi-directional push/pull				
Rapid stepping to alternate sides	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid diagonal forward stepping with alternate feet	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Walking in place	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				
Walking in place, eyes closed	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				
Rapid stepping with alternate feet in random cued direction	❑ Short steps	❑ Long steps	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid step-ups with alternate feet	❑ Low step Step Height: _____	❑ Unstable surface (e.g. dense foam)	6 multi-directional push/pull				
Rapid tap-ups forward with alternate feet	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Rapid tap-ups to alternate sides	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Quasi-mobile' tasks: Session 6

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Rapid stepping forward with alternate feet	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping backward with alternate feet	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping to alternate sides	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Walking in place, eyes closed	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				
'Jogging' (or fast walking) in place	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				
Rapid diagonal forward stepping with alternate feet	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping with alternate feet in random cued direction	❑ Short steps	❑ Long steps	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
'Jogging' (or fast walking) in place, on a thin foam mat	❑ Feet barely off floor	❑ Knees to hip-height	6 multi-directional push/pull				
Rapid diagonal forward stepping with alternate feet, on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Rapid stepping with alternate feet in random cued direction, on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Mobile' tasks: Session 7

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Walking forward	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Walking forward, turning head left and right	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Walking forward, looking up and down	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Walking and stepping over obstacles	❑ Low/short obstacles Define: _____	❑ High/long obstacles Define: _____	6 multi-directional push/pull				
Forward braiding	❑ Walk on the line	❑ Step further across; long steps; traffic light	6 multi-directional push/pull				
Side stepping	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Turning on the spot (alternate between turning to the left and to the right)	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Turning on the spot with eyes closed (alternate between turning to the left and to the right)	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				
Turning on the spot, in cued direction	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				
Four square stepping	❑ Short steps	❑ Long steps	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Mobile' tasks: Session 8

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Walking forward	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Walking backward	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Walking forward with eyes closed	❑ Short steps; walk slowly	❑ Long steps; walk quickly	6 multi-directional push/pull				
Tandem walking forward	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Side stepping	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Sideways braiding	❑ Steps not fully crossed	❑ Traffic light	6 multi-directional push/pull				
Side stepping over obstacles	❑ Low/short obstacles Define: _____	❑ High/long obstacles Define: _____	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Turning on the spot (alternate between turning to the left and to the right)	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				
Turning on the spot in cued direction	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				
Four square stepping	❑ Short steps	❑ Long steps	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Mobile' Tasks: Session 9

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Walking forward on a thin foam mat	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Walking backward on a thin foam mat	❑ Short steps; walk slowly	❑ Long steps; traffic light	6 multi-directional push/pull				
Side stepping on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Four square stepping on a thin foam mat	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Tandem walking forward	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Tandem walking backward	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Sideways braiding	❑ Steps not fully crossed	❑ Traffic light	6 multi-directional push/pull				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Turning on the spot with eyes closed (alternate between turning to the left and to the right)	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				
Forward braiding	❑ Walk on the line	❑ Step further across; long steps; traffic light	6 multi-directional push/pull				
Walking forward with eyes closed	❑ Short steps; walk slowly	❑ Long steps; walk quickly	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Mobile' tasks: Session 10

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Tandem walking forward	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Tandem walking backward	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Forward braiding	❑ Walk on the line	❑ Step further across; long steps; traffic light	6 multi-directional push/pull				
Backward braiding	❑ Walk on the line	❑ Step further across; long steps; traffic light	6 multi-directional push/pull				
Tandem walking forward on a thin foam mat	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Tandem walking backward on a thin foam mat	❑ Not heel-toe; steps close to line	❑ Traffic light	6 multi-directional push/pull				
Forward braiding on a thin foam mat	❑ Walk on the line	❑ Step further across; long steps; traffic light	6 multi-directional push/pull				

Voluntary task	Adaptation to reduce difficulty	Adaptation to increase difficulty	Perturbation	Outcome (0=≤2 steps, 1=multi step, X=loss of balance)	RPC	# Rests during task	Rest after task (Y/N)
Backward braiding on a thin foam mat	❑ Walk on the line	❑ Step further across; long steps; traffic light	6 multi-directional push/pull				
Sideways braiding on a thin foam mat	❑ Steps not fully crossed	❑ Traffic light	6 multi-directional push/pull				
Turning on the spot with eyes closed in cued direction	❑ Turn slowly	❑ Turn quickly	6 multi-directional push/pull				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Mobile & Unpredictable' Tasks: Session 11

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Kicking soccer ball against wall	[none]	❑ Stand further from wall; kick outside BOS; kick with each leg	6 perturbations: PT attempts to take ball, nudges participant				
Throwing hand ball against a wall	❑ Large ball	❑ Small ball; stand further from wall; throw with each arm	6 perturbations: PT attempts to take ball, nudges participant				
Kicking soccer ball against wall, standing on a thin foam mat	[none]	❑ Stand further from wall; kick outside BOS; kick with each leg	6 perturbations: PT attempts to take ball, nudges participant				
Throwing hand ball against a wall, standing on a thin foam mat	❑ Large ball	❑ Small ball; stand further from wall; throw with each arm	6 perturbations: PT attempts to take ball, nudges participant				
Walking with sudden stops and changes in direction	❑ Walk slowly	❑ Walk quickly	6 multi-directional push/pull/trip				
Move to different corners of the room	❑ Walk slowly	❑ Walk quickly	6 multi-directional push/pull/trip				

Voluntary task	Adaptation to reduce difficulty	Adaptation to increase difficulty	Perturbation	Outcome (0=≤2 steps, 1=multi step, X=loss of balance)	RPC	# Rests during task	Rest after task (Y/N)
Walking with sudden stops and changes in direction, obstacles around the room	❑ Walk slowly	❑ Walk quickly	6 multi-directional push/pull/trip				
Move to different corners of the room, obstacles around the room	❑ Walk slowly	❑ Walk quickly	6 multi-directional push/pull/trip				
Four square stepping to unpredictable cued direction	❑ Short steps	❑ Long steps	12 multi-directional push/pull/trip				
'Dodgeball'	❑ Ball thrown at upper body	❑ Ball thrown rapidly at feet	internal				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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'Mobile & unpredictable' tasks: Session 12

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Kicking soccer ball back and forth with physiotherapist	❑ Within reach; kicked slowly	❑ Step to reach; kicked quickly	internal				
Throwing ball back and forth with physiotherapist	❑ Large ball; within reach	❑ Small ball; step to reach	internal				
Kicking soccer ball with physiotherapist, standing on a thin foam mat	❑ Within reach; kicked slowly	❑ Step to reach; kicked quickly	internal				
Throwing ball with physiotherapist, standing on a thin foam mat	❑ Large ball; within reach	❑ Small ball; step to reach	internal				
Walking with sudden stops and changes in direction	❑ Walk slowly	❑ Walk quickly	12 multi-directional push/pull/trip				
Move to different corners of the room	❑ Walk slowly	❑ Walk quickly	12 multi-directional push/pull/trip				
Walking with sudden stops and changes in direction, obstacles around the room	❑ Walk slowly	❑ Walk quickly	12 multi-directional push/pull/trip				

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Move to different corners of the room, obstacles around the room	❑ Walk slowly	❑ Walk quickly	12 multi-directional push/pull/trip				
Four square stepping to unpredictable cued direction	❑ Short steps	❑ Long steps	12 multi-directional push/pull/trip				
'Dodgeball'	❑ Ball thrown at upper body	❑ Ball thrown rapidly at feet	internal				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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Booster sessions

