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Everyday Reasoning Abilities in Persons with Parkinson's Disease

Tiffany L. Young, M.A, **Antoneta Granic, M.A.**, **Tuo Yu Chen, M.S.**, **Christine B. Haley, M.S.**, and **Jerri D. Edwards, PhD**
University of South Florida

Abstract

Parkinson's disease (PD) patients develop progressive cognitive decline [1-3]. The degree to which such decline impacts instrumental activities of daily living (IADL) among individuals in the early stages of PD without dementia is not well documented. The Everyday Cognitive Battery Reasoning subtest (ECB) was used to assess ability to solve everyday reasoning tasks for IADL among 19 non-demented older adults with PD in comparison to 20 older adults without PD. The two groups were similar in age, education, race and gender. Individuals with PD had significantly lower scores (M = 61.98, SD = 12.03) than the comparison group (M = 69.80, SD = 9.48). Individuals with PD, who do not have dementia, may be more likely to experience difficulties in IADL requiring reasoning including medication use, finances, and nutrition. Even more serious implications lie in the capacity to make treatment choices [4].

Keywords

Parkinson's disease; reasoning; Everyday Cognitive Battery; cognitive impairment

Parkinson's disease (PD), a chronic neurodegenerative disorder characterized by a progressive loss of dopaminergic neurons and accumulation of Lewy bodies in the brain [5], affects nearly 1 million people in the United States [6]. Although the disease has deleterious effects on the human motor system, progressive decline in cognitive abilities at all stages are also recognized as a hallmark of the disease [1, 7].

Cognitive impairments are a better predictor of everyday functional capacity and future disabilities among PD patients than their declining motor abilities. Research indicates that non-demented PD patients have cognitive impairments in attention [9, 10], memory [10], event knowledge [11] and executive functions [3, 12], which can impact their everyday functioning. Similarly, other studies indicate that impairments in executive functions also result in reasoning and problem solving difficulties among persons with PD, e.g., [13, 14]. Thus, of

Correspondence: Address correspondence to Jerri D. Edwards & Tiffany L. Young, USF College of Behavioral and Community Sciences, School of Aging Studies, 4202 E. Fowler Ave, MHC 1326, Tampa, FL 33620. jedwards1@cas.usf.edu.

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interest is examining whether such reasoning difficulties impair instrumental activities of daily living (IADL), even in the early stages of PD without dementia.

The domain of reasoning represents an organized, sequential set of cognitive processes that must be properly planned and executed in order to reach a goal [15]. Deductive reasoning is a process by which valid conclusions can be reached from sets of general premises, whereas inductive reasoning involves making generalized inferences based on observable patterns of particular information. According to Marsiske and Margrett [16], problem solving includes “goal directed cognition in which an individual constructs, plans, and/or formulates behavioral responses aimed at resolving a discrepancy between an initial state and a desired end state” (p. 316). The ability to use reasoning is necessary for logical problem solving and assigning meaning to acquired bits of discrete knowledge [17]. Past research has indicated that reasoning abilities, in particular inductive reasoning, predict success in complex, practical problem solving [18-20].

PD and Reasoning

Prior research has demonstrated impaired inductive reasoning abilities in individuals with PD as compared with non-PD controls [21]. Natsopoulos and colleagues [17] tested inductive and deductive reasoning in individuals with idiopathic PD on a series of multiple choice tasks comprised of five tasks of deductive reasoning (syllogisms) and three tasks of inductive reasoning (logical inference, metaphors and similes). Individuals with PD who had early disease onset or late disease onset were compared to each other and controls. Subgroup analyses were also performed comparing individuals with PD with predominately left, right, or bilateral hemisphere symptoms to each other and controls. Only the subgroup of PD patients with earlier disease onset and bilateral disease pathology showed impaired reasoning compared to healthy controls. Additional research is needed to further our understanding of reasoning in PD patients in everyday situations demanding contextual problem solving. Difficulties in reasoning among persons with PD may or may not be evident in IADL.

The use of measures that mimic real life situations is necessary to understand the connection between the deficits in higher cognitive functions and difficulties in everyday functioning. Everyday cognition has been conceptualized as the performance of individuals on problems using natural stimuli [19]. Measures such as the Everyday Cognition Battery (ECB) may be useful in this regard because the questions are based on three real-life situations (i.e., accurate medication use, finance management, understanding nutritional values and food preparation) and may better detect cognitive decline as it relates to IADL.

