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Financial Capacity in Parkinson's Disease

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Abstract

The ability to understand and manage one's personal financial affairs (Financial Capacity) is an interesting and multidimensional topic (field) to study, especially in a disease such as Parkinson's (PD). After understanding and thoroughly investigating the pathophysiology of the disease and the financial behavior in it, the present study aimed at 1) exploring whether patients on different medication (Levodopa and Dopamine Agonists) exhibited different financial capacity, 2) whether the performance in financial tasks could be predicted by neuropsychiatric symptoms, dementia, specific cognitive deficits in PD or by the time elapses since the diagnosis, and 3) if there is a specific point in the natural progression of PD from when on, financial capacity starts to diminish particularly, making it impossible for patients to manage their financial affairs (financial incapable). Indeed, the results revealed a statistically significant difference between the groups of Levodopa and Agonists, with the former performing better in financial tasks. Results also showed that the scores of the financial tasks could be predicted from the neuropsychiatric symptoms and the specific cognitive deficits in PD, but not from dementia or the time since diagnosis. The latter was not correlated with the financial tasks and thus the cut-off in time couldn't be tested for. These results are of great value for the literature and everyday clinical practice. Yet further research is required.

Keywords: financial capacity, Parkinson's, levodopa, agonists, treatment, medication

Introduction

Parkinson's Disease

Parkinson's Disease (PD) is a progressive, chronic, neurodegenerative disorder of the Central Nervous System (CNS) characterized by motor symptoms with mainly resting tremor, stiffness, bradykinesia, and instability. It is considered the second most prevalent neurodegenerative disorder after Alzheimer's disease (AD) and its prevalence is estimated at 1-3% in Western Europe, following an upward trend proportional to the increase in life expectancy (von Campenhausen et al, 2005; Dorsey et al., 2018). In addition to motor symptoms, the disease comprises several non-motor symptoms which include cognitive and psychiatric changes that play a key role in the progression of the disease while adversely affecting patients' quality of life, remaining in most cases undiagnosed and untreated (Chaudhuri & Naidu, 2008).

Progressive decline in cognitive abilities is recognized as a hallmark of the disease (Muslimovic et al., 2009; Aarsland et al., 2003). Cognitive impairments can range from mild deficits (slight decline in a few cognitive abilities) to severe dementia (general cognitive impairments and loss of autonomous functioning) (Marion, 2010). Patients with PD can experience cognitive deficits, even in the early stages of the disease and they can precede the appearance of the corresponding motor symptoms for many years (Chaudhuri et al, 2005; Lee et al, 2007). Cognitive impairments, in contrast to declining motor abilities, are a better predictor of both everyday functioning and upcoming disabilities amongst patients with PD (Aarsland et al., 2000). Research indicates that even non-demented PD patients have impairments in attention (Bronnick et al., 2006; Poliakoff & Smith-Spark, 2008; Goldman et al., 2018), memory (Poliakoff & Smith-Spark, 2008; Palmeri et al., 2017) visuospatial perception (Goldman et al., 2018), psychiatric symptoms including mood disorders (Kaji & Hirata, 2011), and executive

functions (Zgaljardic et al., 2003; Goldman et al., 2018). Furthermore, and regarding problem-solving, and decision-making, the literature suggests that inductive reasoning difficulties may also play an important role (Young et al., 2010; Delazer et al., 2009) and not only executive dysfunctions (Brand et al., 2004; Euteneuer et al., 2009).

Another concern with individuals diagnosed with PD is whether their motor impairments limit their cognitive abilities. For instance, a compensatory technique for an individual who is experiencing memory problems could be to jot down their thoughts. Nevertheless, writing might be a challenging motor skill for someone with PD. There may be a relationship between motor symptoms and cognitive abilities that may further limit functional abilities (Johnson et al., 2005).

Most of Parkinson's patients, regardless of gender and age, experience changes in speech, word recall, sentence formation, and the general understanding of speech (Miller et al, 2006). Patients generally feel that they have lost control of their communication, have reduced self-confidence, find it difficult to express themselves feeling inadequate, and thus dependent on others (McNamara et al, 2006).

