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Multi-limb Control and Attention During Simulated Driving in Parkinson's Disease: Study Methods and Discussion from an Occupational Therapy Perspective

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A dual-tasking study in Parkinson's Disease

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Introduction

- Parkinson's Disease (PD) is the 2nd most common neurological disease worldwide, affects 1:100 over age 60; characterized by motor symptoms of slow, rigid movements, tremors, non-motor symptoms, cognitive and visual deficits (Tysnes & Storstein, 2017)
- Safe driving requires many performance skills that can be impaired by aging or disease and disability; consequences of cessation include depression, faster decline in health, decreased quality and longevity of life (Chihuri et al, 2016)
- PD symptoms that lead to unsafe driving include motor, visual perceptual, and executive function impairments such as attention shifts (Crizzle, Classen, & Uc, 2012)
- Impaired dual-tasking while walking is a well known deficit of PD but not well studied in the occupation of driving

- **Aims of the research:**
  - Compare the effects of explicit instruction of task prioritization with implicit accuracy demands on shifts in attention during lane-keeping (steering) and car-following (braking/accelerating) behavior during simulated driving performance in drivers with PD and in age-matched healthy old adults (McIsaac, 2016)
  - Identify the effect of dopaminergic medication state on attention switching to explicit and implicit cues during driving-like tasks and simulated driving performance behavior in adults with PD (McIsaac, 2016)
  - Explore beliefs and habits surrounding driving cessation with individuals with PD and healthy older adults

Methods

- **Setting:** The A.T. Still Interdisciplinary Research Lab
- **Subjects:** 15 Men/Women with a diagnosis of Idiopathic PD, 15 gender and age-matched healthy controls (HC), with a valid drivers license
- **Recruitment Methods:** Flyers in community centers and PD support groups, emails to healthcare professionals, Michael J. Fox Trial Finder, prior participant database

Materials

- MiniSim™ fixed-based driving simulator
- Scenario building software: TMT™, ISAT™, miniSim™
- A five-day intensive training was completed at the NADS facility in Iowa City, Iowa to learn how to use the two software programs, including authoring scenarios and use of the data acquisition files for data analysis

Development of Driving Scenarios

Implicit Task: an internally motivated and directed response or action to observations a person makes about the context of their environment or situation, typically requires a judgement call

Explicit Task: an externally driven response or action to a visual or auditory directive or instruction received from an outside source, typically clear and precise

Scenario	Scenario Variables	Description
Baseline	Familiarization	5-10 min in length; Used to orient the driver and screen for simulator sickness through a predetermined protocol directed by the researcher conducting the session
1	Implicit Arm (IA)	Reaching task implicitly driven by environmental cues
2	Explicit Arm (EA)	Reaching task explicitly driven by auditory and written instruction
3	Implicit Leg (IL)	Foot pedal task to follow an erratic driver and implicitly adjust their speed and following distance according to situational cues
4	Explicit Leg (EL)	Foot pedal task to follow a police vehicle with emergency lights through a construction zone to explicitly directing the driver to adjust their speed and maintain a steady following distance
5	IAIL (Dual-task)	Combines the implicit arm task with the implicit leg task, requiring attention switching between two implicitly directed tasks involving both arm and leg.
6	IAEL (Dual-task)	Combines the implicit arm task with the explicit leg task, requiring attentional switching given the different extremities and modes of direction for task cueing
7	EAIL (Dual-task)	Combines the explicit arm task with the implicit leg task, requiring attentional switching given the different extremities and modes of direction for task cueing
8	EAEL (Dual-task)	Combines the explicit arm task with the explicit leg task, requiring attention switching between two explicitly directed tasks involving both arm and leg

***Figure 1*: Development of Driving Scenarios**

IA - includes three rain storms that increase in severity throughout the drive, rain gradually covers the windshield to occlude the driver's view until they implicitly decide to reach and press the windshield wiper button, which caused the wipers to respond once across the windshield; the reduction of vision creates press to implicitly warn the driver of unsafe conditions and to respond as needed

EA - auditory directions and text appeared on the simulator's main screen explicitly telling the driver when to turn the headlights on and off, an indicator light displays on the dash and provides an additional explicit cue of the headlight's state (on/off)

IL - involves an unmarked white construction van driving erratically/unpredictably; the driver must follow this lead vehicle and implicitly adjust speed/following distance to avoid a collision, a closely following/honking taxi behind the driver provides additional implicit cues to maintain safe following distances

EL - uses a marked police car with flashing emergency lights to explicitly direct the driver's speed/following distance while driving through a construction zone with concrete barriers to guide the driver's path

Dual-Task - All single task scenarios were then crossed via arm and leg tasks to create four additional dual-tasking scenarios that were implicitly/explicitly directed or combined both types for performance comparison in attentional allocation and prioritization

Results

- Results are preliminary, data collection has not been completed
- Data analysis from experimental drives will be coming soon
- **What impact would driving cessation have?** 17/22- Loss of independence; 15- Loss of roles/Habits/Identity; 11- Would have a large impact
- **How much planning have you done and what support do you have?** 14/22- Have done no planning/Haven't thought about it; 7- Have done some planning; 1- Have done lots of planning/Already implementing a plan
- **Interest level for a class addressing prevention of driving cessation?** 13/22- It would be helpful/Learn something new; 11- High perceived current driving function/Not relevant; 5- It would be helpful to provide support (Group/Family/Spouse)

Future Direction for Research

- Complete data collection and analysis
- Identify deficits in dual-tasking skills from data analysis
- Disseminate findings: scientific journals, research/professional forums
- Next Phase of Research:
  - Review of literature to identify EBP tools in PT/OT rehabilitation intervention that addresses the identified deficits
  - Grant application to test intervention effects on safe driving skills using simulator
- Community-based program for drivers with PD and other diagnoses or age-related impairments to prolong independence through safe driving

***Figure 2*: MiniSim™ Driving Simulator, developed by NADS**

References

See attached.

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