The ECB was developed as an alternative to traditional non-contextual tests of cognition among community-dwelling older adults [19]. The ECB assesses performance on tasks individuals might encounter in their daily lives. The ECB measures inductive reasoning, declarative memory, and working memory by assessing one's ability to comprehend medication use, financial planning, and food preparation and nutrition information through the use of real world printed materials (i.e medication labels, checking statements, and food labels) [19, 20, 22]. Allaire et al. [23] used the ECB memory subtest to demonstrate that older adults with MCI perform more poorly on memory tasks in three domains.

Although the ECB measure is commonly used in the field of cognitive aging [19, 20, 22, 24], to date, it has not been used in studies among individuals with PD. Therefore, the purpose of this study was to use the ECB [19] to compare inductive reasoning for IADL among non-demented individuals with PD to cognitively intact older adults. We hypothesized that PD patients will exhibit greater difficulties with inductive reasoning for everyday tasks than older adults without PD.

Method

Participants

Community-dwelling participants with and without a diagnosis of PD were recruited through a newspaper article describing the research as well as University of South Florida health fairs. Individuals with PD were recruited through the University of South Florida Neurology Clinics and PD support groups throughout the Tampa Bay, Florida area. Forty-three participants (30% females) were screened for this study and ranged in age between 55 and 86 years (M = 70.28, SD = 8.65). The majority of the participants were Caucasian (95%) and had an average of 15.03 (SD = 2.31) years of education. The inclusion criteria for these analyses were a Mini-Mental State Examination (MMSE) score of 23 or higher, no diagnosis of dementia, and a Geriatric Depression Score (GDS) of 10 or lower. Individuals with PD were in the early stages of the disease (Hoehn andYahr stages I-III). Two participants with the PD diagnosis had an MMSE score lower than 23 and 1 participant had a GDS score higher than 10 and were excluded. Participant characteristics by PD diagnosis are reported in Table 1.

Measures

Mini-Mental State Examination (MMSE)—Mini-Mental State Examination (MMSE) was used to confirm participants' eligibility for the study. The test examines orientation, registration, attention, calculation, recall, language, and praxis [25]. The psychometric properties of the measure have been well-established and show high sensitivity and specificity for moderate to severe cognitive impairment [26]. A score of 24-30 typically indicates no dementia [26].

Geriatric Depression Scale: Short Form (GDS-SF)—The GDS-SF is a 15 item yes/no answer formatted scale that was used to measure depressive symptoms. Total scores range from 0 to 15 with higher scores suggestive of depression [27]. The psychometric properties of the measure have been well established such that it has high sensitivity and specificity. Furthermore, the GDS-SF has been found to be highly correlated (r = 0.89, $p \leq 0.001$) with the Geriatric Depression Scale: Long Form [28, 29].

Near Visual Acuity (NVA)—The study used a Goodlite Near Visual Acuity (NVA) chart to examine the participants' visual acuity. The participants were tested 40 cm away from the chart with their lens correction, if any. The scores ranged from -0.30 (20/10) to 1.30 (20/400) Log Minimum Angle Resolvable (logMAR).

Everyday Cognitive Battery: Reasoning Subscale (ECB)—ECB is a measure consisting of 42 items that was used to assess participants' ability to identify information relevant to everyday life and the use of that information to answer a series of questions in three domains: medication use, financial management, and food preparation and nutrition [19, 20, 22]. Similar to traditional measures of inductive reasoning that require participants to scan a series or set of information to identify a pattern, the ECB Test required participants to answer questions based on contextually relevant stimuli (Participants were asked to study a recipe and then were asked relevant questions such as; “Which ingredient is mixed with sour milk?”). Six naturally occurring matrices consisting of information related to Medicare benefits, medication interactions, prescription bottle labels, checking account comparisons, nutrition labels, and the food guide pyramid were presented to participants, each of which was followed by a series of seven related questions. The participants had access to the matrices and could refer back to them to answer the questions such that memory was not taxed. A correct response to an item received a score of two and an incorrect response received a score of zero according to administration instructions [19]. Partial scores of one were received for two part items in which the participant only gave one correct response. Scores were summed across domains to obtain an overall ECB score. The reliability (Cronbach's alpha) of the ECB reasoning items are 0.88 [19]. The inter-rater reliability kappa has been reported as 0.98 [19]. For this study every participant score was reviewed by two raters and there was 100% agreement among raters.

