Performance on daily life activities and executive functioning in Parkinson's disease

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Conflicts of Interest

None declared

Abstract

Purpose

This study aimed to know the impact of executive functions on the performance of Activities of Daily Living (IADL) in Parkinson’s disease (PD).

Methods:

A cross-sectional descriptive study was conducted with 94 participants (64 PD and 30 controls).

Results:

The poor inhibitory control and verbal fluency in PD could be related to their performance on IADL as poorer executive performance directly influences the motor and process skills needed to perform IADL.

Conclusion:

Our results suggest that rehabilitation activities for these executive tasks could be of interest for the performance of PD patients.

Keywords: Activities of Daily Living, Parkinson Disease, Executive Function.

Introduction

Parkinson's Disease (PD) is an example of an age-related neurodegenerative disease[1]. Specifically, PD is the second most common neurodegenerative disease[2] affecting older people[3], with age being a major risk factor for Parkinson's Disease[4]. PD is a chronic neurological disorder that causes a progressive disability and a deterioration in the quality of life of the patient and the caregiver[5], gradually undermining the ability to perform Activities of Daily Living (ADL)[6]. In the advanced stages, the complications of the disease, make it difficult to continue daily routine[7]. PD is associated with aging, the most common age for the onset of diagnosis is 60 years of age. It affects 1% of all people above the age of 60 years[8].

In order to better understand the pathogenesis of PD, it is important to consider possible contributory factors inherent to the aging process, as age-related changes in several physiological systems appear to influence the onset and progression of this neurodegenerative disorder. It is essential to keep in mind that aging affects both motor and cognitive skills.

PD has traditionally been defined by a set of motor symptoms (bradykinesia, rigidity, and tremor) and multiple studies have been carried out on the repercussions of these impairments on the functionality of these patients[9].

According to Tse and Spaulding[3], deficits in the motor function have a great impact on ADL. Patients with PD exhibit difficulties with balance, carrying objects while walking[2] and coordination[10], as well as delays in initiating movement, slowness in making movements, difficulties in stopping or changing sequential movements, and problems when performing two motor actions simultaneously[3]. Therefore, people with PD perform worse in Basic Activities of Daily Life (BADL) and in Instrumental Activities of Daily Life (IADL)[7, 11-12].

In spite of the great impact of the motor symptoms, several authors have suggested that the cognitive function[10] and other non-motor symptoms could have a greater impact on the functionality in PD[13]. As a result, recognition of the presence and impact of non-motor symptoms has increased in recent years[6]. The performance of PD patients when performing ADL may worsen when the disease is associated with non-motor symptoms such as mild[9] or major[14] neurocognitive disorder.

The presence of mild neurocognitive disorder in PD is associated with worse quality of life and functional impairment[15], which negatively influences their performance of ADL as well as their quality of life; additionally, worsening the workload placed on the caregiver[16]. These deficits can be seen in tasks such as medication administration and financial management[9]. Similarly, major neurocognitive disorder implies worse functionality in IADL[14], increasing the caregiver's burden and dependency and decreasing the quality of life[17].

Among the cognitive impairments, the executive dysfunction may be the most well-defined component of PD, characterized by deficits in the internal control of attention, planning, inhibitory control, dual task performance, decision-making, social cognition tasks, sequencing of complex actions, cognitive flexibility[18], and semantic fluency[19]. Executive dysfunction is also a relevant factor impacting ADL in PD[20] given that executive functions orchestrate many of our daily occupations, including the IADL, social interactions, and leisure activities[13]. Due to the cardinal signs of PD are related to motor impairment, the rehabilitation process has been more focused on the motor skills. However, we must also consider cognition, being the executive functions essential skills to optimal functionality[8]. For this reason, rehabilitation programs for PD should target such executive dysfunctions. With this purpose, several studies have attempted to clarify the relationship between specific executive dysfunctions and ADL/IADL[13,20,21].