In cohort studies of people with Parkinson's disease, a significant portion of the patients was found to develop dementia-like symptoms as the disease progresses and especially after ten years (Pagonabarraga, 2012). Symptoms include difficulty in the organization of thought, visual hallucinations, delirium, depression, irritability, and sleep disorders (Emre et al., 2014). Neuropsychiatric manifestations are most frequently observed in Parkinson's patients, especially depression (Nilsson et al, 2001; Nilsson et al, 2002; Leentjens et al, 2003), anxiety and psychotic symptoms, and sleep disorders (Chaudhuri et al, 2006; Dikeos & Georgantopoulos, 2011; Reijnders et al, 2008). Based on studies, 20-40% of patients suffer from depressive symptomatology, more than 40% are anxious while 10-30% of psychotic events are reported

(Weintraub et al, 2004). As expected, the patient who before the onset of the disease was more expressive and socially flexible manages better the communication, social requirements, and stigma during the disease; therefore, women with Parkinson's disease present globally better social profile due to the inherent tendency of the gender to be more expressive (Tickle-Degnen et al, 2014). Also, studies have been conducted on the effect of certain neuropsychiatric symptoms on the quality of life of patients as well as the relationship between comorbidity and disease severity (Andreadou et al, 2011; Barone et al, 2009; Gomez-Esteban et al, 2011; Giannouli & Tsolaki, 2019), stating that such symptoms should not be ignored.

Pathophysiology and the Dopaminergic System

A characteristic feature of Parkinson's disease is the progressive loss of dopaminergic neurons in the substantia nigra pars compacta and the atrophy and deposition of Lewy bodies in the amygdala from the early stages of the disease (Harding et al., 2002; Schapira, 2009). This loss of dopaminergic neurons is known to be one of the underlying mechanisms that contribute to motor symptoms (Jankovic, 2008).

Limbic and midbrain dopaminergic projections that originate from the ventral midbrain neurons near the substantia nigra and project to the medullary and cortical structures that mediate thinking, feelings, emotions, and rewarding behaviors, are correlated with apathy and anhedonia in Parkinson's disease (Giovannoni et al, 2000). Increased degeneration of dopaminergic neurons of the ventricular midbrain has been observed in patients with Parkinson's who are depressed compared to those who do not have emotional disturbances (Willner, 1997).

Dopamine deprivation has been discovered to affect the cognitive aspect of the Theory of Mind (TOM) in PD. This aspect is mediated by the dorsal-lateral-frontal areas of the brain, and in particular by the dorsal and medial dorsal and medullary network. Mid-ventricular-frontal

areas and especially the network that connects them equally to the striatum (Kemp et al., 2012). Related studies suggest that the cognitive component is affected by the early stages of the disease and the emotional, which is the second aspect of TOM, begins to malfunction about 5 years after the onset of the disease and manifests primarily as a social withdrawal disorder (Bodden et al, 2010; Tsuruya et al., 2011).

Financial Capacity in PD

Financial Capacity (FC) -the capability one has for understanding and managing personal finances- is a complex, multidimensional Instrumental Activity of Daily Living (IADL) that is primarily cognitively mediated, requires relatively few motor abilities, and is strongly linked to individual autonomy. Financial skills include using coins and currency, paying bills, managing a checkbook, making investment decisions, and exercising financial judgment (Marson, 2016).

Studies using the Financial Capacity Instrument (FCI) on PD-MCI patients compared to matched controls have revealed systematically lower scores when compared. Significantly reduced was the performance of the PD-MCI group on the domains of Basic Monetary Skills, Financial Concepts, Financial Judgment, Bank Statement Management, Checkbook Management, and Investment Decision-Making and to a lesser extent on the domains of Bill Payment, and Knowledge of Assets/Estate Arrangements (Martin et al., 2013). The researchers (Martin et al., 2013) suggested that difficulties in these types of financial tasks may reflect emerging difficulties in working memory, processing speed, retrieval of semantic knowledge, complex mental calculations, and application of financial concepts which is in accordance with the profile of PD-MCI patients that previous research suggests regarding financial task difficulties (Woods & Troster, 2003; Janvin et al., 2003; Griffith et al., 2003) and risky decision-making tendencies (Pagonabarraga et al., 2007).

In the same manner, PD-D (dementia) patients when compared with controls and PD-MCI appear to score significantly lower in all domains but particularly in Bank Statement Management, Bill Payment, and Investment Decision-Making with relatively preserved -yet lower than the other groups- Financial Judgment and Knowledge of Personal Assets/Estate Arrangements (Martin et al., 2013). These findings demonstrate that PD financial impairments progress following a similar pattern to that of AD (Martin et al., 2008; Triebel et al., 2009).