Initial - HR: **BP:**	**Repeat 1 - HR:** **BP:**	**Repeat 2 - HR:** **BP:**

Voluntary task	**Adaptation to reduce difficulty**	**Adaptation to increase difficulty**	**Perturbation**	**Outcome** (0=≤2 steps, 1=multi step, X=loss of balance)	**RPC**	**# Rests during task**	**Rest after task (Y/N)**
Standing still with feet hip-width apart, eyes closed	❑ Wide base of support	❑ Feet together	6 multi-directional lean-and-release				
Rapid tap-ups forward with alternate feet	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Rapid tap-ups to alternate sides	❑ Low step Step Height: _____	❑ Unstable surface (e.g. soccer ball)	6 multi-directional push/pull				
Rapid stepping with alternate feet in random cued direction	❑ Short steps	❑ Long steps	6 multi-directional push/pull				
Turning on the spot, in cued direction	❑ Turn slowly	❑ Turn quickly; eyes closed	6 multi-directional push/pull				
Side stepping/braiding	❑ Short steps	❑ Long steps; thin foam mat	6 multi-directional push/pull/trip				
Forward tandem/braiding	❑ Steps close to line	❑ Long steps; thin foam mat	6 multi-directional push/pull/trip				

Voluntary task	Adaptation to reduce difficulty	Adaptation to increase difficulty	Perturbation	Outcome (0=≤2 steps, 1=multi step, X=loss of balance)	RPC	# Rests during task	Rest after task (Y/N)
Backward tandem/braiding	❑ Steps close to line	❑ Long steps; thin foam mat	6 multi-directional push/pull/trip				
Walking with sudden stops and changes in direction, obstacles around the room	❑ Walk slowly	❑ Walk quickly	6 multi-directional push/pull/trip				
Kicking soccer ball against wall	[none]	❑ Kick outside BOS; on thin foam mat	6 perturbations: PT attempts to take ball, nudges participant				

HR: _____ BP: _____ ***Overall rating of perceived challenge*: _____**

TOTALS/AVERAGES	0= 1= X=				

Overall comments for the session: _____

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5. TASK DESCRIPTIONS

Types of external perturbations

1) Lean and release

a. Forward-directed lean-and-release perturbation. The participant stands facing the physiotherapist, leaning forward with some of his body weight supported by the physiotherapist. He should be leaning far enough forward that his shoulders and hips are ahead of his toes; however, smaller lean angles can be used with more impaired individuals. The physiotherapist's hands are on the participants' shoulders. At an unexpected time, the physiotherapist releases her hands and the participant starts to fall forward, requiring a step to regain stability. The goal is for the participant to take as few steps as possible to recover.

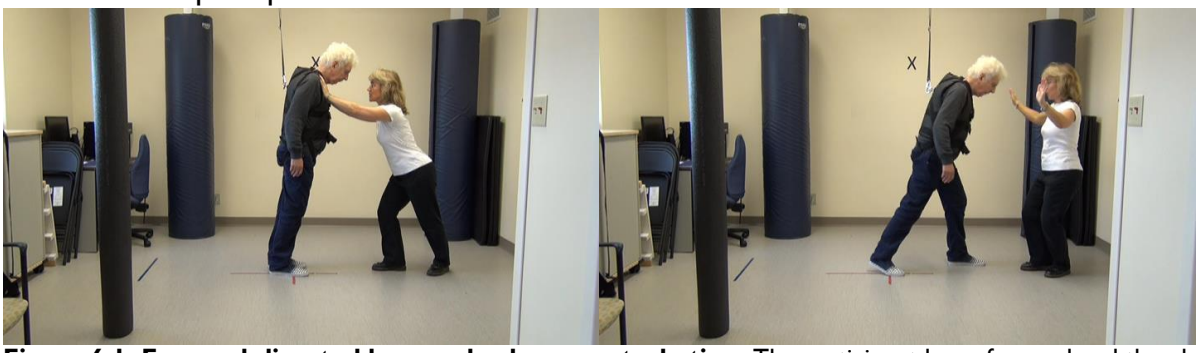


Figure 6.1. Forward-directed lean-and-release perturbation. The participant leans forward and the physiotherapist supports his weight (left). The physiotherapist releases her support and the participant steps to recover his balance (right).

b. Backward-directed lean-and-release perturbation. The participant stands in front of and facing away from the physiotherapist, leaning backward with some of his body weight supported by the physiotherapist. He should be leaning far enough backward that his shoulders and hips are behind his heels; however, smaller lean angles can be used with more impaired individuals. The physiotherapist's hands are on the participants' shoulders. At an unexpected time, the physiotherapist releases her hands and the participant starts to fall backward, requiring a step to regain stability. The goal is for the participant to take as few steps as possible to recover upright standing balance.

Figure 6.2. Backward-directed lean-and-release perturbation. The participant leans backward and the physiotherapist supports his weight (left). The physiotherapist releases her support and the participant steps to recover his balance (right).

c. Lateral-directed lean-and-release perturbation. The participant stands with his feet close together, leaning to the right (or left) with some of his body weight supported by the physiotherapist's hands. He should be leaning far enough to the right (or left) that the midline of the pelvis is aligned over the right (or left) foot; however, smaller lean angles can be used with more impaired individuals. The physiotherapist's hands are on the participant's right (or left) shoulder and

right (or left) hip. At an unexpected time, the physiotherapist releases her hands and the participant starts to fall to the right (or left), requiring a step to regain stability. The goal is for the participant to take as few steps as possible to recover balance.

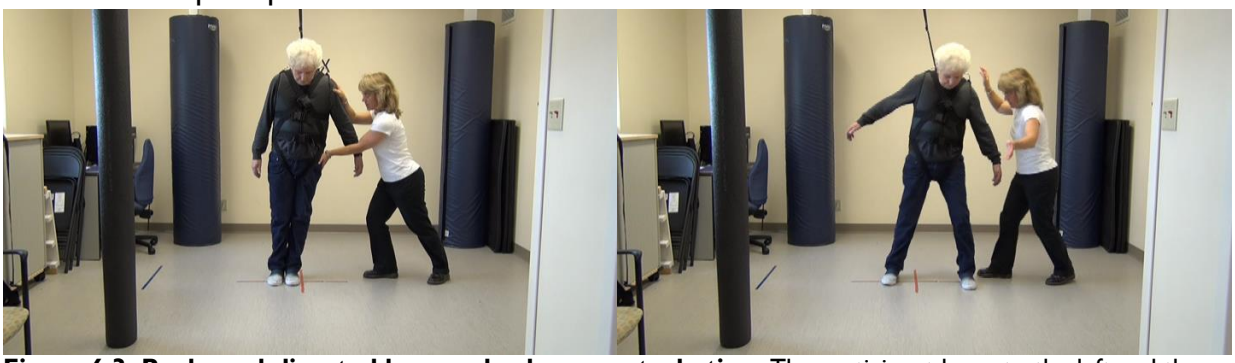


Figure 6.3. Backward-directed lean-and-release perturbation. The participant leans to the left and the physiotherapist supports his weight (left). The physiotherapist releases her support and the participant steps to recover his balance (right).

2) Multi-directional push/pull/trip

a. Multidirectional push. The physiotherapist places her hands on the participant's hips or shoulders and pushes him forward, requiring a reactive step to regain stability. Alternatively, one of the physiotherapist's hands could be on the hip and the other on the shoulder; a push forward at the level of one scapula would facilitate a diagonal reactive step. In all scenarios, the physiotherapist should be ready to assist with the recovery, if necessary, by having a light hold of the safety harness. The physiotherapist should only provide assistance if the participant is unable to regain stability independently; this is true with every reaction. Note that backward-directed pushes are not performed.

Figure 6.4. Forward-directed push perturbation. The physiotherapists' hands may be placed at the hips (top images) or with one hand on the hips and one on the shoulders.

