Multi-limb dual-task cost in Parkinson disease: Evaluating effects of implicit and explicit cues

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Background and Rationale
Dual tasking requires the ability to shift attention between tasks and to prioritize one task over another. The authors thank the study participants who volunteered their time. In general, both groups were able to utilize implicit cues and explicit instruction to prioritize that task over the other. The authors thank the study participants who volunteered their time.

Hypotheses
1. PD reduces ability to shift focus between arm tasks and foot tasks based on implicit cues but does not affect ability to shift focus based on explicit task prioritization.
2. The dopaminergic medication state, On versus Off, will result in reduced attention switching to implicit and explicit cues.

Methods: Participants & Clinical Assessments
Participants
- Inclusion criteria:
  - Individuals with PD, Hoehn & Yahr stages 1-3 (n = 15)
  - Healthy age-matched adults (n = 15)
- Exclusion criteria:
  - Signiﬁcant co-morbidities (e.g., diabetes, stroke)
  - Cognitive impairment (< 24/30 Montreal Cognitive Assessment)
  - Impaired vibration sensation at the ankle
- Recruited from local community, local rehabilitation clinics, PD support groups, and ﬁtness centers throughout the Phoenix metropolitan area.
- PD subjects tested in “On” medication state (>1 hr after dose) and in the previously deﬁned “OFF” state (in the morning prior to ﬁrst daily dose, 212 hrs. from session). 1 Week apart, counterbalanced for order of session.

Methods: Materials & Procedure
Instruments
- Motion capture system (Vicon® and MotionMonitor®)
- Instrumented foot pedal and glass carafe
- Head-mounted camera and computer monitor, to control for visual gaze location across single and dual tasks

Experimental Tasks
- Arm single-task: on hearing auditory cue, participants reached to, raised and replaced a glass, and returned hand to start position.
- Foot single-task: participants tracked moving target on computer screen by pressing pedal with right foot.
- Dual-task: participants performed arm and foot tasks simultaneously.

Experimental Conditions
- Explicit cue for priority / Instructed priority:
  - No priority, Arm task priority, Foot task priority
- Implicit cue for priority / Accuracy constrained:
  - Reach task - Easy (glass empty); Hard (glass full)
  - Foot-pedal task - Gradual ramp; Steep ramp

Results: Clinical Performance
Subject Characteristics and Clinical Function

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>PDoff</th>
<th>PDon</th>
<th>Age (yrs)</th>
<th>Gender</th>
<th>PDoff</th>
<th>PDon</th>
<th>Age (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDoff</td>
<td>Male</td>
<td>12</td>
<td>17</td>
<td>62 ± 8</td>
<td>Male</td>
<td>12</td>
<td>17</td>
<td>62 ± 8</td>
</tr>
<tr>
<td>PDon</td>
<td>Male</td>
<td>4</td>
<td>3</td>
<td>57 ± 12</td>
<td>Male</td>
<td>4</td>
<td>3</td>
<td>57 ± 12</td>
</tr>
</tbody>
</table>

Results: Multi-limb Dual-Task Performance
PD compared with Controls

<table>
<thead>
<tr>
<th>Condition</th>
<th>Reaction Time (ms)</th>
<th>Foot Pedal Reaction Time (ms)</th>
<th>Reach Reaction Time (ms)</th>
<th>Foot Pedal Velocity (mm/s)</th>
<th>Reach Velocity (mm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDOff</td>
<td>68.2 (1.3)</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
</tr>
<tr>
<td>PDOn</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
<td>68.1 (1.3)</td>
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</tbody>
</table>

Conclusions
- Participants with PD had reduced performance in all measures of both the Reach and the Foot-Pedal tasks than healthy control subjects.
- In general, both groups were able to utilize implicit cues and explicit instruction to prioritize that task over the other.
- Dopaminergic medication improved performance only on peak velocity of reaching, not on reaction time, movement time or foot-pedal tracking error.
- Small sample size is a limitation that may obscure signiﬁcance.
- Experimental tasks may not have had enough ecological validity for implicit contextual processing. Studies are underway with PD subjects to test the use of implicit contextual and explicitly instructed cues in a driving simulator.

Acknowledgments
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- The authors thank the study participants who volunteered their time.
- The authors report no conﬂicts of interest.
- The authors are responsible for all content and all procedures. The authors thank the study participants who volunteered their time.

References

The Effect of Medication State on the Reach peak velocity (E2, C1, D1, E1, F1).
- Reach peak velocity was lower (p < 0.05) when subjects were implicitly cued to prioritize the Reach task (B1) compared with the Foot task (A1) and when implicitly cued to prioritize the Foot task (D1) compared with the Reach task (C1).
- Reach peak velocity was higher (p < 0.05) when subjects were explicitly cued to prioritize the Reach task (B2) compared with the Foot task (A2).

The Effect of Disease appeared in all measures of the Reach task (panels A-C) and Foot Pedal task (panel D).
- Reach reaction time was shorter with implicit cues to prioritize the Reach task (A1), but was similar with implicit cues and explicit instructions for the Reach task (B1).
- Reach reaction time was longer when subjects were implicitly cued to prioritize the Reach task (B1) compared with the Foot task (A1), but was similar with implicit cues and explicit instructions for the Reach task (B1).
- Reach reaction time was longer when subjects were explicitly cued to prioritize the Reach task (B2) compared with the Foot task (A2), but was similar with implicit cues and explicit instructions for the Reach task (B1).
- Reach reaction time was longer when subjects were explicitly cued to prioritize the Reach task (B2) compared with the Foot task (A2), but was similar with implicit cues and explicit instructions for the Reach task (B1).
- Reach reaction time was longer when subjects were explicitly cued to prioritize the Reach task (B2) compared with the Foot task (A2), but was similar with implicit cues and explicit instructions for the Reach task (B1).