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Parkinsonism and Related Disorders

Dual task performance in Parkinson's disease: A sensitive predictor of impairment and disability

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ABSTRACT

Background: Dual task (DT) performance assesses the ability to perform two tasks simultaneously. Difficulty with DT performance may be a sensitive indicator of early Parkinson's disease (PD) impairment. The objective of this study was to assess what elements of a DT performance (cognition or gait) are most associated with impairment and disability in PD.
Methods: Performance in single and DT conditions was examined in 154 PD patients. The single task assessments included the time required to walk 50 feet (gait speed) and the number of words generated in a verbal fluency task (word generation). The DT comprised simultaneous performance of the single tasks. Impairment and disability were measured with the Unified Parkinson's Disease Rating Scale, Hoehn &Yahr, Berg Balance Scale, and Older Americans Resource and Services Scale. Age, education, and gender were control variables. Standardized residuals from regressions of DT upon single task performance were computed separately for word and gait, indicating the extent that the individual performed proportionally better/worse than predicted in DT considering their single task performance.
Results: Multiple regressions revealed that individuals who performed worse than expected in DT-word had greater impairment and disability. Dual task-gait was not significant in any model. Verbal fluency during DT performance is more closely associated with PD-related impairment and disability than gait speed during DT.
Conclusion: This suggests that subjects prioritize gait performance at the expense of cognitive performance, and that DT word generation may be a sensitive indicator of early PD impairment and disability.

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1. Introduction

Early studies of cognition in Parkinson's disease (PD) implicate attentional impairment [1–3] and executive dysfunction [4–6] in addition to the motor deficits. A link between executive control and motor performance in healthy older subjects found poor executive control was associated with poorer performance on an obstacle course [7]. Other studies have further investigated the link between cognition and motor control using DT paradigms which assess the ability to execute two tasks simultaneously. In many cases a motor task, for example walking, is combined with a cognitive task, for example counting backwards from 7. In studies of DT performance in healthy aging, adults successfully use strategies such as slowing walking speed or reducing the timing of the secondary cognitive task and show little change to their gait patterns when walking.

If the performance of two tasks is similar when the tasks are carried out either individually or concurrently, it is assumed that the two tasks are functionally independent and use different resources, however the two tasks are considered to use the same cognitive resource if there is a decrement in one or both during DT performance [8]. If gait and cognitive function are indeed independent systems, then increasing cognitive load would have no effect on gait. However there is mounting evidence that gait and cognition are not independent since increasing cognitive load alters gait performance in older adults [9], adults with Alzheimer's disease [10,11], stroke patients [12,13], and adults with PD [14,15].

Some but not all cognitive tasks interfere with postural control and walking in PD [16,17]. Cognitive tasks such as counting backwards [14,16,18], naming colors [19], answering simple questions [17,20] and generating names [21] have been reported to affect postural sway, stride time and variability [14] and cadence in PD [18]. In most DT studies investigators analyzed motor performance and not the secondary cognitive task. During DT performance a participant may show a decrement in one or both of the tasks. By analyzing performance levels on both tasks information regarding resource sharing, task prioritizing, and individual differences in impairment among participants is obtained.

Progression of Parkinson's disease ultimately leads to disability however, before overt disability is recognized there is a period of preclinical disability. During this time patients describe few difficulties in daily living, however, closer inspection reveals that this is usually due to successful compensation in their activities or daily functions [22,23]. Earlier identification of preclinical disability may allow for improved care and earlier intervention to delay disability. Decrement in DT performance may assess subtle impairment in this preclinical stage. A person may successfully complete the single tasks of word generation and walking but impaired performance of either or both tasks during dual tasking may provide evidence for earlier identification of preclinical disability.

To date, no study has examined the relationship between DT performance and disability and impairment while concurrently investigating the specific effects of dual tasking on both motor and cognitive performance in PD. In this study performance on a word generation task and walking task in patients with PD in single task and DT conditions is documented. Given the links between impaired gait and disability in PD [23–25], we hypothesized that walking speed decrements would be more closely associated with impairment and disability in PD than word generation impairment.

2. Method

2.1. Sample

This study used data from 154 patients diagnosed with PD at the University of Maryland's Parkinson's Disease and Movement Disorders Center. Patient data was collected between June, 2006 and January, 2008. Criteria for diagnoses were based on asymmetrical onset of at least two of the following signs: resting tremor, rigidity, and bradykinesia. All participants gave their written informed consent and this study was approved by the University of Maryland School of Medicine Human Research Protections Office.