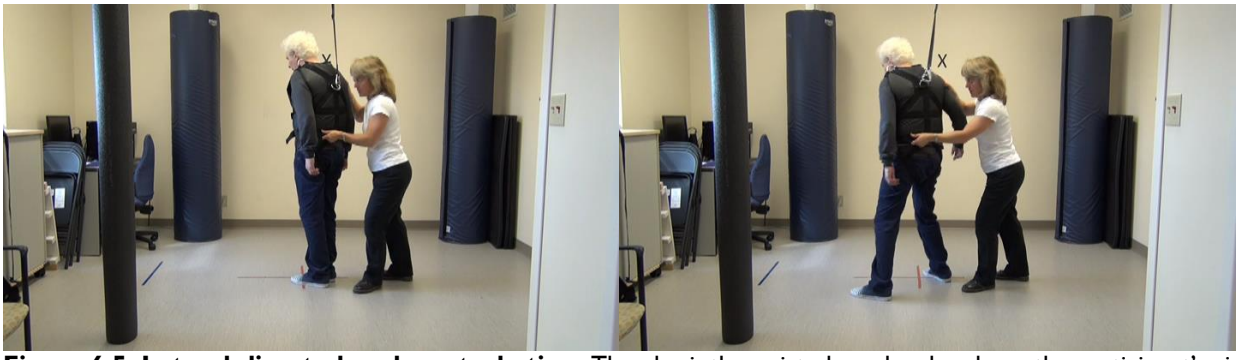


Figure 6.5. Lateral-directed push perturbation. The physiotherapist places her hands on the participant's right (or left) hip or shoulder and pushes him to the left (or right), requiring a reactive step to regain stability.

b. Multi-directional pull perturbation. The physiotherapist may pull the participant's shoulders or pull on the harness to cause the participant to start to fall forward, requiring a reactive step to regain stability.

Figure 6.6. Forward-directed pull perturbation. The physiotherapist places her hands on the participant's shoulders (top) or pulls on the harness (bottom).

Figure 6.7. Backward-directed pull perturbation. The physiotherapist uses the shoulders, hips, or harness to pull the participant backward, requiring a reactive step to regain stability.

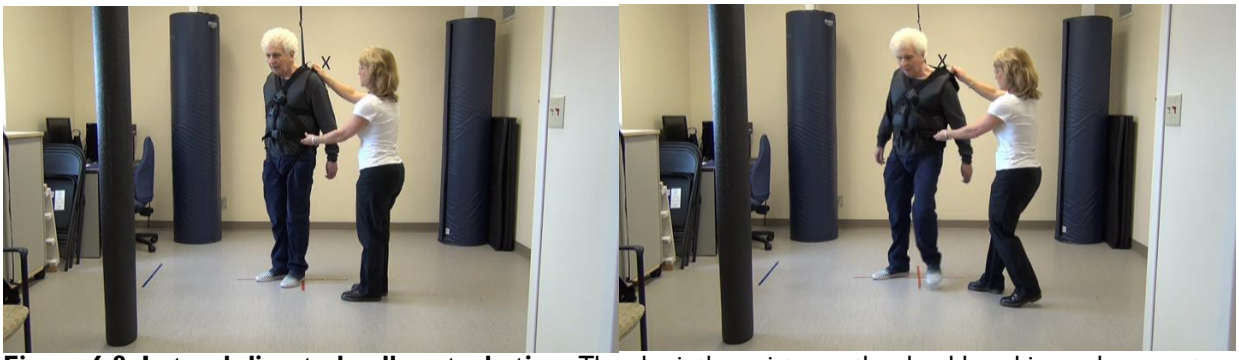


Figure 6.8. Lateral-directed pull perturbation. The physiotherapist uses the shoulders, hips or harness, to pull the participant to the right (or left), requiring a reactive step to regain stability.

c. Trip perturbation while walking. As the participant walks (forward, backward, sideways), the physiotherapist places her foot in the path of the swing limb causing a trip. A reactive step is required to regain stability. A second person is recommended in this scenario as it is difficult for the physiotherapist doing the tripping to be in a place to provide support should it be needed.

Figure 6.9. Trip perturbation. The physiotherapist catches the participants' limb with her foot while walking.

Descriptions of voluntary tasks

Standing still with feet hip-width apart – participant stands unassisted with the eyes open and the feet positioned as wide as the hips. The lean-and-release perturbations are performed in random directions (forward, backward and lateral).

Adaptation to reduce difficulty – have participant adopt a wider base of support (BOS)
Adaptation to increase difficulty – have participant stand with the feet together
Progressions of this task:
Eyes closed – if participant is unable, the lights in the room should be dimmed (alternatively, dark sunglasses may be worn)
Standing on a thin foam mat
Standing on a thick foam mat
Turning head to the right and left – to spot a target
Looking up and down – to spot a target
Counting backwards by 3's – from a random number given by physiotherapist
Eyes closed and counting backwards – as written above, but combined

Rapid weight-shifting left and right – participant shifts his body weight from one foot to the other as quickly as possible, and the feet remain in contact with the floor. The task is repeated until all perturbations are accomplished.

Adaptation to reduce difficulty – have participant adopt a wider BOS

Adaptation to increase difficulty – have participant stand with the feet together

Rapid weight-shifting forward and backward –participant stands with feet either 'side-by-side' or in a 'stride position' and shifts his body weight forward and backward; if feet are 'side-by-side' then body weight rocks from toes to heels and back; if feet are in stride then body weight transfers from one foot to the other as quickly as possible; part of each foot always remains in contact with the floor. The task is repeated until all perturbations are accomplished.

Adaptation to reduce difficulty –have participant adopt a wider BOS, with the feet either side-by-side or in stride

Adaptation to increase difficulty – have participant stand with the feet together (if side-by-side) or with the feet in tandem (if in stride position)

Throwing and catching a ball – if the participant has use of both arms he should catch and throw a ball back and forth with the physiotherapist; if the participant has functional use of only one arm he should hit a ball back that has been thrown by the physiotherapist.

Adaptation to reduce difficulty – have participant adopt a wider BOS

Adaptation to increase difficulty – have participant stand with the feet together

Rapid arm raises forward and to the sides – participant raises one arm, then both arms, to 90 degrees of shoulder flexion as quickly as possible and stops as quickly as possible; participant raises two arms, then one arm at a time, to 90 degrees of shoulder abduction as quickly as possible and stops as quickly as possible.

Adaptation to reduce difficulty – have participant adopt a wider BOS

Adaptation to increase difficulty – have participant stand with the feet together

Rapid stepping forward with alternate feet – participant steps forward as quickly as possible with the right foot then returns it to the starting position, then steps forward as quickly as possible with the left foot, and then returns it to the starting position; there should be a transfer of body weight to the stepping foot once it touches down in the forward position. The task is repeated until all perturbations are accomplished.

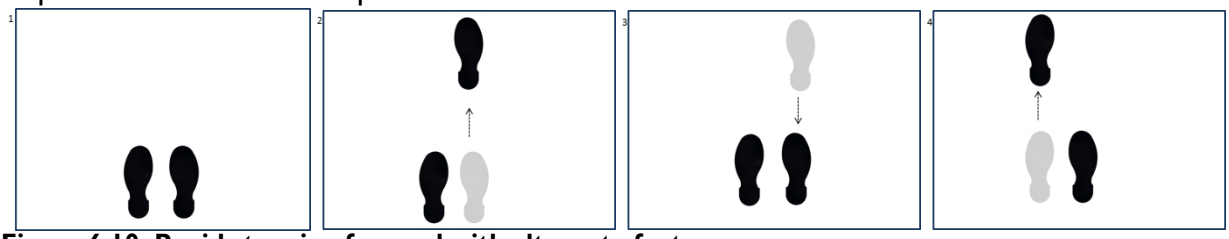


Figure 6.10. Rapid stepping forward with alternate feet

Adaptation to reduce difficulty – have participant take short steps

Adaptation to increase difficulty – have participant take long steps

Progressions of this task:

Standing on a thin foam mat

Rapid stepping backward with alternate feet – participant steps backward as quickly as possible with the right foot, then returns it to the starting position, then steps backward as quickly as possible with the left foot, and then returns it to the starting position; there should be a transfer of body weight to the stepping foot once it touches down in the backward position. The task is repeated until all perturbations are accomplished.