Current rehabilitation practices emphasize the need for approaches based on neuroplasticity principles to challenge the impaired system, for example, executive functions[22]. Foster and Hershey[13] found that the executive deficits in patients with PD significantly interfere with their daily routine, particularly affecting self-care strategies, given their considerable demand on executive skills such as planning, initiation, and self-control. However, neurocognitive assessment in this study does not differentiate between the possible effects of specific executive functions. Kudlicka et al.,[20] using a semi-structured interview to assess performance of patients with PD, demonstrated that the executive functions were associated with worse daily functioning and reduced quality of life. The executive function impairments were more noteworthy in IADL, in tasks associated with control of attention, planning, reasoning, decision-making, and management of objects. The use of a semi-structured interview though, rather than observational evaluations, limits the assessment of the true effects of these deficits on the ADL performance in this study. Foster[21] evaluated the global cognitive functioning in PD using the Mini-Mental State Examination (MMSE), and its relationship with

IADL. Results of this study showed that medication management, shopping and sharp utensil use activities appeared to be most sensitive to cognitive performance problems in PD. Also, performance of IADL was less efficient, less precise, or required an increased effort compared to non-PD participants[21].

Although multiple studies have evaluated the functionality of ADL in PD, most of them have used tools such as the Unified Parkinson's Disease Rating Scale (UPDRS)-part II, the Barthel Index[7], Index of Lawton & Brody[9] or the Nottingham Extended Activities of Daily Living Scale[11]. Despite their good psychometric properties and wide utilization, these instruments do not allow to obtain information about the specific performance on the motor and processing skills in the evaluation of IADL. One of the instruments designed for the evaluation of IADL performance in patients with PD, including motor and process skills is the Assessment of Motor and Process Skills (AMPS)[23]. The AMPS is a standardized observational evaluation instrument with a widely-documented reliability and validity in populations with multiple diseases, although its use in patients with PD is scarce[24-25].

Although the impact of motor deficits on daily activities of patients with PD is well-known, the evaluation of the impact of cognitive deficits, and more particularly at the executive level, still requires more research. The purpose of this study is to measure and compare the executive functioning and performance in IADL of people with PD with those of healthy people and evaluate the relationship between specific executive functioning in patients with PD and their observed performance on instrumental activities of daily living. Our results will contribute to improve rehabilitation programs for PD in the elderly, improving abilities to perform IADL.

Method

Design

This a cross-sectional descriptive study with a quasi-experimental design carried out using a quantitative methodology.

Procedure

Before undergoing the evaluation, all participants gave their written informed consent to participate in the study. This project was approved by the Ethics Committee of the

Hospital Universitario Central de Asturias (HUCA) in 2016 (Number: 178/16). Data collection was carried out between September 2015 and December 2017.

Participants

A total of 94 adults (64 diagnosed with PD and 30 controls; 58.5% women), with ages ranging from 50 to 86 years (mean age = 68.5 years, SD = 8.02), participated in the study. Three people were excluded because they presented a cognitive and/or functional deficit that prevented them from developing all the necessary tests for research.

Participants with PD were selected from among the patients in the Movement Disorder Unit of the Hospital Universitario Central de Asturias (HUCA). The inclusion criteria were: 1) diagnosis of PD by a specialist; 2) age between 30 and 75 years; 3) being in treatment and follow-up by the Movement Disorder Unit of the HUCA. The control group was made up of participants without a diagnosis of Parkinson’s disease, who were recruited by asking for volunteers. The inclusion criteria were: 1) absence of a diagnosis of Parkinson’s disease and/or neuropathology, and 2) aged between 30 and 75 years.

Instruments

All participants completed a battery of instruments evaluating sociodemographic characteristics and neuropsychological performance. The entire assessment was carried out by specifically trained Occupational Therapists and Psychologists and was conducted in the Asociación Parkinson Oviedo (Asturias). Participants with PD were tested while on their regular antiparkinsonian medications.