Medication and financial behavior in PD

Nowadays the most common treatment approaches for PD seem to be Levodopa and Dopamine Agonists (Zhang & Tan, 2016). For decades, Levodopa has been the first medicine of choice used for the treatment of Parkinson's. It is a precursor of dopamine that can surpass the blood-brain barrier. It is typically administered in combination with decarboxylase inhibitors (benserazide/carbidopa), which increase levodopa brain concentration, tolerance, and clinical efficacy (LeWitt, 2015) and with a monoamine oxidase inhibitor (entacapone), that improves wearing off symptoms (Kouppamäki et al. 2015). Dopamine Agonists, which tend to work by opening the dopamine receptors, have proved to be effective in the management of both early and advanced-stage PD. According to literature data, both levodopa and dopamine agonists were associated to gambling disorder (which is under the umbrella of Impulse Control Disorders – ICDs) in PD (Boyle and Ondo 2015; Symmonds et al. 2013; Pontieri et al. 2015; van Eimeren et al. 2010) however, dopamine agonists have been proved to be the treatment most strongly associated with the development of pathological gambling (Voon et al., 2006; Weintraub et al., 2006, 2010; Gallagher et al., 2007; Gatto & Aldinio, 2019) with pramipexole having the largest effect (Dodd et al., 2005).

The involvement of dopamine signaling in real-life decision-making, such as financial decisions, has remained a controversial topic since the earliest studies that compared decision-making performance in patients with PD 'on' and 'off' medication (Czernecki, et al., 2002; Cools et al., 2003). For instance, Czernecki et al. (2002) found that levodopa administration did not alter the decision-making abilities of patients with PD—in the Iowa Gambling task (IGt), patients who were 'on' or 'off ' medication did not identify that two decks of cards were 'advantageous' and the other two were 'disadvantageous'. Cools et al. (2003) showed that compared with controls, patients with PD who were 'on' medication showed abnormal betting behavior, which was characterized by impulsive betting and delay aversion on the Cambridge Gambling test (CGt). The Czernecki et al. and Cools et al. studies employed two different decision-making tasks for the successful completion of which activity in different regions of the brain is required.

On the Game of Dice test (GDt), which is served by activity in the dorsolateral prefrontal cortex for successful completion, patients with PD were shown to have severe decision-making deficits compared with controls. These deficits are positively correlated with deficits in emotional feedback processing and executive functions, indicating that impaired decision-making in PD might be a consequence of dysfunctional dorsolateral prefrontal–striatal and limbic–orbitofrontal–striatal loop (Brand et al., 2004). Similarly, an older PET study that assessed the performance of patients with early-stage PD showed that deficits in the limbic–orbitofrontal–striatal loop were associated with poor performance on the IGt. The dorsolateral prefrontal–striatal loop, however, was found to be relatively unimpaired (Gleichgerrcht et al., 2010). Deficits in the limbic–orbitofrontal–striatal loop probably also account for the impaired performance of late-stage PD patients on the IGt (Perretta et al., 2005). Patients with PD who

perform poorly on the IGt have typically impairments also on TOM tasks, such as the Reading the Mind In the Eyes task (RMIE) (Mimura et al., 2006; Ibarretxe-Bilbao et al., 2009).

In view of the heterogeneous patterns of decision-making impairments with which PD patients can present, Poletti et al. (2010) investigated the performance of de novo PD patients without dementia -none of whom had yet received dopaminergic medication- and matched controls on the IGt. No significant differences between the groups were found. Since dopamine levels in the particular patients had not been altered by medication yet, the researchers concluded that decision-making impairments in PD are most probably associated with dopaminergic overstimulation of the orbito-frontostriatal circuits caused by dopaminergic drugs. Overall, the literature suggests that Parkinson's disease-related neurobiological features do not play a primary role in the development of gambling per se, but do interact with individual vulnerability to increase susceptibility (Voon & Fox, 2007).

Generally, Impulse Control Disorders (ICDs), including pathological gambling, occur in 6.1% of PD patients which can increase and even doubled when treated with dopamine agonists (Voon et al., 2006; Giladi et al., 2007; Marion, 2010). Findings of full or partial remission of impulse control behaviors after the discontinuation or decrease of the dopamine agonist suggest a causal relationship between the two (Mamikonyan et al. 2008; Drapier et al. 2006; Olley et al., 2015).