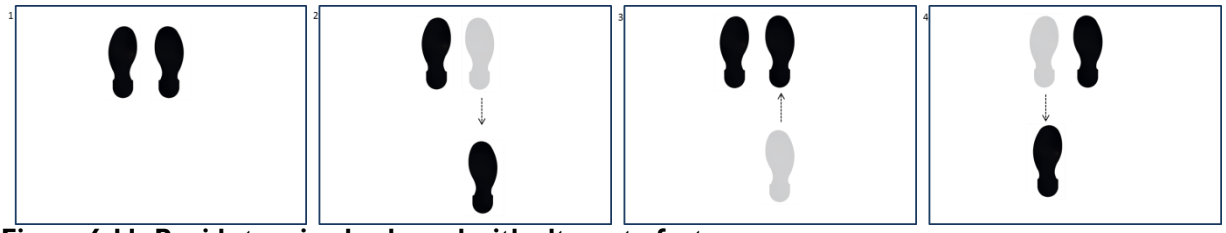


Figure 6.11. Rapid stepping backward with alternate feet

Adaptation to reduce difficulty – have participant take short steps
Adaptation to increase difficulty – have participant take long steps
Progressions of this task:
Standing on a thin foam mat

Rapid stepping to the right (right foot) – participant steps with the right foot to the right as quickly as possible, then back to the starting position; there should be transfer of body weight to the right foot once it touches down in the lateral position. The task is repeated until all perturbations are accomplished.

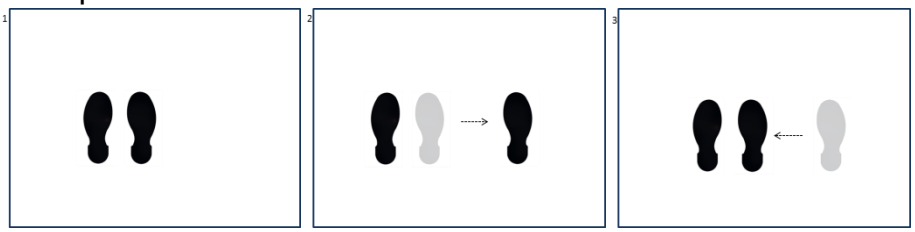


Figure 6.12. Rapid stepping to the right (right foot)

Adaptation to reduce difficulty – have participant take short steps
Adaptation to increase difficulty – have participant take long steps

Rapid stepping to the left (left foot) – participant steps with the left foot to the left as quickly as possible, then back to the starting position; there should be transfer of body weight to the left foot once it touches down in the lateral position. The task is repeated until all perturbations are accomplished.

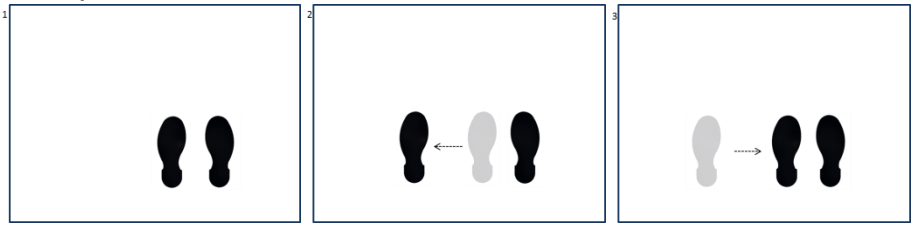


Figure 6.13. Rapid stepping to the left (left foot)

Adaptation to reduce difficulty – have participant take short steps
Adaptation to increase difficulty – have participant take long steps

Rapid stepping to alternate sides– participant steps with the right foot to the right as quickly as possible (including body weight transfer), then back to the starting position; then he steps with the left foot to the left as quickly as possible (including body weight transfer), then back to the starting position. The task is repeated until all perturbations are accomplished.

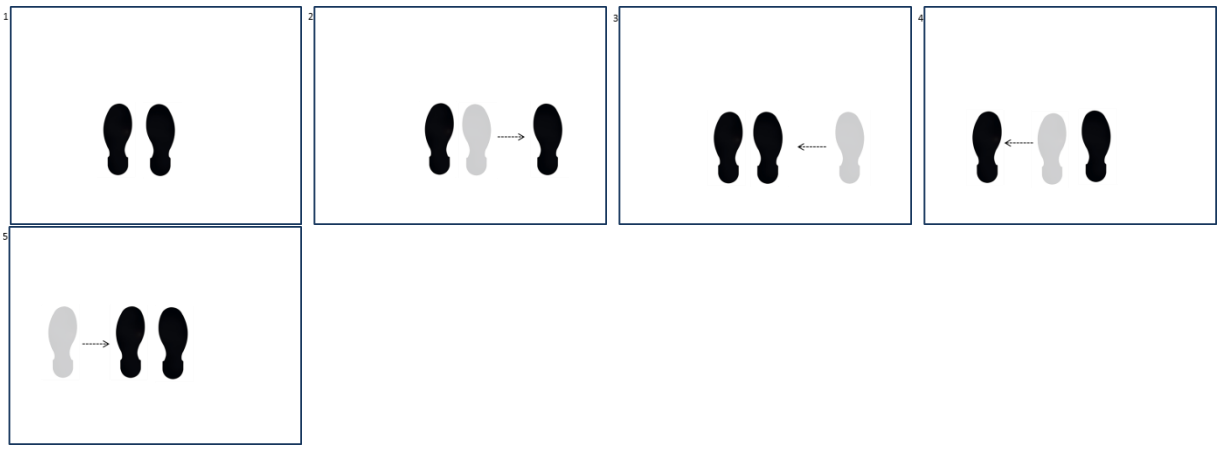


Figure 6.14. Rapid stepping to alternate sides

Adaptation to reduce difficulty – have participant take short steps
Adaptation to increase difficulty – have participant take long steps
Progressions of this task:
Standing on a thin foam mat

Rapid tap-ups forward with alternate feet – participant stands with a step in front of his feet; he lifts up the right foot and lightly touches the step, then places it back on the floor; then he lifts up the left foot and lightly touches the step, then places it back on the floor. The goal is to maintain the body weight over the stance limb, i.e. no transfer of body weight forward. The task is repeated until all perturbations are accomplished.

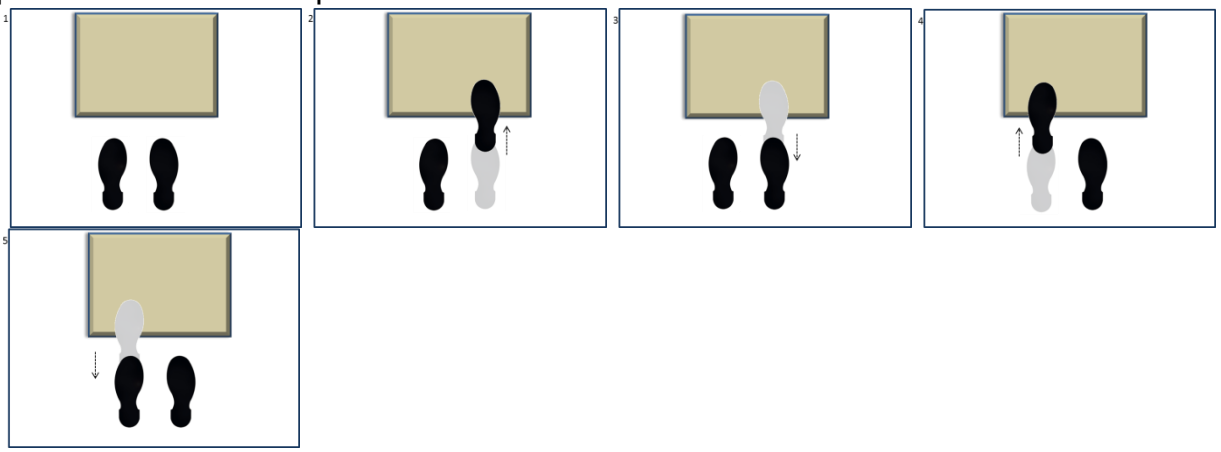


Figure 6.15. Rapid tap-ups forward with alternate feet

Adaptation to reduce difficulty – have participant tap-up to a low step
Adaptation to increase difficulty – have participant tap-up to an unstable surface, e.g. a soccer ball
Progressions of this task:
Standing on a thin foam mat

Walking in place – participant alternates stepping with the right and the left foot. The participant should not move from the spot, though a small amount of 'drift' is typical. The task is repeated until all perturbations are accomplished.

