Performance at the clock drawing test of individuals affected by Parkinson's disease and healthy subjects: a retrospective study

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Abstract:	Clock Drawing Test (CDT) is a screening tool used in neuropsychological assessment for evaluating comprehensively different cognitive functions. Aberrant performance at CDT was observed in Parkinson's disease, due to impaired executive functioning as well as visuo-spatial difficulties. However, previous studies suffered of different limitations, such reduced sample size and absence of comparison with healthy individuals. The aim of this retrospective study was to verify CDT accuracy in discriminating between 240 patients with idiopathic Parkinson's disease and 145 healthy subjects. We verified CDT accuracy in discriminating patients when classified in relation to their global cognitive functioning measured through the Mini Mental State Examination and the Frontal Assessment Battery. Our results showed that affected individuals reported a worse performance in CDT than healthy controls; this difference was not related to age or level of education. Instead, no difference was found between patients when categorized in relation to their performance at the Mini Mental State Examination or Frontal Assessment Battery. We confirmed that Parkinson's disease patients reported low performance at the CDT. We encouraged to use CDT for early detection of possible cognitive difficulties in Parkinson's disease for clinical and research purpose.
Response to Reviewers:	Reviewer #1 The present retrospective study investigates abnormalities of the Clock Drawing Test (CDT) in a large cohort of 240 patients with Parkinson's disease (PD), and a sample of 145 healthy participants. The CDT was adopted as a measure of global cognitive decline assessed by Mini Mental State Examination - MMSE and Frontal Assessment Battery - FAB. The Authors found that the CDT performance was lower in PD in

comparison to healthy controls, however no significant CDT difference emerged between patients when categorized in relation to their global cognitive profile, i.e. MMSE and FAB scores. The rationale of the study is clear, and the manuscript is well written. The results are reasonable, although not particularly novel. I have a few comments that the authors should carefully take into account.

REPLY: We thank the Reviewer for his/her comments to our manuscript. We provided a point-to-point answers to the comments.

Major

One major issue of the study is that PD patients and healthy controls (HCs) were not well matched for age and education ("…patients were significantly older and with lower years of Education respect to the controls" see page 5). Thu, between-group differences in CDT are possibly explained by age and education differences. The authors performed a covariate analysis to exclude the effect of age and education (details at page 6). However, I believe that this issue should be better addressed; I would suggest increasing the sample size of the healthy controls group including older subjects.

REPLY: According to the Reviewer's suggestion, in the new version of the manuscript we presented a new enlarge sample of controls (n = 205 participants). Now, the PD group and the controls were comparable in the demographical aspects (Age p = 0.42; Education p = 0.47), as reported in Table 1. Thus, the covariate analyses was no longer reported. Since we added new participants, the successive analyses relative to the difference between patients and controls were run again. The results were not different in comparison with what we reported in the previous version of our work. We provided a new Figure 1 about the ROC curve to report the updated results.

Please add more clinical detail on the PD patients (disease duration, UPDRS score, medications…). Moreover, clarify whether patients were tested while they were ON medication.

REPLY: In the new version of our manuscript, we reported the data relative to the years from symptoms onset (pag. 3). Thus, we studied the relationship of this factor with the CDT score. No significant results emerged, as reported at pag. 5.
We underline that in our Institute, the neuropsychological assessment is routinely performed when PD patients are in on-state. Thus, in our text (pag 3), we specified that all data were collected when patients were in on-state.
Finally, since this study was retrospective and it was mainly focused on the neuropsychological assessment, at this stage we were not able to report further details about our PD patients in terms of UPDRS score or drugs. We agree that this information might be useful in order to study a possible relationship to the CDT score. We introduced a statement underlining this criticism in the last paragraph of our Discussion (pag. 8).

Minor

Page 2: "…PD patients with and without diagnosis of dementia reported a significant performance in CDT." It seems that this sentence is incomplete. Do the Authors mean "a significant different performance…"? Please clarify.

REPLY. We clarified this sentence (pag. 2): according to the Camargo and colleagues, PD patients with and without dementia reported a significant different score to the CDT.