Following the literature, the reader might be left with the impression that the scientific community isn't definite about the effects of treatment on the cognition of PD patients. That is due to the different aspects each study was exploring. Studies that assessed financial ability did it in the perspective of decision making and studies exploring the effects of the medication were focused on impulse control disorders. To this day, there is no published research, at least to our

awareness, which specifically investigates the effects of treatment on financial capacity and particularly in the Greek population.

To sum up, when considering the underlying neuropathological changes that characterize PD, and since specific neurotransmitter systems -including dopaminergic pathways- have been proved to be involved in cognitive functions such as value representation, weighing gains and losses, choosing between alternatives (Trepel et al.,2005), and reward anticipation (Bechara et al., 2003; Kobayakawa et al., 2007), PD has become a popular disease for studying decision-making, and an interesting field to explore treatment and financial behavior.

Aim of the present study

Upon thoroughly reviewing the literature, we concluded to the following assumptions which we focused on researching:

H1: Patients on a different medication for PD (levodopa or agonists of dopamine) have significantly different scores regarding their performance in financial capacity tasks. Patients under treatment with agonists of dopamine are expected to have lower scores.

H2: These scores of financial capacity can be predicted by comorbid difficulties (neuropsychiatric symptoms, dementia, specific cognitive deficits in PD), and the time passed since the diagnosis.

H3: There is a cutoff point in the timeline of the progression of PD, past which, for most patients financial capacity declines significantly, leaving them vulnerable to financial exploitation and loss of personal assets.

These findings will widen our understanding of the disease under treatment and help answer some of the remaining questions of the literature on the topic, all by using a new tool (LCPLTAS) in the Greek population.

Methods

Sample size

Although a G*Power analysis was conducted for the current study and proposed an optimum sample of 52 participants for large effect size (d'= .80), the final sample size was 39 (Female *n* = 14, Male *n* = 25) due to many cancellations because of the unforeseen pandemic of COVID-19 (See Figure 1). The sample consisted of Parkinson's patients with the criterion of being solely on Levodopa or Dopamine Agonists treatment for it to split into two groups accordingly.

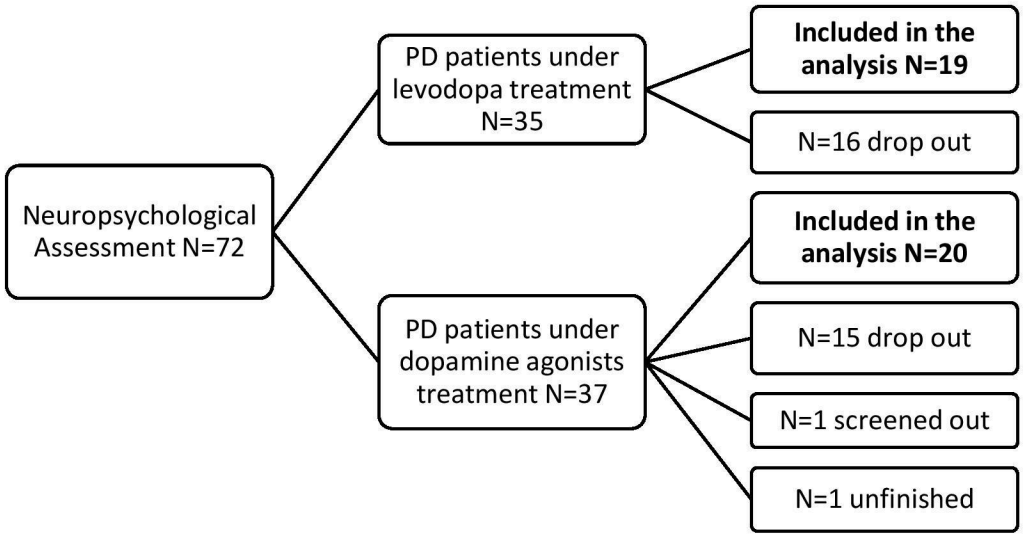

Figure 1 Process flow chart illustrating the recruitment of participants and the progress until data analyses.

Participants

To be part of this research, participants should be diagnosed with PD and under treatment. Diagnoses of dementia, psychiatric disorders, cognitive decline, age, and education won't be criteria of exclusion as they will provide clues for the secondary hypotheses at hand. All participants were Greek speakers and the education level, as well as the age, didn't differ between the two groups. The months since the diagnosis differ significantly between the groups which is logical since Dopamine Agonists is a treatment used in the early stages of the disease in

contrast to Levodopa which is usually administered later on. See Table 1 for descriptive statistics.