Procedure

This case-control pilot study was approved by the USF Institutional Review Board. All assessments were administered during in-person visits at the USF School of Aging Studies. Trained research assistants facilitated the testing session in a quiet testing room within a two-hour time frame with frequent rest periods to avoid participants' fatigue. The testing session included in-person assessment of PD diagnosis (e.g., disease onset, first symptoms and duration), vision, hearing, depressive symptoms, everyday reasoning, and demographic information. The primary outcome for the study was everyday reasoning performance assessed by the ECB in three instrumental domains (i.e., medication use, financial management, and nutrition and food preparation).

Results

There were 40 eligible participants. However, one participant with PD refused to complete the testing. Thus, the final participant number was 39; 19 PD and 20 comparisons. Descriptive analyses were conducted to examine characteristics by PD status (Table 1). Two missing data points were substituted using regression.

To establish if the participants in the PD diagnosis group were equivalent to the participants in the comparison group on age, educational level, gender, race, and MMSE, NVA, and GDS-SF scores, MANOVA and Chi-square analyses were conducted. MANOVA illustrated that there were no overall groups differences in age, education, or depressive symptoms, Wilks' Lambda = .771, F(5, 33) = 1.97, p =.110. Chi-square analyses demonstrated that there were no significant differences between the groups in gender, $\chi^2(1, N = 39) = 0.011$, p = .915 or race, $\chi^2(2, N = 39) = 2.00$, p = .37.

An independent t-test was conducted to examine if there was a difference between the PD diagnosed and comparison groups on ECB performance. A significant difference was found, $t(34.21) = 2.25$, p = .031, an effect size (d) of 0.72. The participants in the PD diagnosis group had significantly lower scores (M = 61.98, SD = 12.03) than the comparison group (M = 69.80, SD = 9.48). The PD diagnosis group performed on average at 74% proficiency ranging from 41% to 97%, while the comparison group performed on average at 83% proficiency ranging from 61% to 98%; thus, there were individual differences in performance among the PD group. Across the three domains individuals with PD (financial, M=22.17, medication M=20.61, nutrition, M=18.39) performed lower overall than the comparison group (financial, M=25.10, medication M=23.00, nutrition, M=21.60).

Preliminary exploration of the relationship of available demographic and cognitive factors among both the PD and comparison groups to ECB performance was conducted using regression. Age, MMSE, and GDS scores were significant indicators of ECB performance (ps< .015), while vision was not. These three variables accounted for 57% of the variance in ECB reasoning scores (Table 2). We further tested if the relationship between PD status and ECB reasoning performance was mediated by depressive symptoms using linear regression and Baron and Kenny's [30] criteria for the Sobel test. Results indicated that depression was not a significant mediator (z= -1.606, p=.108).

Discussion

This study was designed to investigate the reasoning abilities of PD diagnosed individuals in relation to a comparison group as measured by the ECB. The hypothesis that PD diagnosed individuals would exhibit deficits on the inductive reasoning subtest of the ECB was supported. The PD diagnosed group scored lower on the ECB than the comparison group. As the ECB measure requires older adults to problem solve for "real world" activities, the results of this study suggest that early cognitive decline in reasoning among persons with PD may also result in IADL difficulties.

Although some research has attributed decision-making difficulties among persons with PD to executive functioning [31, 32], these results indicate that inductive reasoning may also play an important role. However, it is important to note that these studies measured decision-making in the presence of positive and/or negative feedback. Making good decisions in the absence of or prior to, receiving feedback requires the ability to use reasoning to think critically about a set of factors in order to reach an appropriate conclusion. Many everyday tasks, such as those performed in the present study, call for problem solving with no feedback given prior to the point at which a decision must be made. Therefore, persons with PD who have reasoning impairments may also have diminished capacity to make good decisions.