Page 3: "…and show a positive answer to medication", please rephrased as follows "improved upon dopaminergic medication"

REPLY. We really thank the Reviewer for this suggestion. We rephrased the sentence.

Page 5: "2. Analyses within PD patients' group". I would delete the number 2 (as for the other paragraph).

REPLY. We deleted the number of paragraph.

	Page 5: "we studied the possible relationship of CDT score with respectively MMSE score and FAB score through the Pearson's correlation". MMSE and FAB scores are not continuous data (and moreover they are usually not normally distributed), therefore the Spearman's Rank Order Correlation is a more suitable test. REPLY. We thank the Reviewer for this comment. We run again the analyses adopting the Spearman's Rank Order Correlation. In the paper and in the Table 2, we changed the text accordingly. Page 5: "the relationship between the CDT score and the level of Age and Education was calculated through the calculation of the Pearson's correlation coefficient"; again, consider the Spearman's Rank Order Correlation (see previous comment) REPLY: Following this comments, we run again in analyses adopting the Spearman's Rank Order Correlation. Please, refer to Table 4.

Title: Performance at the Clock Drawing Test of individuals affected by Parkinson's disease and healthy subjects: a retrospective study.

Running Head: CDT in Parkinson's Disease

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Author contributions. FS and AM contributed to the study conception and design. LP performed patients' clinical assessment. Material preparation and data collection were performed by FS and CP. Data analyses was performed by FS. The first draft of the manuscript was written by FS and CP and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Abstract

Clock Drawing Test (CDT) is a screening tool used in neuropsychological assessment for evaluating comprehensively multiple cognitive functions. Aberrant performance at CDT was observed in Parkinson's disease, due to impaired executive functioning as well as visuospatial difficulties. However, previous studies suffered from different limitations, such as reduced sample size as well as no comparison with healthy individuals.

This retrospective study aimed to verify CDT accuracy in discriminating between 240 patients with idiopathic Parkinson's disease and 205 healthy subjects. We verified CDT accuracy in discriminating patients when classified according to their global cognitive functioning measured through the Mini-Mental State Examination and the Frontal Assessment Battery.

Our results showed that affected individuals reported a worse performance in CDT than healthy controls. Instead, no difference was found between patients when categorized according to their performance at the Mini-Mental State Examination or Frontal Assessment Battery.

We confirmed that patients with Parkinson's disease reported low performance at the CDT. We encouraged to use of CDT for early detection of possible cognitive difficulties in Parkinson's disease for clinical and research purposes.

Keywords: Clock Drawing Test; Parkinson's Disease; cognitive screening; neuropsychological assessment.

Introduction

Clock Drawing Test (CDT) [1] is a common, quick and easy-to-apply neuropsychological instrument to assess global cognitive functioning. Indeed, multiple cognitive domains, including language comprehension, numerical knowledge, executive functions, attention, visuospatial abilities and verbal short-term memory [2-3], are implied to solve it. Because of its usefulness in detecting comprehensively significant information about individuals' cognitive functioning, CDT is frequently used by geriatric experts [4] in clinical settings. Interestingly, CDT was reported to be less affected by demographical and cultural differences than other tests [5], such as the Mini- Mental State Examination (MMSE) [6]; thus, it seems to be suitable in case of low level of education and different ethnicity. Moreover, it shows a good sensitivity in discriminating individuals with mild cognitive impairment (MCI) from healthy individuals [7], and also in discriminating between multiple forms [9-10] and stages of dementia [10]. Finally, CDT requires lower amount of time than other tests for assessing global functioning, as well as it can be administered in not structured settings, such as patient's bedside.

Individuals affected by Parkinson's Disease (PD) generally show difficulties in executive functions, specifically in the components of selective attention, reasoning, cognitive flexibility, and planning, even in absence of dementia [11-12]. However, difficulties in other cognitive domains, such as language, memory, and visuospatial capabilities, can be observed even in early stages of the disease, independently from the presence of executive dysfunction [13]. In light of this heterogeneity, CDT may be a useful screening test in PD, specifically in the early stage of the disease, before the emerging of any moderate or severe symptoms as well as dementia [10].