Neuropsychological Assessment

A battery of 4 neuropsychological tests was administered. The battery comprises of the Addenbrooke's Cognitive Assessment – Revised (ACE-R), the Parkinson's Diseases Cognitive Rating Scale (PD-CRS), the Neuropsychiatric Inventory (NPI), and the Legal Capacity for Property Law Transactions Assessment Scale (LCPLTAS). The approximate time of administration was one hour, depending on the cooperation of the participant. Authorization of the creators of the scales had been requested for research purposes and had been granted.

ACE-R is a well-known and useful tool for the screening and diagnosis of dementia in routine clinical practice and/or research protocols (Mioshi et al., 2006). It is sensitive to the early stages of dementia as well as in differentiating subtypes including AD, FTD, and atypical parkinsonian syndromes. For the purpose of the current research, the greek version from Konstantinopoulou et al. (2011) was used.

PD-CRS was designed by Pagonabarraga (2008) to cover the range of cognitive deficits in Parkinson's patients. Significantly lower scores in the PD-CRS scale are indications of "cortical" and "subcortical" brain regions deficits. The distinction between "subcortical" and "cortical" functions increases the sensitivity and specificity of the scale. It aims at dividing patients into subgroups according to the pattern of cognitive deficits they manifest in the early stages and differentiates patients with a high risk of dementia and patients with Parkinson's disease and dementia. It consists of nine subtests and is divided into seven "subcortical" and two "cortical". Subcortical subtests measure learning and delayed retrieval, attention, working memory, verbal fluency, and the ability to alternate speech flow. The cortical subtests measure

the ability to name images and the ability to copy and construct from memory a shape. The distinction between "subcortical" and "cortical" was made based on the findings of neuropsychological and neurodegenerative research (Pagonabarraga et al., 2008). PD-CRS has been translated, standardized, and adapted in Greek by Konstantinidou (2014).

The Neuropsychiatric Inventory (NPI) was created and revised by Cummings et al. (1994 & 1997) to assess dementia-related behavioral symptoms. The wide variety of behavioral domains that NPI covers means that, unlike other dementia scales, the NPI can screen for multiple types of neuropsychiatric symptoms in, not only Alzheimer's Disease but all types of dementia. The Hellenic NPI form was created and validated by Politis et al. (2004).

LCPLTAS is a newly created neuropsychological scale that was developed based mostly on the existing theory of Marson (2000) to assess financial capacity. The LCPLTAS full form (which will be used for the current study) consists of 7 domains: 1) basic monetary skills, 2) cash transactions, 3) bank statement management, 4) bill payment, 5) financial conceptual knowledge, 6) financial decision making (includes scenarios that are mostly confronted in the Greek courtrooms), and 7) knowledge of personal assets. It contains some items in the form of tasks and some others in the form of a semi-structured interview and is culturally adapted for the Greek everyday reality (Giannouli, 2015).

Cutoff scores for distinguishing capable from marginally capable status, and marginally capable from incapable status was set at 1.5 *SD* and 2.5 *SD* (respectively) below the control group mean for LCPLTAS which is 207 (*S.D.* = 13.64) points out of the maximum 212. The mean score for the MCI patients was 182.42 (*S.D.* = 27.66) and for the PD patients with dementia was calculated at 141.83 (*S.D.* = 54.09) by the creators (Giannouli et al., 2018).

Statistical Analyses

Given the aim of the first hypothesis being the comparison of the scores in LCPLTAS between the two groups, the most appropriate statistical criterion is the independent samples t-test. The independent samples *t*-test is used to determine if there is a significant difference between two groups on a scale-level dependent variable. This test uses the difference between the average scores of the two groups to compute the *t* statistic, which is used with the *df* to compute the *p*-value (i.e., significance level). A significant result indicates the observed test statistic would be unlikely under the null hypothesis. In this case, the null hypothesis is that the two groups will not have significant differences regarding the scores in LCPLTAS. The independent samples *t*-test carries the assumptions of independence of observations, normality, and equality (or homogeneity) of variance.

As the second hypothesis is to explore whether the overall scores in LCPLTAS can be predicted by the neuropsychiatric symptoms (NPI), dementia (ACE-R), specific cognitive deficits in PD (PD-CRS), and the time passed since the diagnosis (calculated in months), the suited statistical criterion is multiple linear regression. As a predictive analysis, the multiple linear regression is used to explain the relationship between one continuous dependent variable, in this case, LCPLTAS, from two or more independent variables, in this case, NPI, ACE-R, PD-CRS, and months of diagnosis. The R^2 statistic is used to assess how well the regression predicted the dependent variable. While the unstandardized beta (*B*) describes the increase or decrease of the independent variable(s) with the dependent variable.

