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[3]. 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)[4]. 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 [5].

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[6].
- 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 particpant[7].

Data Processing

Parameters of Interest

Onset of perturbation: velocity of both the feet exceeds 1% of the peak treadmill velocity which is 0.6 m/s

Step initialization: point when difference in foot velocities exceeds 1% of the treadmill velocity or the when distance between the first lifted foot part (heel or toe) exceeds 5mm

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 5mm

Results

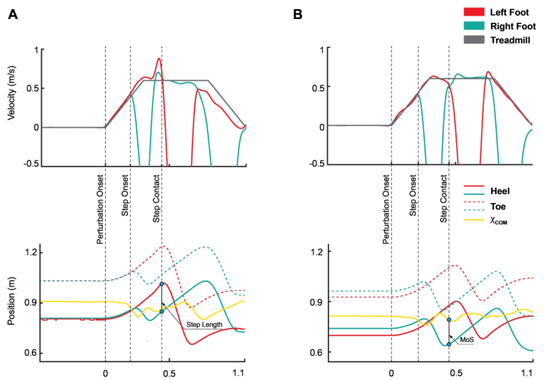


Figure 1. Representative trial graph for a backwards trial during a single task (A) and dual task level 2 (B).
Velocity of the feet relative to velocity of treadmill (top) and position of the feet relative to the position of the treadmill in the anterior posterior direction (bottom)

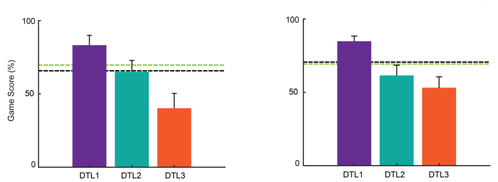


Figure 2. Differences in average game scores between 3 levels of the dual task. Game score decreased as level increased. No learning effect present as the pre and post game scores were similar

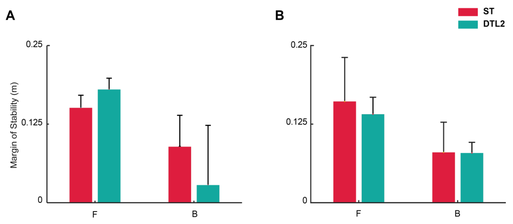


Figure 3. Difference in margin of stability between a single task and dual task level 2 trials in both forward and backward perturbations. Participant 1 (A) and participant 2 (B)
Indicates a decrease in the margin of stability with the addition of a cognitive task.

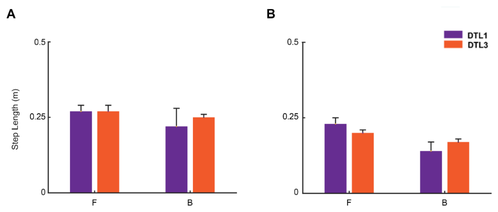
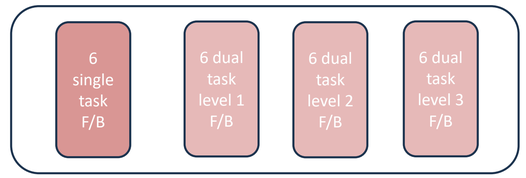
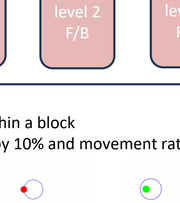


Figure 4. Difference in step length between a dual task level 1 and dual task level 3 trials in both forward and backward perturbations.
Showed no difference in step length with a change in cognitive task difficulty level.

Methods



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



- Pearl Markers
  - Hip, shoulder, shins, feet
- Vicon motion capture cameras x8
- Treadmill with force plates
- Safety harness
- Joystick and game monitor

Future Work

1. Subject Populations

2 subjects → Increase sample size

2. Cognitive Task

Same task doesn't accurately show effect of greater disturbance → -Test between different types of tasks -Have different levels of immersion

Acknowledgments

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References

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