Previous - but not conclusive - evidence about the CDT applicability as a screening tool in PD was reported in literature [3,9,14,15]. According to Stella and colleagues [14], PD patients showed difficulties in visuospatial organization and visuoconstructive skills in CDT; instead, Saur and colleagues [15] suggested that the patients' poorly performance, characterized specifically by errors in planning of numbers and hands position as well as by the use of postmeridian digits, might suggest more prominent executive deficits rather than visuospatial impairments. In a successive study by Camargo and colleagues [3], PD patients with and without a diagnosis of dementia showed a different performance in CDT. Interestingly, the authors reported that when CDT was used together with MMSE, the level of sensitivity in distinguishing between the two

groups increased respect to MMSE alone. However, some limitations might be recognized in these previous studies. First, the samples consisted of a limited number of PD patients [3,14,15]. Moreover, they were compared with other neurodegenerative syndromes [8-9,15], patients with and without dementia were included in the same sample or no comparison with healthy individuals was reported [3,9].

In this retrospective study, we verified CDT accuracy in discriminating the performance of a large cohort of PD individuals without dementia, respect to healthy individuals. Moreover, we studied the CDT accuracy in discriminating patients when categorized according to the their global cognitive functioning measured through MMSE [6], since it is generally adopted in conjunction with CDT [15]. Moreover, considering the most prominent executive nature of cognitive difficulties in PD [11-13], we studied CDT accuracy in discriminating patients when they were categorized according to their performance at the Frontal Assessment Battery (FAB) [16].

Methods

Participants. The study was approved by the Ethic Committee of the I.R.C.C.S Istituto Auxologico Italiano and was performed in accordance with the Declaration of Helsinki's principles (World Medical Association, 1991). The data relative to the tests adopted in the present study was part of a standard neuropsychological assessment that was routinely performed by expert neuropsychologists. Thus, in-patients furnished their written informed consent when they admitted to the hospital. Healthy participants were recruited outside the hospital; they furnished their written informed consent.

240 individuals affected by PD were considered for this retrospective study (Table 1). They were in-patients consecutively admitted for a routine hospitalization at the Division of Neurology and Neurorehabilitation of the I.R.C.C.S. Istituto Auxologico Italiano, Ospedale San Giuseppe (Piancavallo, Italy). According to the clinical assessment performed by expert neurologists, all patients received diagnosis of idiopathic PD according to the UK Parkinson's Disease Society Brain Bank clinical diagnostic criteria [17] and improved upon dopaminergic medication. The following exclusion criteria were adopted: (i) neurological and motor deficits not related to PD, (ii) deficits severe enough to impair daily life (social, occupational, or personal care) over and above motor or autonomic symptoms [12]. As routinely done in the involved institute, all

patients were assessed during subjective on-phase, when symptoms are managed through medication. The mean relative of the years from the symptoms onset (i.e. years of disease) was of 8 (SD = 6). This study also included a group of 205 healthy participants (Table 1). They did not report any sensory, neurological or psychiatric impairment, as confirmed through a clinical interview.

Procedures. All participants completed the Italian version [18] of the CDT [1]. Participants received a sheet with a pre-drawn circle. They were requested to place the digits and the hands at 2:45. No time limit was imposed. The test had a 10-points scoring system, designed to test: the presence of the numbers (score range: 0-4 points), the layout of the numbers (score range: 0-3 points), the position of the hands (score range: 0-2.5 points), the hands dimensions (score range: 0-0.5 points). Higher scores reflected better performance. Moreover, only for PD patients we collected the scores relative to MMSE [6,19] as measure of global cognitive functioning, and the FAB [16,20] as measure of the frontal executive functioning.