For the third hypothesis of finding the cutoff in the timeline of the progression of the disease, past which the financial capacity declines significantly, the ROC curve is the fitted analysis to be conducted. ROC curves are frequently used to show graphically the

connection/trade-off between clinical sensitivity and specificity for every possible cut-off for a test or a combination of tests. Also, the area under the ROC curve gives an idea about the benefit of using the test(s) in question.

All the above analyses were conducted using SPSS 26.0 with the level of significance set at 0.05.

Results

A two-tailed independent samples t-test was conducted to examine whether the mean scores of LCPLTAS was significantly different between the Agonists (n = 19) and Levodopa (n = 20) groups of medication for a total sample of 39 patients. The relevant assumptions of this statistical analysis were tested and met. Results indicate that there is a significant difference in the mean scores for Agonists (M = 104.05, $S.D.$ = 9.82) and Levodopa (M = 144.16, $S.D.$ = 22.99) patients; t(37) = -7.020, $p < .001$, d = 2.27, hence the null hypothesis can be rejected. The results are presented in Table 2. A bar plot of the means is presented in Figure 2.

A linear regression analysis was conducted to assess whether PD-CRS, ACE-R, NPI, and Months Of Diagnosis significantly predicted LCPLTAS. The relevant assumptions of this statistical analysis were tested and met. The results of the linear regression model were significant, $F(4,34) = 15.00$, $p < .001$, $R^2 = 0.64$, indicating that approximately 64% of the variance in LCPLTAS is explainable by PD-CRS, ACE-R, NPI, and Months Of Diagnosis. PD-CRS significantly predicted LCPLTAS, $B = 0.64$, $t(34) = 2.16$, $p = .038$. This indicates that on average, a one-unit increase of PD-CRS will increase the value of LCPLTAS by 0.64 units. ACE-R did not significantly predict LCPLTAS, $B = 0.57$, $t(34) = 1.25$, $p = .220$. Based on this sample, a one-unit increase in ACE_R does not have a significant effect on LCPLTAS. NPI significantly predicted LCPLTAS, $B = -0.50$, $t(34) = -3.11$, $p = .004$. This indicates that on

average, a one-unit increase of NPI will decrease the value of LCPLTAS by 0.50 units. Months Of Diagnosis did not significantly predict LCPLTAS, $B = 0.01$, $t(34) = 0.16$, $p = .872$. Based on this sample, a one-unit increase in Months Of Diagnosis does not have a significant effect on LCPLTAS. Table 3 summarizes the results of the regression model and the correlations are displayed in Table 4.

With the current sample consisting of 39 patients and the Months of Diagnosis not being significantly correlated with the LCPLTAS scores, the third hypothesis couldn't be tested using a ROC analysis as initially was planned, and therefore it is rejected. Alternatively, the scores of LCPLTAS in relation to the months of diagnosis are presented in Figure 3.

Table 1 Descriptive Statistics (n=39), (Female n=14, Male n=25)

	Levodopa		Agonists	
Variables	Mean	S.D.	Mean	S.D.
Education	11.21	3.36	11.75	3.35
Age*	70.95	8.18	65.35	10.38
Months of Diagnosis	68.47	75.37	28.90	33.19
NPI	13.11	9.37	34.60	17.95
Ace-R	83.26	11.49	75.75	10.57
PD-CRS	69.37	18.86	57.75	15.29
LCPLTAS	144.16	22.99	104.05	9.82

*Age is calculated in years.

Table 2 Two-Tailed Independent Samples t-Test for LCPLTAS by medication

	Agonists		Levodopa				
Variable	M	SD	M	SD	t	p	d
LCPLTAS	104.05	9.82	144.16	22.99	-7.020	< .001	2.27

Note. $N = 39$, $df = 37$.

