Comparison of Responses in Proactive vs. Reactive Balance Control

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Comparison of Responses in Proactive vs. Reactive Balance Control

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Introduction
Approximately 28-35% of adults over the age of 65 experience at least one fall over a one year period. Of those adults, an estimated 20% must seek medical attention due to injuries from the fall or to prevent another fall. Within community-based and standardized Physical therapy, balance training and exercises are widely used to address poor balance. One downside to current balance training procedures is that most are taught under proactive conditions (self-initiated actions), while falls generally occur due to an inadequate reactive response to an external force. Even though recent research suggests reactive balance training (unexpected, external perturbations) has more effective, long term results than proactive training, the latter is used most often in a clinical setting due to its affordability and convenience. Reactive balance training devices tend to be costly, difficult to transport, and more hazardous than proactive balance training. This study seeks to develop a safe, affordable, and easily portable perturbation-inducing device to be used for reactive balance training. In addition, this device will be used to help determine how well skills gained under proactive conditions transfer to reactive conditions. Lastly, a comparison will be made to determine whether proactive balance training skills are comparable to skills gained under only reactive conditions.

Purpose of the Study
1. To develop a device which provides safe, controlled, simple, and inexpensive reactive balance training for adults.
2. To compare skills gained under reactive conditions to skills gained in proactive balance training.

Methods

Device & Tools
Slip-Trainer
The Slip-Trainer is a translational platform specially made for this pilot study (MASS Rehab, Dayton, OH.) It is:
• not electronic or mechanized
• moves only in the anterior-posterior directions
• low-lying (only 7 cm above the ground) to allow for ease of subject use
• easily movable for storage (weights only 17.3 kg)
• low coefficient of friction (µ)

Harness
• attached to ceiling to prevent falls from actually occurring
• allows adequate anterior-posterior and lateral movement for slip training and testing
• shifts the primary load-bearing position of the body from the waist to the groin

Weight Stack
• ropes cut to make two separately usable but connected pulleys
• Pulley #1 attaches to back of Slip-Trainer
• Pulley #2 allows experimenter to hold 20-30% of subjects’ body weight in elevated position
• When tension is released, weights fall and cause Slip-Trainer to be tugged backwards, thereby inducing a perturbation

Stopper
Consists of:
• yoga mat cut to ~115.6 cm in length, folded into thirds and glued together
• extra piece was cut in half and each section was folded into fourths and glued to the top of the yoga mat
• two sandbag weights were taped to the top of each extra piece section
-This entire apparatus was taped to the ground ~35.1 cm behind of the Slip-Trainer

Experimental Procedure

Set-Up
(including harness and markers)
Group A: Reactive balance training
Group B: Proactive balance training
1 Hour Break
Group A: Reactive balance training
Group B: Proactive balance training

Finished!

Results

<table>
<thead>
<tr>
<th>Problem with Device</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip-Trainer rolled over stopper</td>
<td>• shortened slip distance</td>
</tr>
<tr>
<td>When Slip-Trainer strikes stopper, another perturbation is caused</td>
<td>• shortened slip distance to diminish size of perturbation, perturbation caused by stopper does not interfere with initial perturbation</td>
</tr>
<tr>
<td>One participant too tall for cameras to accurately record all markers</td>
<td>• maximum height for subjects is now 5'10&quot;</td>
</tr>
<tr>
<td>Harness prevents full movement when playing Xbox Kinect video games</td>
<td>• subjects need to wear harness for unity across groups, no viable solution to this problem</td>
</tr>
</tbody>
</table>

Pilot Trial
Overview

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Subjects; 1 Male</td>
<td>1 Subject; 1 Male</td>
</tr>
<tr>
<td>20-24 years old</td>
<td>19 years old</td>
</tr>
<tr>
<td>8-14 total slips completed</td>
<td>6 total slips completed</td>
</tr>
<tr>
<td>Stopped slip training exercise after each particular subject exhibited 3 almost identical reactions to the perturbations</td>
<td></td>
</tr>
</tbody>
</table>

Results

<table>
<thead>
<tr>
<th>Subject</th>
<th>1st Experimental Procedure</th>
<th>2nd Experimental Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 Slips</td>
<td>Fell on first slip</td>
</tr>
<tr>
<td>2</td>
<td>8 Slips</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>½ hour game play</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>8 Slips</td>
<td>Fell on first slip</td>
</tr>
</tbody>
</table>

*Fall = two or more steps in response to a perturbation

Conclusion
Even though it may be more effective at preventing falls, reactive balance training is not typically used clinically because proactive balance training is easier, safer, and more cost effective. Through this pilot study, we were able to determine that the Slip-Trainer device specifically designed for this study allows for safe and cost effective reactive balance training. During the experimental trials, we finalized a workable protocol by improving some aspects of the procedure. These modifications include changing the harness support system to prevent injury, shortening the slip distance to prevent an extra perturbation from occurring and so the Slip-Trainer would not roll over the stopper, and making 5’11" the maximum height for all potential subjects. In the future we intend to assess the effectiveness of the Slip-Trainer and revised protocol on older adults due to the positive results obtained from the subjects tested thus far.

Data Collection
Kinematic data collected in the Motion Analysis Lab in the School of Health Science, 8 Camera motion capture and analysis (Motion Analysis Corp, Santa Rosa, CA) of 29 reflective markers attached to subjects’ bodies