Analyses between groups: PD patients vs healthy controls. We studied CDT accuracy in discriminating between PD patients and controls. First, an independent sample t-test was performed to verify any difference between the two groups in terms of demographical characteristics of *Age* and *Education* (measured in years), while difference in terms of frequency of males and females (*Gender*) between groups was analyzed trough the $\chi 2$ test. Successively, for each group independently, the relationship between the CDT score and the level of *Age* and *Education* was calculated through the Spearman's rank correlation. A priori, we might expect a negative value of ρ when *Age* was considered: thus, older age would be related to lower CDT score; on the contrary, higher level (i.e. number of years) of *Education* would be related to higher CDT score (i.e. a positive r value). Only for PD participants, the relationship with the years from the symptoms onset (i.e. years of disease) was also investigated. Also, possible difference between males and females was assessed through the independent sample t-test, independently for the two groups.

Finally, we performed an independent sample t-test to verify possible difference in CDT score between PD patients and controls. Also we performed a Receiver Operating Characteristic (ROC) Curve Analysis to verify the accuracy of CDT in discriminating PD patients and controls; through the Youden's index [21], the cut-off point was calculated.

Analyses within PD patients group. Considering the PD patients' performance, we studied the possible relationship of CDT score with respectively MMSE score and FAB score through the Spearman's rank correlation; in the case of significant results, a linear regression was calculated to predict CDT score on the MMSE and FAB scores; the variance inflation factor (VIF) was reported as measure of multicollinearity. After, we considered the performance at the neuropsychological tests of MMSE and FAB. First, we categorized the PD patients in two groups according to the MMSE score. In details, for each patient we verified if the MMSE raw score was below or upper to the Italian normative cut-off [19]. If the score was below the cut-off, we considered the performance as *impaired*, otherwise it was considered *unimpaired*. Thus, an independent sample t-test was performed to verify any difference between the two groups (*impaired vs unimpaired*) in terms of demographical characteristics of *Age* and *Education*, while $\chi 2$ test was used to verify any difference about *Gender* frequency. For each group independently, the relationship between the CDT score and the level of *Age* and *Education* was calculated through through the Spearman's rank correlation. Finally, we performed an independent sample t-test to verify possible difference in CDT score between the two groups and we used the ROC curve analysis to verify the accuracy of CDT in discriminating between PD patients with impaired or unimpaired performance at the MMSE; the cut-off point was calculated independently from the prevalence according to the Youden's index [21]. The same set of analyses was applied when the PD patients were categorized according to the FAB score. Again, for each patient we verified if the FAB score was below or upper the normative cut-off [20] and then categorized the case as *impaired* (in case of score below the cut-off) or *unimpaired* (score upper the cut-off).

Finally, we compared the Area Under the Curve (AUC) [22] values of ROC curves relative to MMSE and FAB, to detect a possible difference in the accuracy of two models in disentangling impaired vs unimpaired patients.

Results.

Between groups: PD patients vs controls. PD patients and controls were comparable in terms of *Age* and years of *Education*; the prevalence of males and females was different between groups (Table 1). According to the Spearman's rank, a significantly relationship between the *CDT* score and the years of *Age* and

Education emerged, in both groups (Table 2). For PD patients, no significant relationship emerged between years from the symptoms onset (i.e. years of disease) and CDT score [ρ(120)= -0.14; p = 0.12]. For PD patients (males: N = 212; M = 7.72; SD = 3.03; females: N = 172; M = 7.99; SD = 2.73) [t(382) = 0.89; p = 0.37; Cohen's d = 0.093) and controls (males: N = 105; M = 8.02; SD = 2.24; females: N = 93; M = 8.48; SD = 2.23) [t(196) = 1.44; p = 0.15; Cohen's d = 0.2), no difference was observed in relation to the *Gender*.

Interestingly, about CDT score, a significant difference between groups emerged [Levene's Test F = 37.19; p < 0.001; t(426.26) = 4.29; p < 0.001; Cohen's d = 0.41); specifically, PD participants reported lower score than controls (Table 1). The ROC curve analyses was significant [AUC = 0.587; SE = 0.026; z = 3.27; p = 0.001; 95% confidence interval from 0.539 to 0.633] (Figure 1). A cut-off equal or minus to 7 corresponded to a level of sensitivity of 0.75 and a level of specificity of 0.43 [Youden's index J = 0.18].