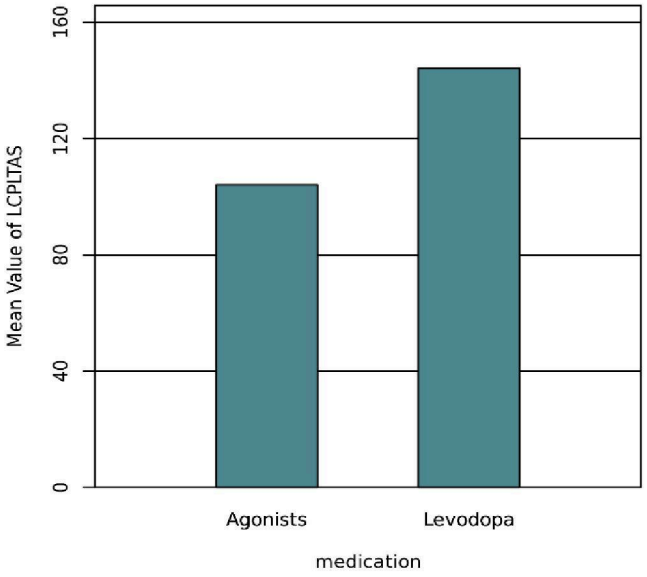

Figure 2 The mean of LCPLTAS by levels of medication

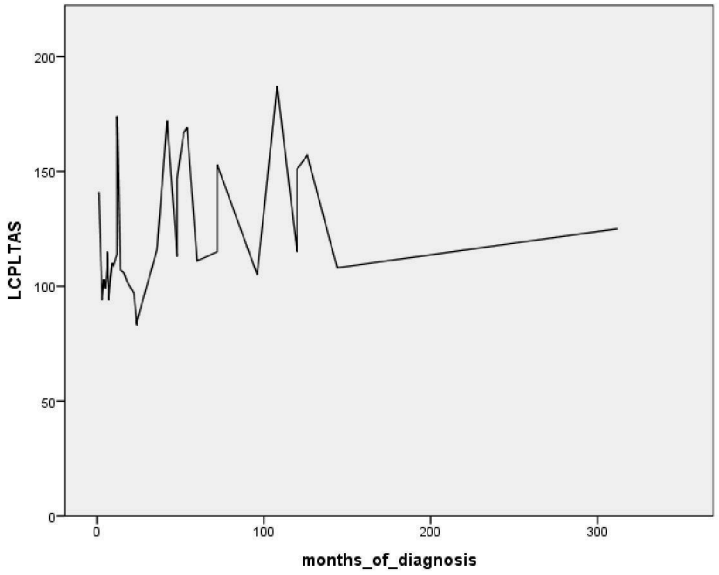

Figure 3 Scores of LCPLTAS in relation to the months of diagnosis

Table 3 Results for Linear Regression with PD-CRS, ACE-R, NPI, and Months Of Diagnosis predicting LCPLTAS

Variable	*B*	*SE*	β	R^2	adj R^2
(Intercept)	49.95	24.24	0.00	0.64	0.596
PD-CRS	0.64	0.29	0.43*		
ACE-R	0.57	0.45	0.24		
NPI	-0.50	0.16	-0.34**		
Months of Diagnosis	0.01	0.05	0.02		

Note. Results: $F(4,34) = 15.00$, $p < .001$, *$p = .38$, **$p = .004$
Unstandardized Regression Equation: LCPLTAS = 49.95 + 0.64*PD_CRS + 0.57*ACE_R -0.50*NPI + 0.01*Months_Of_Diagnosis

Table 2 Correlations of Variables entered

Variables	LCPLTAS	Months_Of_Diagnosis	NPI	ACE_R	PD_CRS
LCPLTAS	1.000	.264	-.484*	.690**	.705**
Months_Of_Diagnosis	.264	1.000	-.242	.190	.275***
NPI	-.484*	-.242	1.000	-.239	-.193
ACE_R	.690**	.190	-.239	1.000	.845**
PD_CRS	.705**	.275***	-.193	.845	1.000

Note. Significance is displayed for 1-tailed, *$p = .01$, **$p < .001$, ***$p = .045$

Discussion

The influence that Parkinson's disease treatment approaches have on financial behavior and the financial capacity itself has been given minimal attention in the Greek population compared to the existing need for evidence. Given the diverse profiles with which patients with PD can present and the standard way that the disease progresses pathophysiologically, PD is an interesting field for studying decision-making, financial capacity and treatment approaches. This study aimed at exploring the possible differences that patients on different medications may experience regarding their ability to manage financial tasks. The data presented and discussed are preliminary as the study is meant to be continued.