Adaptation to reduce difficulty – have participant step with minimal height from floor

Adaptation to increase difficulty – have participant step with maximum height from floor, i.e. knees raised to hip-height
Progressions of this task:

- Walking on the spot on a thin foam mat
- Eyes closed – if participant is unable, the lights in the room should be dimmed
- Increased speed to 'jogging', or fast walking, on the spot
- Jogging, or fast walking, on the spot on a thin foam mat

Rapid stepping forward and backward with the right foot – participant shifts his body weight to the left foot and then steps forward with the right foot, shifting some body weight forward but not enough to completely unweight the left; then the participant shifts his body weight back to the left foot in order to take a full step as far backward as possible with the right foot, and accepts some body weight on the right. The task is repeated until all perturbations are accomplished.

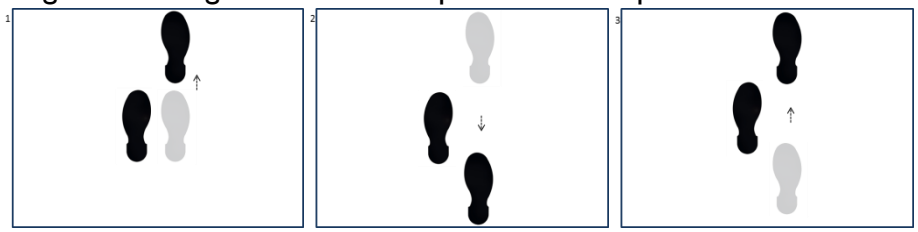


Figure 6.16. Rapid stepping forward and backward with the right foot

Adaptations to reduce difficulty – have participant take short steps; have participant rest momentarily between transitioning from front to back or from back to front
Adaptation to increase difficulty – have participant take long steps
Progressions of this task:

- Standing on a thin foam mat

Rapid stepping forward and backward with the left foot – participant shifts his body weight to the right foot and then steps forward with the left foot, shifting some body weight forward but not enough to completely unweight the right; then the participant shifts his body weight back to the right foot in order to take a full step as far backward as possible with the left foot, and accepts some body weight on the left. The task is repeated until all perturbations are accomplished.

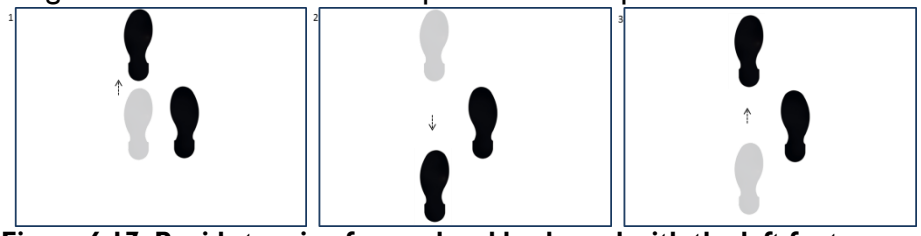


Figure 6.17. Rapid stepping forward and backward with the left foot

Adaptations to reduce difficulty – have participant take short steps; have participant rest momentarily between transitioning from front to back or from back to front
Adaptation to increase difficulty – have participant take long steps
Progressions of this task:

- Standing on a thin foam mat

Rapid step-ups with alternate feet - participant stands with a step in front of his feet; he steps up onto the step with the right foot, shifts his body weight forward and steps up with the left foot, placing it on the step in a comfortably-wide position; then he steps down with the right foot, shifts his

body weight back onto the right foot and steps down with the left. The process is repeated with the right foot leading until 3 perturbations are completed; then the left leads until the final 3 perturbations are completed.

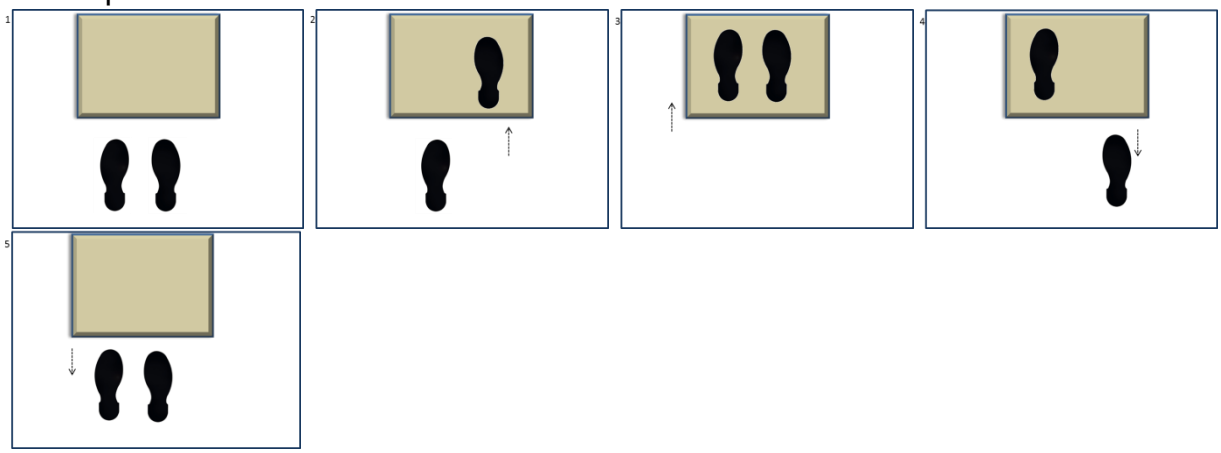


Figure 6.18. Rapid step-ups with alternate feet

Adaptation to reduce difficulty – have participant step-up to a low step
Adaptation to increase difficulty – have participant step-up to an unstable surface, for e.g., a step placed on a thin foam mat, or thick foam pad
Progressions of this task:

Standing on a thin foam mat – i.e. the person is standing on the mat, but the step may be on a hard surface, depending on the adaptation for difficulty

Rapid tap-ups to alternate sides – participant stands with a step lateral to each foot; he lifts up the right foot and lightly touches the step on the right, then places it back on the floor; then lifts up the left foot and lightly touches the step on the left, then places it back on the floor. The goal is to maintain the body weight over the stance limb, i.e., no transfer of body weight to the side tapping-up. The task is repeated until all perturbations are accomplished.

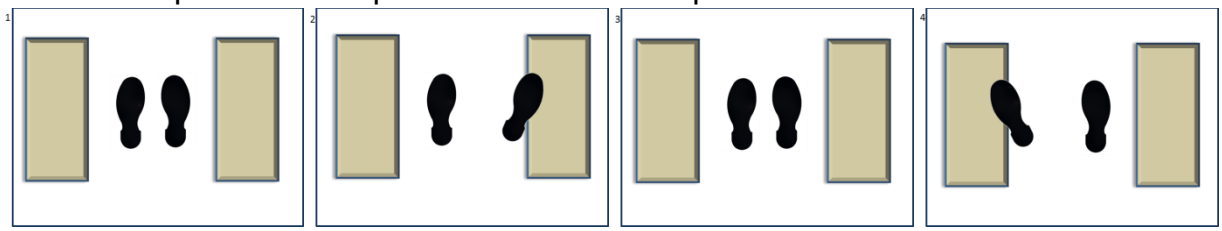


Figure 6.19. Rapid tap-ups to alternate sides

Adaptation to reduce difficulty – have participant tap-up to a low step
Adaptation to increase difficulty – have participant tap-up to an unstable surface, e.g. a soccer ball
Progressions of this task:

Standing on a thin foam mat – i.e. the person is standing on the mat, but the step/obstacle may be on a hard surface, depending on the adaptation for difficulty

Rapid diagonal forward stepping with alternate feet – participant steps diagonally forward (a 45° angle) as quickly as possible with the right foot, then returns it to the starting position, then steps diagonally forward as quickly as possible with the left foot, then returns it to the starting position; there should be a transfer of body weight to the stepping foot once it touches down in the diagonal position. The task is repeated until all perturbations are accomplished.