Hoehn & Yahr scale[26] measures the severity of the PD by considering five stages in eight levels. This scale shows satisfactory acceptability and a moderate to high correlation with other measures of PD[27].

The Unified Parkinson's Disease Rating Scale - Part III (UPDRS-Part III) [28] measures the longitudinal course of the disease. Part III is specifically aimed at evaluating motor function. The score ranges between 0 and 108, with the highest score representing total motor disability and 0 no disability. Hoehn & Yahr scale has lower inter-rater variability compared to UPDRS-III: 0.9547 ($p < .001$)[29].

The neuropsychological assessment battery included the following instruments:

Montreal Cognitive Assessment (MOCA)[30]. MOCA evaluates attention, concentration, executive functions (including the capacity for abstraction), memory, language, visuoconstructive capabilities, calculation, and orientation. The MOCA is divided into 7 different subsections, and its test-retest reliability yields a correlation coefficient of .79, and an interrater reliability of .81[31]. Scores between 14 and 21 signal the presence of a minor neurocognitive disorder, and scores below 14, signal the presence of a major neurocognitive disorder[32].

The Tower of London (TOL)[33] evaluates the impairment in the planning processes associated with frontal lobe dysfunctions. This test consists of two towers, one for the person evaluated and the other for the evaluator. The towers are formed by three bars, organized from larger to smaller sizes, and three colored balls (blue, red, and green). The evaluator marks a pattern in his/her tower, and the person evaluated has to achieve the same pattern following a series of norms and with the fewest possible number of moves. Out of the eight possible measures provided by the instrument, two were selected for the present study: Total Correct Score, which indicates the number of items resolved in the fewest number of moves; and the Total Move Score, which reflects the number of moves the participant needed to resolve all the items. This instrument presents a reliability index ranging between .329 and .794 [34].

The Color and Word Test (STROOP)[35] was used to evaluate cognitive flexibility, selective attention, information processing speed, and inhibition of automatic responses. The index obtained is an indicator of the ability to resist verbal interference. This test is composed of three tasks presented in a fixed order: word reading; reading names of colors; and reading incongruent names of colors (such as the color red printed in green ink). This last task requires participants to respond to the color of the ink and inhibit the reading of the written word. While the two first tasks are relatively automatic, reading words that show incongruence between letters and color of the ink requires the inhibition of the interfering automatic response (reading the word). The measure used is the direct scores from the Stroop Interference Index. Positive scores in interference indicate that the participant has good control over interference, e.g., that they are able to inhibit the natural tendency to read the word. This instrument presents a test-retest reliability of alpha = .70 on all the Stroop cards[36].

Categorical Evocation Subtest of the Barcelona Test (EVOCAT) was used to evaluate semantic verbal fluency[37]. This is a test that requires the utilization of working memory and executive functions, such as initiation and search strategies. It includes two subtests: on the first, as many as possible names of animals have to be given for one minute and on the second, words beginning with the letter «p» or «m» have to be given for one minute. In our study, only the animal naming subtest was used since phonological fluency is already examined with the MOCA. Two variables are collected: direct scores and percentiles. The subtest selected for this study, categorical evocation (animals), has an intraclass correlation of .63 (IC 95%: .36-.80)[38].

The Assessment of Motor and Process Skills (AMPS)[23] is an observational measure of functional competence on IADL that allows the simultaneous evaluation of the motor and process skills necessary to competently perform tasks[39]. Motor skills are goal-directed actions a person undertakes to position one's body and task-objects effectively, such as the ease and efficiency in using the vacuum cleaner. Motor skills in the AMPS include 4 general and 16 specific factors. Process skills denote the person's ability to initiate and logically sequence the required actions for the execution of the task and draw upon cognitive abilities. Five specific general and 20 specific factors are included in the process skills of the AMPS. One trained and calibrated rater, having observed the individual perform the four tasks, scored each of the factors according to a Likert scale of 1 to 4 (severe deficiency to competent execution). To perform the analysis of the specific factors in each of the skills (motor and processing), the data must be introduced into the AMPS Software. In the present study, and in line with previous studies[40-41] we have used the skill measure for ADLs, in logits. Motor skills score in a range of -3 to 4 logits, and process skills ranges from -4 to 3. Ability measures above the 2.00 logits cut-off on the ADL motor scale and above the 1.00 logit cut-off on the ADL process scale indicate effortless, efficient, safe and independent ADL task performance in everyday life, whereas scores below those cut-offs indicate increased effort or fatigue during task performance. Test-retest reliability is .91 for motor skills and .90 for processing skills (Fisher and Bray Jones, 2012).