As predicted initially, indeed the results revealed a statistically significant difference between the groups of Levodopa and Agonists, with the former performing better in financial tasks. The mean scores of the participants were overall close to the normative data for the PD-dementia patients (Giannouli, 2015), which we attribute to the fact that we selectively chose to include in the study patients given their current medication and didn't screen out when detected mild or severe cognitive impairments. Although there is no prior study in the literature to our awareness that explored the particular research question, the difference in the scores found makes sense when taking into consideration previous findings regarding the behavior outcomes on certain medication (Voon et al., 2006; Weintraub et al., 2006, 2010; Gallagher et al., 2007; Gatto & Aldinio, 2019; Dodd et al., 2005).

In the attempt to explore whether LCPLTAS scores could be predicted by the other neuropsychological scales, results provided only NPI and PD-CRS as significant predictors. NPI was negatively correlated with the scores of LCPLTAS meaning that as the neuropsychiatric symptoms increase in presence and severity, the ability to manage financial tasks diminishes. These

findings come in accordance with previous literature (Pachara et al., 2014; Giannouli & Tsolaki, 2019). PD-CRS as a predictor of LCPLTAS can be explained simply by the purpose they were created to serve. PD-CRS assesses the cognitive functions that are known to be affected in Parkinson's Disease and LCPLTAS was developed to assess specific executive functions that are used in financial tasks. Therefore, if a difficulty is detected in the former, it shall be a difficulty in the latter as well since they are both sensitive and valid tools.

Even though NPI and PD-CRS appear to predict and be correlated with LCPLTAS, that still doesn't suggest a causal relationship between the results - only a co-change- (Konstantinidou, 2014), at least not in these preliminary data.

The fact that ACE-R was not correlated with LCPLTAS and couldn't predict the financial capacity can be attributed to its rough screening nature in comparison to PD-CRS. While it is a useful and fast-administered assessment for the clinical practice, in such studies hasn't been proved to correlate with financial tasks (Pachana et al., 2014).

Months since the diagnosis were neither a predictor nor a correlated variable according to the results, and consequently, the cut-off in the progression of PD for the financial capability couldn't be tested. This assumption was for the beginning a far shot and followed the notion of previous studies which longitudinally explored the progression of cognitive decline in PD through the years (Wilson et al., 2020). Such studies revealed the heterogenous patterns different PD patients express with and the steady rhythm of decline between follow-ups for medication-free patients, PD-MCI, and PD-dementia patients. Given the fact that the risk for cognitive impairment can now be predicted and managed, the current research attempted to discover the progression of specific, financial ability related, impairments through time but found it impossible provided the existing data.

Limitations and Future directions

Although the results provide plenty of useful and unique evidence, there are still some domains that should be investigated. For the present research, the global scores of each neuropsychological assessment were used. Nonetheless, each one of them comprised of several subscales/subtests measuring different functions and abilities which could provide very interesting findings. For example, the literature suggests that even patients with dementia have relatively preserved the knowledge of personal assets (Martin et al., 2013) and could be an innovative future project to explore the correlation of it with the other subscales of the LCPLTAS in PD and between the subscales of cognitive and behavioral scales.

The fact that we didn't include a control group of healthy participants in the sample is not a limitation. Healthy participants as well as PD patients had been included in the initial development of LCPLTAS (Giannouli, 2015) and certain normative data were published for them for the Greek population. Also, healthy controls were not necessary while assessing for the effect of treatment on financial tasks in PD.

Furthermore, in the current data, prior experience with financial transactions wasn't included as a variable due to the existing entries in LCPLTAS which are scored higher if the participant has financial experience (i.e. "Describe to me who and how pays your bills. Also, describe all the possible ways of paying an account that you know and that are valid today in Greece" highest score is 2 if the participant pays their bills and knows at least a couple of ways to pay for them). Probably, the financial experience could be used as a covariate in future research.

Lastly, the fact that months of diagnosis weren't correlated with the financial capacity scores can probably be explained by the small sample size and the way the sample was collected. Possibly, if de novo PD patients free of treatment, patients under mixed levodopa and agonists

treatment, and patients on other treatment plans were included, the exact time frame could be spotted. Future research could account for that and run a prospective study.

Conclusion

As the geriatric population increases in contemporary times, there is a growing need for exploring and managing financial abilities that seem to decline with age. These results are potentially valuable for the literature and everyday clinical practice. They provide a better understanding of Parkinson's disease on medication in a population -the Greek population- that had not been explored until now. This study shall add evidence in the literature and possibly encourage more research to be conducted. Nonetheless, the data provided are preliminary and the study will continue until adequate sample size is reached.

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