2.2. Measures of impairment and disability

Four measures of impairment and disability were administered by a treating neurologist or qualified research assistant. Patient-reported disability was measured using the Older Americans Resource and Services (OARS) Disability subscale [26], which measures ability to perform certain tasks. The OARS was modified for use in PD: 1) the three responses of no difficulty, needs some help, or unable to perform were increased to five with the addition of two intermediate responses: slower/with greater difficulty and needs moderate help, and 2) since motor function varies throughout the day all subjects were asked to choose two responses for each daily activity, describing their ability to perform each task at their best (OARSBest) and worst (OARSWorst) function during the past week. The Unified Parkinson's Disease Rating Scale (UPDRS) [27] and Hoehn and Yahr Staging (HY) [28] measured disease severity. The Berg Balance Scale (BBS) [29] determined balance ability.

2.3. Motor and cognitive performance measures

Performance in single task (ST) and DT conditions was examined in 154 patients. The single task motor condition was a gait speed task that required the patient to walk 50 ft. at a comfortable pace (STGAIT). The single task cognitive condition involved a 60 s verbal fluency task which participants performed while seated. This task measured the number of words a patient could generate in 60 s, given a specific letter (F, A, or S). By dividing this value by 60, we measured words per second (STWPS). Dual task performance comprised simultaneous performance on both tasks. Each participant performed the single task verbal fluency task first, followed by the single task motor condition, and performed the dual task last.

2.4. Control variables

Age, education and gender were used as control variables. Due to significant skew, education was dichotomized to college graduates (60%) and non-college graduates (40%).

2.5. Data analysis

Data analysis used the Statistical Package for Social Sciences (SPSS) Version 16. Total scores for OARSBest, OARSWorst, UPDRS, HY, and BBS were computed to measure disability and impairment. Scores on the BBS were reverse coded with higher scores indicating greater impairment to be consistent with the other scales. We computed predicted scores of the dual task functioning (DTGAIT or DTWPS) from the scores on the single task (STGAIT or STWPS) and then used the standardized residuals (which is a form of predicted score minus actual score) as our main predictive variables (GAIT_RES and WPS_RES). This method of analysis was necessary for two reasons. First, while difference scores between DT and ST could be calculated on gait variables, a simple subtraction of WPS between ST and DT was not feasible. In the ST verbal task, patients had 60 s to generate as many words as possible. However, in DT, they had as long as it took them to walk 50 feet. Therefore, many times the WPS calculation in DT was based on time frames much lower than 60 s. Research indicates that word generation is more abundant within the first 15 s and reduces as more time passes [30]. Thus, DTWPS is not comparable to STWPS using a straightforward difference score. By using ST to predict DT and saving the residuals, we were able to bypass this issue. The second reason was that simple difference scores also do not take into account the sample as a whole and how each individual is expected to perform based on the performance of others in the sample. In order to address the difficulty in comparing ST and DT performance, and for the sake of parsimony, a regression of residuals allowed the study to more effectively measure whether DT can predict disability and impairment.

A series of hierarchical regressions was used to determine if residuals from DTGAIT and DTWPS could be used to predict impairment and disability as measured by OARSBest, OARSWorst, UPDRS, HY, and BBS. Control variables of age, gender, and education were entered in to each regression model at step 1. Residuals for DTGait and DTWPS were both entered at step 2. This allows us to understand the relationship between performance on DT above and beyond an individual's age, gender, and education level.

3. Results

Patients had a mean age of 64.3 (9.4) years (mean (standard deviations)) and the majority of subjects were male (62%), white (95%), and college graduates (60%). The mean score on the Mini Mental State Examination [31] was 29.1 out of 30, and the mean depression rating from the Brief Symptom Inventory (BSI) [32] was 48.2 percentile, for which the average rating in the general population is 50.

The OARS total at best performance ranged from 15 to 38 with a mean (SD) of 16.3 (5.6). The OARS total at worst performance ranged from 11 to 59 with a mean of 21.1 (9.3). The UPDRS Motor Exam total ranged from 0 to 66 with a mean of 24.7 (12.2). The majority of subjects (61%) had bilateral PD without impairment of balance on the HY (Stage 2) with 10% having less severe symptoms (HY < 2) and 29% having more severe PD (Stages 2.5, 3, and 4). The Berg Balance total score ranged from 23 to 30 with a mean of 29.1 (1.2).

The mean single task gait speed was 17.6 (6.4) seconds while the mean dual task gait speed was 23.7 (11.0) seconds. The mean single task word generation was .29 (.10) words per second and the mean dual task word generation was .40 (.18) words per second.

Hierarchical regressions controlled for age, education, and gender. The results of the hierarchical regressions reveal that the proportional change in word generation performance between single and dual task (DTWPS_RES) significantly predicted disability and impairment on OARSBest, OARSWorst, UPDRS, HY and BBS (Beta range −0.20 to −0.25, all $t > 2.2$, all $p < 0.05$) even accounting for the change in gait performance. The proportional change in gait performance between single and dual task (DTGAIT_RES) was not a significant predictor of these same measures of disability and impairment (Beta range −0.02 to 0.09, all $t < 1.1$, all $p > 0.10$) when