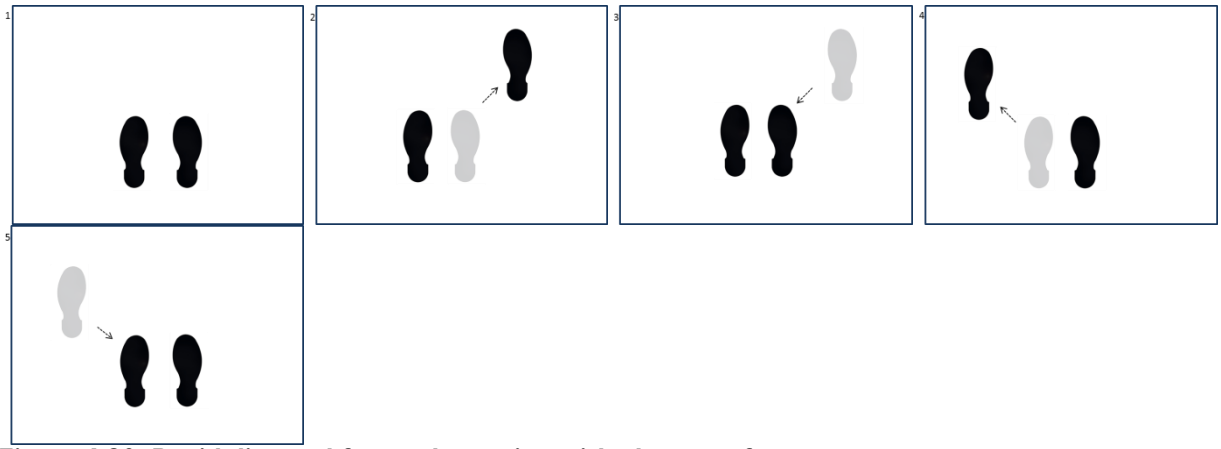


Figure 6.20. Rapid diagonal forward stepping with alternate feet

Adaptation to reduce difficulty – have participant take short steps
Adaptation to increase difficulty – have participant take long steps
Progressions of this task:
Standing on a thin foam mat

Rapid stepping with alternate feet in random physiotherapist-cued directions – participant stands in the centre of 6 targets placed on the floor (e.g., different colored Agility Dots); physiotherapist calls out a color and the participant steps to the colored dot with one foot (transferring some body weight) and then returns that foot to the centre; the process repeats with the next randomly called color. The task is repeated until all perturbations are accomplished.

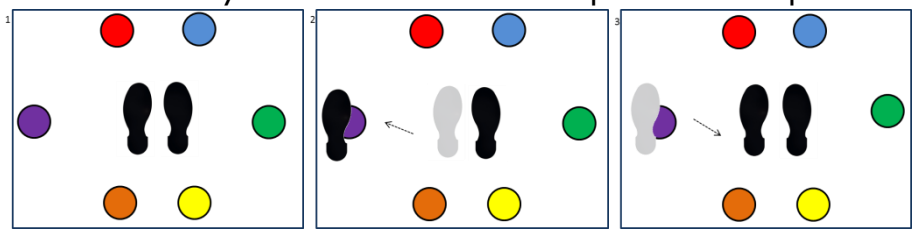


Figure 6.21. Rapid stepping with alternate feet in random physiotherapist-cued directions

Adaptation to reduce difficulty – targets require short steps
Adaptation to increase difficulty – targets require long steps
Progressions of this task:
Standing on a thin foam mat

Walking forward – participant takes steps to travel in a forward direction. Walking continues until all perturbations are accomplished.

Adaptations to reduce difficulty – have participant take short steps, or walk slowly
Adaptation to increase difficulty – have participant take long steps; traffic light*
Progressions of this task:
Turning head to the right and left – to spot a target
Looking up and down – to spot a target
Stepping over obstacles –e.g. pool noodles

* Traffic Light = participant walks at a fast pace like he would if crossing a street; physiotherapist counts down like the traffic light would in the crosswalk

Eyes closed – if participant is unable, the lights in the room should be dimmed
Walking on a thin foam mat

Forward braiding – participant takes a step forward with the right foot that crosses the midline path and lands lateral to, and slightly ahead of, the left foot; then he brings the left foot out and around the right foot, taking a step across the midline path that lands lateral to, and slightly ahead of, the right foot; then the process repeats until all perturbations are accomplished.

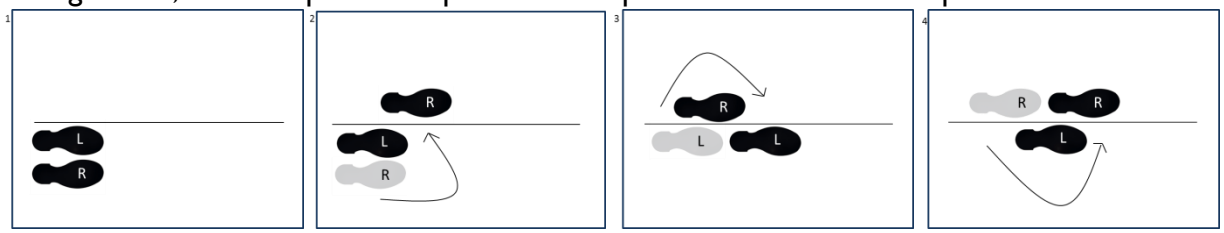


Figure 6.22. Forward braiding

Adaptation to reduce difficulty – walk on the line
Adaptations to increase difficulty - increase distance of step across line; take bigger steps; increase the walking speed
Progressions of this task:
Walking on a thin foam mat

Side stepping – participant stands on left side of room; he takes a step to the right with the right foot, followed by a step to the right (medially) with the left foot; the stepping continues until the edge of the room/available space is reached; then, starting from the right side of the room, he will walk in the opposite direction – left foot steps to left, followed by right foot stepping to left. Stepping continues until all perturbations are accomplished.

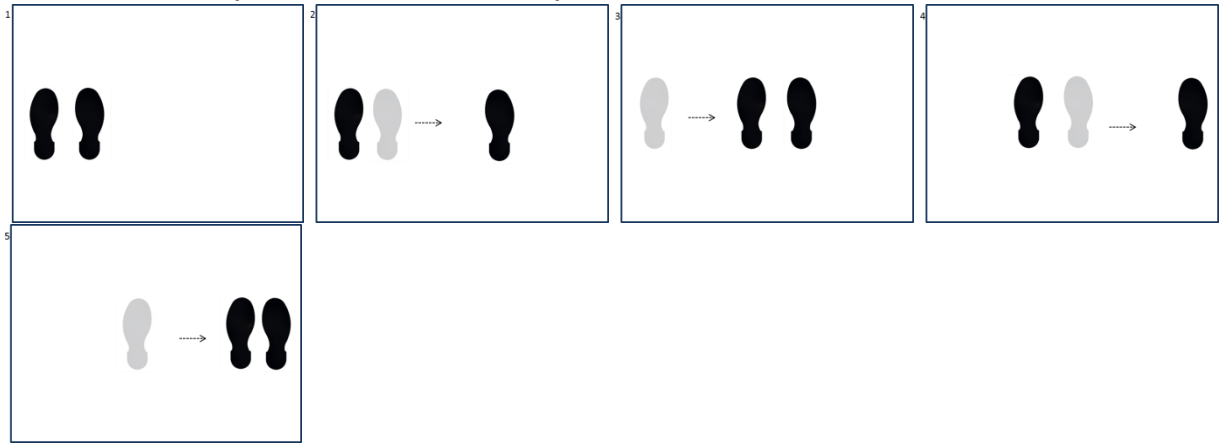


Figure 6.23. Side stepping

Adaptation to reduce difficulty – have participant take short steps
Adaptation to increase difficulty – have participant take long steps
Progressions of this task:
Stepping over obstacles –e.g. pool noodles
Walking on a thin foam mat

Turning on the spot, alternating to the right and left – participant takes steps to turn continuously in a clockwise direction. After a few turns (or 3 perturbations) the participant changes direction and turns counter-clockwise (until the final 3 perturbations are completed).