Performance on two tasks and four IADL was evaluated. Task 1 is composed of the following IADL: L1 - Fold a basket of clean clothes; and J4 - Vacuum, moving light furniture. Task 2 is composed of: F4 - Grilled cheese sandwich and drink; and D2 - Scrambled or fried eggs, toast, and coffee or tea, boiled or filtered. The tasks were thus grouped according to two premises: domestic activities vs. cooking activities, and according to the degree of difficulty of the tasks established by the AMPS.

Statistical analysis

The data were analyzed using the statistical package SPSS version 24.0 for Windows. First, univariate descriptive statistics (mean and standard deviation) were carried out for the general sample and for the two groups on the sociodemographic variables. Second, the evaluation of statistically significant differences between the two groups on the sociodemographic variables was carried out through Analysis of Variance (ANOVA), for the continuous variables, using Bonferroni correction to control for Type I error, and Chi-squared for the categorical variables.

Third, evaluation of differences between the two groups on the results of the neuropsychological tests (TOL, MOCA, Stoop and EVOCAT) were evaluated using Analysis of Variance (ANOVA).

Finally, in order to evaluate the relationship between executive functioning and performance in IADL, Partial correlations were performed between the scores obtained on the neuropsychological tests and the AMPS separately for each group, controlling for sex and age of participants. All analyses were carried out with a Confidence Level of 95%.

Results

Table 1 shows the participants' descriptive results in the whole sample and by groups.

- Insert Table 1 here-

Results indicate that there are significant differences in the average age of the groups ($p = .014$), with a mean of 70.2 years for the PD group and 64.8 years for the control group. With regards to sex, the PD group had a significantly higher proportion of women ($p = .014$). Significant differences were found also in the employment status ($p \leq .001$). In the PD group, most participants (41.7%) were in the second stage of the Hoehn & Yahr scale, indicating a bilateral PD without alteration of the balance. With regards to the UPDRS the average score of PD participants was 15.06.

-Insert Table 2 here-

Table 2 shows the differences between healthy participants and patients on the AMPS and executive functioning scores. Statistically significant differences were found between the two groups on the AMPS tasks ($p \leq .001$), both in the motor and the process level. The CG scored significantly higher in motor and processing skills of the two AMPS tasks, with scores indicating an effortless, efficient, safe and independent performance. Regarding the motor performance, the PD group obtained scores under 1.5

logits in task 1, indicating an increased effort or fatigue during the task performance and the need of assistance. On Task 2, PD group scored >1.5 logits, indicating a lower effort requirement and need for assistance. Regarding processing skills, PD patients obtained scores < .70 logits in both Task 1 and 2, which indicates the need for moderate to maximal assistance regarding meal preparation tasks.

Results for the total score on the TOL indicate that the control group obtained a significantly better score (5.27; p = .001) on the performance of the task compared to the PD group (3.69), which means they completed a larger number of trials using the fewest number of possible moves. In the variable "total number of moves", the PD group obtained significantly higher results (39.29; p = .010) than the control group (24.50), indicating that they required a greater number of moves to complete the test. The control group obtained significantly higher scores than the PD group on the MOCA (p = .027) indicating that they had a better overall cognitive performance.