[Figure 1 around here]

Within group: PD patients. CDT score showed a significant positive relationship with the MMSE score [ρ(238) = 0.49; p < 0.001] and with the FAB score [ρ(232) = 0.47; p < 0.001]. According to the linear regression analysis, a significant regression equation was found [F(2, 229) = 43.15; p < 0.001] with an R^2 of 0.27. Both MMSE score [VIF = 1.64; B = 0.29; p < 0.001] and FAB score [VIF = 1.64; B = 0.21; p = 0.001] were significant predictors for CDT score.

According to the performance at the MMSE, we categorized the patients in two groups, according if they reported a lower score (*impaired*) or a upper score (*unimpaired*) respect to the normative cut-off. No difference between groups emerged in terms of *Age* and *Education* in years, as well as in terms of *Gender* frequency (Table 3). Interestingly, for PD patients with an unimpaired score, the CDT score was significantly related to both *Age* and *Education*. Instead, when PD patients with an impaired score's performance was analyzed, a significant relationship emerged only for *Education* (Table 4).

About CDT score, no difference was found between the two groups (Table 3). The ROC curve analyses was significant [AUC = 0.724; SE = 0.042; z = 5.25 p < 0.001; 95% confidence interval from 0.663 to 0.782]. A cut-off minus to 5 corresponded to a level of sensitivity of 0.82 and a level of specificity of 0.56 [Youden's index J = 0.38] (Figure 2.A).

[Figure 2 around here]

We also categorized PD patients according to the to the performance at the FAB. The two groups were comparable in terms of demographic characteristics of *Age*, *Education* and *Gender* frequency (Table 3). Very interestingly, for both groups we found a significant relationship between CDT score and *Age* and *Education* (Table 4). No difference emerged between groups about CDT score (Table 3). The ROC curve analyses was significant [AUC = 0.708; SE = 0.0334; z = 6.24 p < 0.001; 95% Confidence Interval from 0.646 to 0.765] (Figure 2, right part). A cut-off minus to 8 corresponded to a level of sensitivity of 0.67 and a level of specificity of 0.65 [Youden index J = 0.33] (Figure 2.B).

When we compared the AUC relative to the two ROC curves [22], no significant difference emerged [z = 0.32; p = 0.74]: the two models (PD patients classified in relation to their score at the MMSE vs FAB) showed the same level of accuracy in detecting impaired and unimpaired patients.

Discussion

This retrospective neuropsychological study had two main aims. The first one was to verify CDT accuracy in discriminating between PD patients' and controls' performance. The second one was to verify CDT accuracy within the PD patients, when the global cognitive functioning (measured through the MMSE [6]; Italian version [19]) or the frontal executive functioning (measured through the FAB [16]; Italian version [20]) was taken in account.

Our results showed that individuals affected by PD and healthy individuals showed a significant different performance at CDT: in detail, PD patients reported lower scores than controls. Our result was in line with previous investigations [8,15]. However, in these previous studies reduced samples were compared [15] and in conjunction with other neurodegenerative syndromes [8]. According to the ROC curve analyses, we might suggest a score equal or minus to 7 as a cut-off for discriminating healthy individuals and PD patients. This value was lower compared with the cut-off suggested by Camargo and colleagues [3] (i.e. a cut-off value of 8). However, it should be noticed that the authors computed this score referring to the performance of PD patients with and without cognitive impairment, and in absence of any comparisons with healthy individuals.

According to our results, CDT showed a similar level of accuracy in discriminating PD patients with an impaired cognitive performance from those with no cognitive difficulties (i.e. unimpaired patients) when categorized according to their global cognitive functioning, measured through the MMSE [6], in comparison

with the patients' categorization performed according to the global executive functioning, measured through the FAB [16]. Focusing on MMSE, we confirmed a significant relationship with CDT score, in line with previous studies [3,7,8,14,15]. Moreover, we observed that MMSE score was as a significant predictor of CDT performance. However, no difference in CDT score was found between PD patients with an impaired MMSE score from those with an unimpaired score. This result was in contrast to what reported by Saur and colleagues [15] who adopted the same methodological approach. Indeed, the authors reported that PD participants with lower global cognitive functioning (suggested by impaired MMSE score) performed worse in CDT than the PD patients with an unimpaired MMSE score. It should be noted that the two studies differed about the CDT scoring systems; moreover, Saur and colleagues adopted a MMSE cut-off (a score of 28) higher than in our study (that was around the score of 22, according to Magni et al. [19]).