Adaptation to reduce difficulty – have participant turn slowly
Adaptations to increase difficulty – have participant turn quickly
Progressions of this task:
Eyes closed – if participant is unable, the lights in the room should be dimmed
Cued direction – physiotherapist calls out 'right' or 'left' and the participant turns in the direction called; it may be the same direction or a change in direction
Cued and Eyes closed – as written above but combined

Four square stepping – using tape, a cross is marked out on the floor creating 4 squares; participant stands in the bottom right-hand square facing forward; he is asked to step forward over the line with one foot then the other into the top right-hand square; then to step sideways, over the tape with the left foot and then the right into the top left-hand square; then to step backwards with one foot and then the other into the bottom left-hand square; and then finally, to step sideways with the right foot, then the left into the bottom right-hand square. He does that pattern a few times (or 3 perturbations) and then switches directions, moving in a clockwise pattern (until the final 3 perturbations are completed).

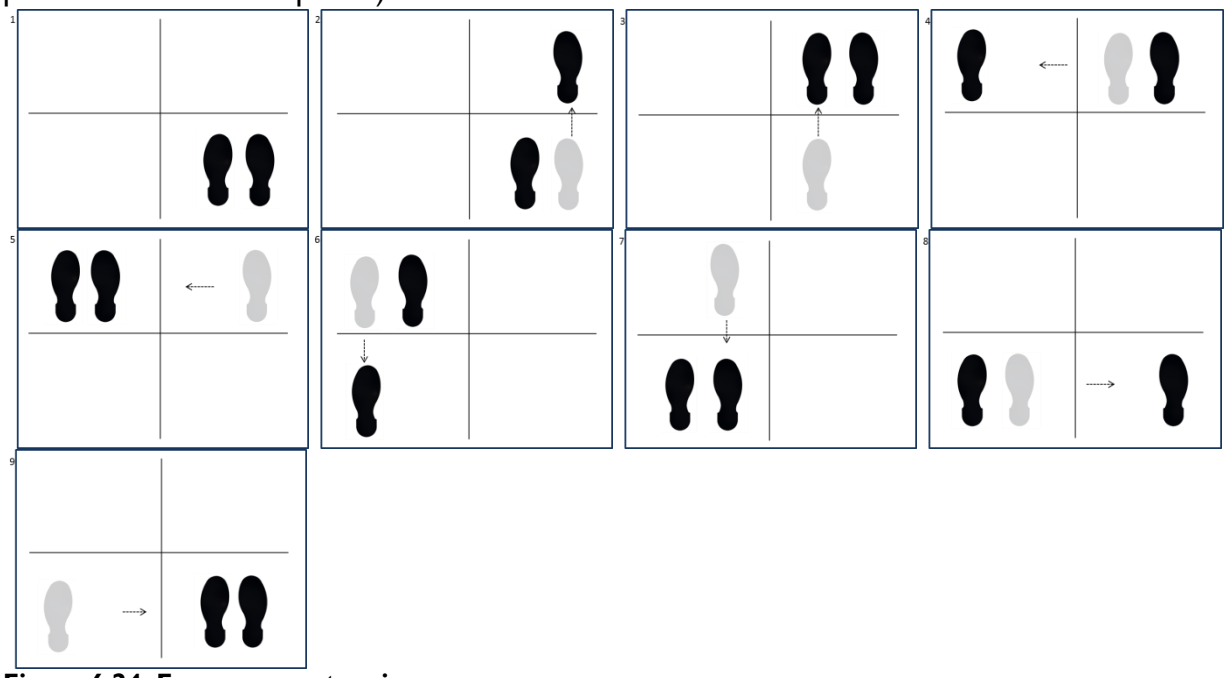


Figure 6.24. Four square stepping

Adaptation to reduce difficulty – have participant take short steps over the lines
Adaptation to increase difficulty – have participant take long steps over the lines
Progressions of this task:
Stepping on a thin foam mat
Cued direction – physiotherapist calls out 'change' or 'switch' and the participant begins moving in the opposite direction

Walking backward – participant takes steps to travel in a backward direction. Walking continues until all perturbations are accomplished.
Adaptation to reduce difficulty – have participant take short steps, or walk slowly
Adaptation to increase difficulty – have participant take long steps; traffic light
Progressions of this task:
Walking on a thin foam mat

Tandem walking forward - participant takes a step forward with the right foot and places the right heel ahead of the left toes; then he brings the left foot out and around the right foot, and places the left heel ahead of the right toes; then the process repeats until all perturbations are completed.

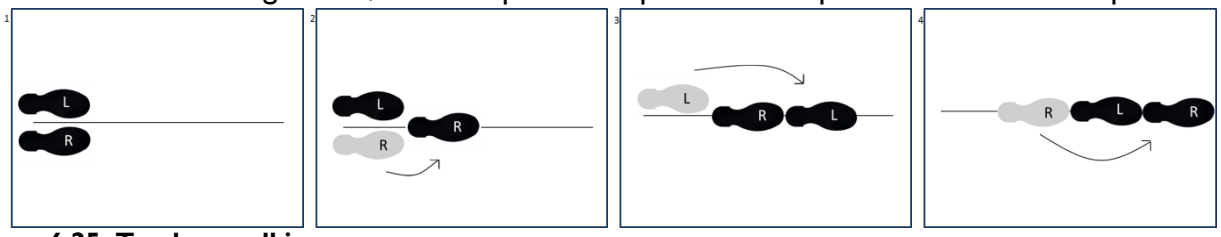


Figure 6.25. Tandem walking

Adaptations to reduce difficulty – participant takes longer steps (i.e. heel and toes don't touch) or participant places feet close to the line but not on the line
Adaptation to increase difficulty – traffic light
Progressions of this task:
Walking on a thin foam mat

Sideways braiding – participant stands at the right edge of the room; he is asked to walk to the left; he takes a step with the right foot that crosses over the left foot and lands lateral to, and slightly ahead of, the left foot, with part of his foot on the midline; then he brings the left foot out from behind the right and steps to the left, landing on the midline; then he takes a step with the right foot that crosses behind the left foot and lands lateral to, and slightly behind, the left foot, with part of his foot on the midline; then he takes the left foot over the right foot and steps to the left; and then the process repeats until he walks as far as he possibly can within the available space. Then he is asked to do the opposite and walk to the right. This pattern continues until all perturbations are accomplished.