Regarding the STROOP test, the differences between groups were not significant (p = .113). Therefore, there are not significant differences between the PD group and the control group in their inhibitory control capacity. Finally, the PD group (15.44) evoked significantly fewer animals in one minute than the control group (19.13) (p = .02).

- Insert Table 3 here -

Table 3 shows the results of the partial correlations between the different neuropsychological tests and AMPS tasks, with their respective logits motor and process scores, for each group, controlling for sex and age. In the control group, no significant correlation was detected between scores in the neuropsychological tests and performance in the tasks evaluated by the AMPS. As of the PD group, in the case of the Tower of London, no significant correlations were detected with performance in the AMPS, either in Total Correct Score or Total Move Score. Regarding the MOCA, scores correlated significantly with motor skills on Task 1 (.335) and process skills of Task 1 were significantly and moderately correlated (.341), whereas correlation with motor and process skills of Task 2 were not significant (p > .05). Stroop's direct interference scores were significantly correlated with the logits of the motor and process skills of Task 2 (.305; .279, respectively). Both scores of the Barcelona test correlated significantly with processing skills of both tasks of the AMPS, with a stronger correlation in the case of task 2 (See Table 3). EVOCAT direct score also correlated significantly with motor skills of Task 2.

Discussion

The present study used a representative sample of aged patients with PD to evaluate the impact of the executive impairments on IADL. With this purpose, performance in IADL was evaluated by means of the AMPS, an observational instrument. Results of this study indicate that PD patients have an executive functioning deficit and a deficit in the performance of daily life activities. In addition, executive deficits in inhibitory control and categorical fluency are significantly related to the difficulties presented in IADL. These results have significant impact on the development of effective rehabilitation programs for elderlies diagnosed with PD.

Patients with PD obtained significantly worse results on flexibility, selective attention, information processing speed, and inhibition of automatic responses, generalized cognitive performance, and semantic fluency, compared to the control group. These results coincide with the literature showing that PD has an impact on the executive dysfunction[13,20]. Although the MOCA test indicates that none of the groups met the criteria for minor or major neurocognitive disorder, it seems likely that some participants in the PD group might have dementia given the high variability reflected in the standard deviations.

According to our results, aged patients with PD show worse performance on IADL than healthy population, with significantly lower performance on all the evaluated tasks. Specifically, patients with PD present difficulty in process and motor skills, with a more pronounced impairment in the process skills, based on the scoring criteria established by the AMPS. The scientific literature has already shown that patients with PD present worse performance on IADL[21], but this can be corrected when they receive thalamic stimulation treatment[24]. Our study confirms and extends previous research by utilizing a standardized observational tool, underutilized in population with PD, that demonstrates that these deficits have a significant impact on the execution of IADL in a real context.

Previous studies had suggested that deficits in executive functions could have a significant impact on the IADL performance in patients with PD[13,20]. The executive functions are a set of cognitive processes aimed at controlling behaviors directed toward objectives, from the initial intention to carrying them out[18]. In our study, a significant relationship was found between performance on several executive functions and performance in IADL, after controlling for sex and age of participants.

PD patients obtained significantly lower scores in the TOL, which measures planning ability, which is the ability to identify and organize the necessary steps to formulate and carry out an intention and achieve an objective. In our study, this performance was not significantly correlated with their performance in task 1 and 2 of the AMPS, meaning that such impairments in planning process were not related with performance in IADL.

Secondly, according to the MOCA, there is a positive significant correlation between the cognitive general performance and the motor skills on Task 1 of the AMPS. This means that deficits in overall cognitive performance influence IADL performance. These results go in the line of previous studies that show that low MOCA scores are related to neurocognitive disorder, and therefore, lower IADL performance[14-15]. Moreover, our study confirms previous results[14-15] by using an observational evaluation of performance in IADLs. Also, our study uses MOCA to evaluate overall cognitive performance rather than MMSE, used by studies such as that of Foster[21], since several studies justify that MOCA has greater specificity and sensitivity than MMSE for detecting cognitive changes[14,30].

