Effects of Parkinson’s Disease and a Secondary Cognitive Task on Reactive Balance

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Background

- Parkinson’s disease is a progressive disorder of the central nervous system which leads to disturbances in movement [1].
- Primary symptoms: less automaticity of gait and balance, decreased coordination, and a reduced reaction time.
- Each year, around 45% to 68% of people with Parkinson’s disease will fall, with a large proportion (50–86%) falling recurrently, often time causing physical pain to the patient[2].
- Traditional balance evaluation techniques: Berg Functional Balance Scale, time up and go (TUG), and Balance Evaluation Systems Test [2]. Limitations in their use: low specificity, not comprehensive, and not allowing for intrinsic responses.
- Prior research showed that presence of a dual task negatively affected the gait pattern (step length and gait speed)[5]. Dual-task interference was observed for healthy and Parkinson’s patients, yet, it is more pronounced in PD patients showing that the presence of a cognitive load would impact them more [3].

Motivations

Objective 1: Understand the relationship between presence of cognitive loads and reactive stepping performance.

Objective 2: Test the feasibility of the experimental framework to evaluate reactive stepping performance

Expectations:

- With the presence of a secondary cognitive task, reactive stepping performance would worsen. Because it is more difficult to perform concurrent motor and cognitive tasks there would be a decrease margin of stability, and step length, and increase step latency[5],
- With changes in the level of cognitive load, there would be no change in stepping performance. Changing the difficulty of a task doesn’t change the cognitive demand or immersion of the participant[6].

Data Processing

Parameters of Interest

- Onset of perturbation: velocity of both the feet exceeds 5% of the peak treadmill velocity which is 60 m/s.
- Step initialization: point at which the difference in foot velocities exceeds 5% of the peak treadmill velocity or the relative distance between the first lifted foot part (heel or toe) exceeds 5cm.
- Step contact: point at which the difference in foot velocities is less than 5% of the peak treadmill velocity and the distance between the heel or toe and the treadmill is less than 5cm.

Results

- Figure 1. Representative trial graph for a backwards trial during a single-task (A) and dual-task level 2 (B). Velocity of the feet relative to velocity of treadmill (top) and position of the feet relative to the position of the treadmill in the anterior posterior direction (bottom).

- Figure 2. Differences in average game scores between 3 levels of the dual task. Game score decreased as level increased. No learning effect present as the pre and post game scores were similar.

- Figure 3. Difference in margin of stability between a single task and dual-task level 2 trials in both forward and backward perturbations. Participant 1 (A) and participant 2 (B). Indicates a decrease in the margin of stability with the addition of a cognitive task.

- Figure 4. Difference in step length between a dual-task level 1 and dual-task level 3 trials in both forward and backward perturbations. Showed no difference in step length with a change in cognitive task difficulty level.

Methods

- Randomization of 6 trials within a block
- Size of bigger circle increases by 10% and movement rate increases to change difficulty levels

Future Work

1. Subject Populations
2. Cognitive Task

Future work: Change difficulty levels and the Influence of Cognitive Status.

Acknowledgments

I would like to thank Dr. Hyunglae Lee, Dr. Daniel Peterson, Omik Sava, and all members of the Neuromuscular Control and Human Robotics Laboratory.

References