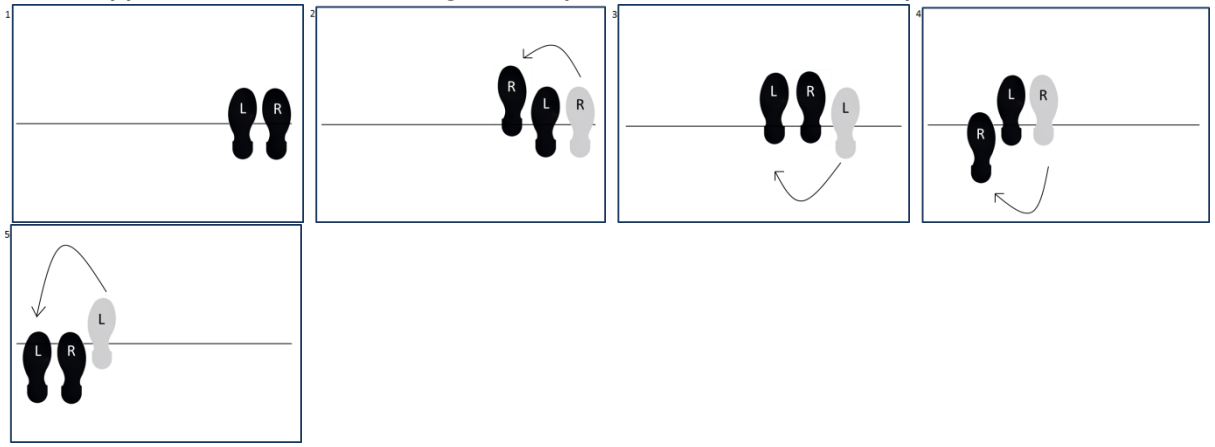


Figure 6.26. Sideways braiding

Adaptations to reduce difficulty – participant's foot does not fully cross over or behind the stance foot; or, participant's foot crosses but does not come into contact with midline
Adaptation to increase difficulty – traffic light
Progressions of this task:
Walking on a thin foam mat

Tandem walking backward - participant takes a step backward with the right foot and places the right toes behind the left heel; then he brings the left foot out and around the right foot, and places the left toes behind the right heel; then the process repeats until all perturbations are completed.

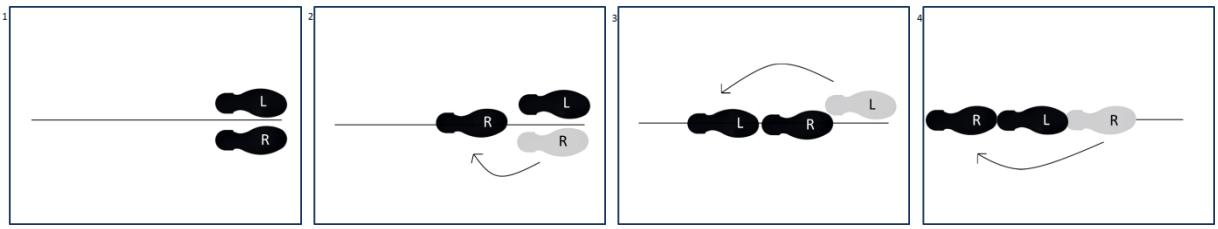


Figure 6.27. Tandem walking backward

Adaptations to reduce difficulty – participant takes longer steps (i.e. heel and toes don't touch) or participant places feet close to the line but not on the line
Adaptation to increase difficulty – traffic light
Progressions of this task:
Walking on a thin foam mat

Backward braiding – participant takes a step backward with the right foot that crosses the midline path and lands lateral to, and slightly behind, the left foot; then he brings the left foot out and around the right foot, taking a step backwards across the midline path that lands lateral to, and slightly behind, the right foot; then the process repeats until all perturbations are accomplished.

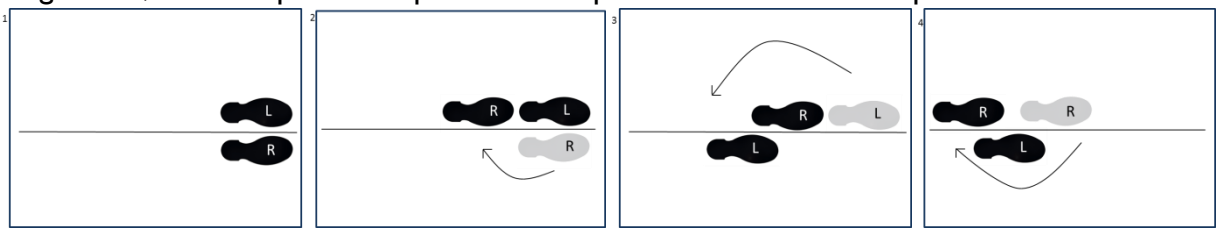


Figure 6.28. Backward braiding

Adaptation to reduce difficulty – walking on the line
Adaptations to increase difficulty - increase distance of step across line; take longer steps; traffic light
Progressions of this task:
Walking on a thin foam mat

Kicking a soccer ball against wall – participant stands at least 1 metre away from a wall; he kicks a soccer ball with enough force that it bounces back to him from the wall; he receives the ball and kicks it again. The task is repeated until all perturbations are accomplished.

Adaptation to reduce difficulty – none
Adaptations to increase difficulty – have participant stand further away from the wall; have participant kick it outside of his base of support; have participant alternate kicking with each foot
Progressions of this task:
Standing on a thin foam mat
Kicking the ball to the physiotherapist and receiving it back; this may require moving to reach the ball
Kicking the ball with the physiotherapist while standing on a thin foam mat

Throwing a handball against the wall – participant stands at least 1 metre away from a wall; he throws a hand ball with enough force that it bounces back to him from the wall; he receives the ball and throws it again. The task is repeated until all perturbations are accomplished.

Adaptation to reduce difficulty – have participant throw a large ball

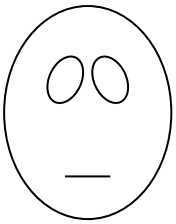
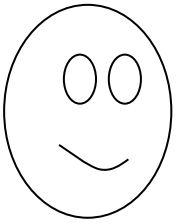
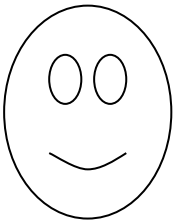
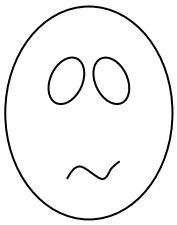
Adaptations to increase difficulty – have participant throw a small ball; have participant stand further away from the wall; have participant throw the ball with each arm
Progressions of this task:
Standing on a thin foam mat
Throwing the ball to the physiotherapist and receiving it back; this may require moving to catch it
Throwing the ball with the physiotherapist while standing on a thin foam mat

Walking with sudden stops and changes in direction – participant walks forward and at any time, the physiotherapist says 'stop', and the participant has to stop walking quickly, or says 'right' ('left'), and the participant has to turn to the right (left) and continue walking. The task continues until all perturbations are accomplished.
Adaptation to reduce difficulty – have participant walk slowly
Adaptation to increase difficulty – have participant walk quickly
Progressions of this task:
Stepping over obstacles, e.g. pool noodles or steps – the participant has to walk in the frame and manage the obstacles while also stopping or changing direction on command

Move to different corners of the room – participant stands in the centre of the room facing forward; he is asked to move to one corner of the room (marked with different colored Agility Dots or numbers); he walks forward to the corners in front of him, then backward to return to the start position, or he walks backward to the corners behind him, then forward to return to the start position. The task continues until all perturbations are accomplished.
Adaptation to reduce difficulty – have participant walk slowly
Adaptation to increase difficulty – have participant walk quickly
Progressions of this task:
Stepping over obstacles, e.g. pool noodles or steps – the participant has to walk in the frame and manage the obstacles while making his way to the correct pole

Dodgeball – the participant must avoid being hit by the ball that is being thrown at him by the physiotherapist. This requires transfer of weight and reactive stepping.
Adaptation to reduce difficulty – physiotherapist throws ball at upper body
Adaptation to increase difficulty – physiotherapist throws ball rapidly at participant's feet

6. RATING OF PERCEIVED CHALLENGE SCALE

NO CHALLENGE AT ALL		1
A LITTLE BIT OF CHALLENGE		2
SOME CHALLENGE		3
MUCH CHALLENGE		4
CAN NOT DO		5

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