Thirdly, previous studies have shown deficits in STROOP performance in patients with PD[18,42]. In our study, Stroop Interferences's Direct Score was significantly correlated with motor and process skills in Task 2 of the AMPS. These results indicate that Inhibitory control deficit is correlated positively with worse performance in IADL. These results are in line with previous studies[42] and indicate that the worse the executive deficit in cognitive flexibility, selective attention, information processing speed, and inhibition of automatic responses, the greater the deficit in the performance of their IADL in population with PD.

Fourthly, according to EVOCAT, there is a positive correlation between the verbal fluency capacity and process skills on both AMPS tasks. Semantic verbal fluency tasks (EVOCAT) require the production of words from a certain verbal category and PD patients have demonstrated significant language impairments[43]. Previous studies have indicated that verbal fluency is reduced in demented and non-demented PD, especially semantic fluency[19, 44-46]. Verbal fluency evaluates working memory as the ability to track previous responses and prevent activation of other categories through executive skills, and it is also related to the initiation and generation of new ideas. Therefore, a verbal fluency deficit in PD patients represents an executive dysfunction. It is logical that worse performance on categorical evocation tests, which implies poor executive functioning, is related to worse performance on IADL that require these processes.

Our study confirms and extends previous results with a standardized observational measure, emphasizing the specific role of executive deficits on motor and processing skills utilized in IADL carried out by this population. Our results are in line with previous studies showing that the executive function could be related to poor performance on IADL[13,20] and that cognitive skills have a significant impact on IADL performance[9,13,21,24]. Our study confirms also previous research indicating that PD patients show executive dysfunctions[9, 13-15, 21, 47], and that these deficits also have a significant impact on IADL[20]. However, our evaluation protocol is more complete than the previous ones since the performance in the IADL has been assessed in vivo using the AMPS.

All these results provide significant guidelines for the development of cognitive rehabilitation programs aimed at PD patients. These programs have shown promising results with this population in previous studies[48-49]. Brain changes have been detected after cognitive rehabilitation in PD patients, supporting the existence of brain plasticity associated to cognitive training in degenerative diseases[48]. The executive functions are of considerable importance to allow the patient to plan, monitor and perform complex actions, coordinating other cognitive functions, with a significant impact on the patient's autonomy and on his functional recovery[50]. With regards to executive functions impaired in this population, some studies have reported that PD patients significantly improve their semantic fluency and planning using pencil and paper as well as computer-assisted exercises[51]. Time management and cognitive flexibility[52] or inhibition have also been reported to be significantly improved in PD after cognitive exercises using pencil and paper tasks[48].

The present study has some limitations. Firstly, despite the exhaustive neuropsychological evaluation used in this protocol, it did not include all the neuropsychological functions impaired in PD patients. However, including more tasks in the protocol would have resulted in high fatigue of participants. Secondly, participants in the PD group were in different stages of the disease. Nevertheless, most of them were in stage 2 and all of them were between 1 and 3.

Conclusion

PD aging patients present with executive function impairments that can be observed in their performance on specific neuropsychological tests that measure inhibitory control and categorical fluency. These deficits were related to difficulties in the performance of IADL, measured with the AMPS. PD patients also showed worse IADL performance compared to healthy people, both on motor and process skills. These results should be taken into account to guide clinical practice and future interventions with this population. PD patients need the experience of all rehabilitation disciplines to manage their illness[53]. In order to improve functioning of PD patients in their IADL, professionals are encouraged to develop and implement rehabilitation modules for the executive functions of this population.