It is important to note that reasoning is a complex cognitive process that relies on several interconnected fundamental mental activities such as perception, attention, executive function and memory [33]. Although deficits in prospective memory [34] are believed to underlie the inability of PD patients to implement adequate cognitive strategies [35] necessary for successful higher-cognitive functioning, Allaire and Marsiske [19] found that neither basic knowledge, declarative memory, or working memory accounted for performance in the ECB reasoning subtest. Thus, it may be unlikely that the ECB reasoning difficulties observed among some participants with PD can be contributed to memory deficits.

It is important to note that additional analyses indicated that the MMSE predicted performance on the ECB. This finding suggests that more general cognitive processes also play a role in facilitating tasks that require reasoning abilities. Although GDS scores also contributed to ECB performance, the relationship between PD status and ECB performance was not mediated by GDS scores. Thus, it is important for future researchers to disentangle these processes to further understand reasoning deficits in and applicable cognitive training interventions for individuals with PD.

To live independently, one must be able to perform numerous IADL. In this study we focused on three domains of IADL (i.e. medication use, financial management, and food preparation and nutrition). Other research has found that individuals with PD without dementia also have difficulties with IADL as indicated by driving due to cognitive speed of processing difficulties independent of motor speed, as measured by the Useful Field of View Test [36]. This test is also strongly related to performance of other IADL [37]. Thus due to cognitive difficulties (such as reasoning and speed of processing), individuals with PD may have a broad range of IADL difficulties, even in the early stages of the disease and without evidence of dementia.

Furthermore, if individuals with PD do experience reasoning deficits and impaired decision-making abilities, then there are serious implications for their capacity to make treatment choices[4]. Two facets of treatment choices are medication use and insurance benefits as measured by the ECB. Understanding and choosing appropriate medication and insurance benefits require complex reasoning. Researchers examining medical decision capacity found that individuals with PD needed to be cued to make treatment choices due to the symptomatic characteristics of PD such as inattention and slowed speed of processing [4]. Our results further indicate that reasoning may play a role as well. It is necessary that physicians and family members are aware of reasoning deficits in some individuals with PD as they may need assistance in making proper health related choices [19].

Another concern with individuals diagnosed with PD is whether their motor impairments limit their reasoning abilities. For example, a strategy for an individual who is experiencing memory problems would be to write down their thoughts. However, writing may be a problematic motor skill for someone with PD. While the focus of this study was to explain reasoning deficits as a probable predictor of functional impairment in lieu of motor symptoms, it is possible that there is a relationship between motor symptoms and reasoning abilities that may further limit functional abilities [38]. Thus, future studies examining individuals with PD should also assess how their motor symptoms and reasoning skills operate together.

Furthermore, researchers should investigate if cognitive training may potentially facilitate gains in the reasoning abilities of individuals with PD. Recent research among older adults has found that reasoning can be improved through training [39]. Researchers have found that the effects of reasoning training endure for up to five years and positively impact self reported IADL [39]. Future research should examine whether reasoning training may be beneficial to older adults with PD.

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Table 1

Characteristics of Eligible Participants by Parkinson's Disease (PD) Diagnosis

	PD (n=19)		Comparison (n=20)	
Variable	***M***	***SD***	***M***	***SD***
Age (years)	70.35	9.13	69.75	8.98
Education (years)	14.53	2.12	15.10	2.38
Mini Mental State Exam Score	27.74	1.88	28.45	1.85
Near Visual Acuity Score (LogMAR)	0.12	0.16	0.40	0.13
Geriatric Depression Scale-Short Form Score	3.03	2.51	1.15	1.66
Everyday Cognitive Battery Reasoning Total Score†*	61.98	12.03	69.80	9.48
Gender (female)	32%		30%	
Race (Caucasian)	95%		95%	

Note. All eligible participants had MMSE score of 23 and higher.

*Mean difference $p < 0.05$.

†Total ECB scores are out of 84

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Table 2

Regression Analyses Predicting Participants'(with and without Parkinson's Disease) Everyday Cognitive Battery Reasoning Score

Variables	R^2	β	p
Model Summary	.569		
Age		-.335	.012
Mini Mental State Exam		.491	.000
Geriatric Depression Scale		-.261	.040
Near Visual Acuity		.113	.368