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Table 1

Table 1. Sociodemographic characteristics of the whole sample and depending on the diagnosis

Variables	PD group	Control group	*p*
N (%)	**64 (68,1)**	**30 (31.9)**	
Age[Mean,(S.D.)]	70.2 (8,23)	64.8 (6.24)	.001
Sex[%,(n)]			
Women	50 (32)	76.7 (23)	.014
Marital Status [%,(n)]			
Single	6.3 (4)	6.7 (2)	.237
Married	65.6 (42)	83.3 (25)	
Divorced	4.7 (3)	0 (0)	
Widowed	23.4 (15)	10 (3)	
Living Situation [%,(n)]			.226
Alone	20.3 (13)	13.3 (4)	
Partner	50 (32)	56.7 (17)	
Partner/Children	14.1 (9)	26.7 (8)	
Children	6.3 (4)	3.3 (1)	
Others	9.4 (6)	0 (0)	
Education [%,(n)]			.473
No studies	10.9 (7)	3.3 (1)	
Primary	48.4 (31)	46.7 (14)	
Secondary	20.3 (13)	36.7 (11)	
Occupational Tr.	1.6 (1)	0 (0)	
University	18.8 (12)	13.3 (4)	
Employment status [%,(n)]			≤ .001
Active	3.1 (2)	20 (6)	
Unemployed	0 (0)	3.3 (1)	
Retired	85.9 (55)	40 (12)	
Housework	10.9 (7)	36.7 (11)	
Years since diagnosis [Mean, (S.D.)]	9.3 (5.4)	-	
UPDRS [Mean, (S.D.)]*	15.06 (8.68)	-	
H & Y [Mean, (S.D.)]**	1.75 (0.57)	-	
H & Y Stages [%,(n)]**			
1	26.7 (16)	-	
1.5	16.7 (10)	-	
2.0	41.7 (25)	-	
2.5	10.0 (6)	-	
3.0	5.0 (3)	-	

* n = 63; ** n = 60

Table 2

Table 2. Comparison of means between executive and AMPS variables

Variables	PD group	Control group	*p*
N (%)	64 (68.1)	30 (31.9)	
AMPS			
TASK 1 (L-1 & J-4)			
-Logit Motor [Mean, (S.D.)]	1.34 (1.85)	2.49 (0.43)	= .001
-Logit Process [Mean, (S.D.)]	.59 (.52)	1.41 (0.43)	≤ .001
TASK 2 (F-4 & D-2)			
-Logit Motor [Mean, (S.D.)]	1.60 (2.29)	2.72 (0.49)	.009
-Logit Process [Mean, (S.D.)]	.33 (.76)	1.24 (0.53)	≤ .001
TOL Total Correct Score [Mean, (S.D.)]	3.69 (2.10)	5.27 (1,93)	.001
TOL Total Move Score [Mean, (S.D.)]	39.29 (28.09)	24.50 (16.15)	.010
MOCA [Mean, (S.D.)]	23.44 (4.29)	25.50 (3.53)	.027
STROOP direct score [Mean, (S.D.)]	2.29 (7,65)	-18.66 (104.74)	.113
EVOCAT direct score [Mean, (S.D.)]	15.44 (7.99)	19.13 (4.44)	.02
EVOCAT percentiles [Mean, (S.D.)]	54.86 (33.83)	67.70 (24.42)	.066

Table 3. Partial correlations between the AMPS and Executive Function Test, controlling for sex and gender.

	Control Group				PD Group			
	Task 1		Task 2		Task 1		Task 2	
Variables	Logits Motor	Logits Processing	Logits Motor	Logits Processing	Logits Motor	Logits Process	Logits Motor	Logits Process
TOL								
Total Correct Score	-.037	.038	-.194	-.176	.193	.043	-.049	.140
Total Move Score	.124	.045	.198	.259	-.143	-.143	.048	-.156
MOCA	-.267	-.096	-.328	.165	.335*	.341*	.243	.245
STROOP								
Interference's Direct score	.047	-.109	.047	-.155	.237	.242	.305*	.279*
EVOCAT								
Direct score	.023	-.106	.008	-.137	.000	.338*	.304*	.374*
Percentiles	-.069	-.201	.015	-.090	-.061	.322*	.186	.403**

* p < .05 ** p < .01