As the best of our knowledge, no previous study used FAB score to categorize PD patients. FAB [16] is one of the most widely neuropsychological tests to investigate comprehensively executive frontal functioning [16,20]. It should be more advisable than the MMSE, particularly among PD patients without cognitive impairment [24][24] in order to discriminate executive dysfunction [25-26]. In the present study, no difference emerged when patients were categorized between impaired and unimpaired score, according to the performance at FAB. However, while FAB focused specifically on executive domain, measuring specific executive behavior (recognition of similarities; phonological verbal fluency; ability in performing motor series; ability in applying conflicting instructions in motor task; capability to perform a motor no-no go task; and finally prehension behavior) [16,20], CDT refers to other multiple cognitive domains, including language comprehension, numerical knowledge, attention, visuospatial abilities, memory, as well as executive functions [2-3]. Thus, possible difficulties in executive functions might be compensated by other preserved cognitive processes, resulting ultimately in an adequate performance at CDT. This explanation, requiring further investigation, seems to be supported by the performance of our sample, in which no patient with dementia was included.

The retrospective nature of this neuropsychological study imposed some limits that should be overcome in future investigation. It was reported that MMSE might be a less sensitive measure for recognizing cognitive difficulties in PD compared with the Montreal Cognitive Assessment Battery [23], specifically in the absence

of dementia. Thus, in the future, global cognitive functioning might be measured through other MOCA [23], instead of MMSE [6]. Moreover, the multiple executive functions should be investigated through proper neuropsychological tests rather than through a global measure as FAB [16,20]. The role of specific cognitive domains [2-3] on performance in CDT should be investigated. Also, it should be clarified what might be the most suitable and comprehensive scoring system between those reported in literature [8] to assess PD patients' performance. Finally, the disease's characteristics described according to the traditional clinical scales, as well as the administered dopaminergic therapy should be also taken in account.

In summary, CDT is a simple screening test and involves several aspects of cognition, that might be impaired in PD. Considering that CDT score shows an interesting relationship with patients' difficulties in daily life activity [14], we might encourage to use it for early detection of possible cognitive difficulties in PD patients in clinical and research setting. However, we would underline that CDT as well the other global cognitive tests [6,23], cannot replace the whole neuropsychological assessment, through which specific cognitive difficulties are recognized and measured.

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Figure Captions

1. ROC curve about the level of accuracy of Clock Drawing Test in disentangling PD patients from controls. The true positive rate (Sensitivity) was plotted in function of the false positive rate (100- Specificity) for different cut-off points.

2. A. ROC curve about the level of accuracy of Clock Drawing Test in disentangling PD patients with an impaired score at the Mini-Mental State Examination from PD patients with an unimpaired score. **B.** ROC curve about the level of accuracy of Clock Drawing Test in disentangling PD patients with an impaired score at the Frontal Assessment Battery from PD patients with an unimpaired score. In both figures, the true positive rate (Sensitivity) was plotted in function of the false positive ate (100- Specificity) for different cut-off points.

Table 1: Demographical characteristics and results at the CDT were reported for PD patients and controls. * denotes a significant difference; F = females; M = males.

	PD patients	**Controls**	
N	240	205	
Gender	F= 113; M =127	F =107; M = 98	χ^2 **= 8.29**, **p = 0.016**
Age in years	70 (9)	69 (5)	Levene's test F = 25.15**; p < 0.001**; t(412.85) = 0.8; p = 0.42
Education in years	8 (3)	9 (4)	t(443) = 0.7; p = 0.47
CDT score (range 0-10)	7.09 (3.23)	8.24 (2.25)	Levene's test F = 37.19; **p < 0.001**; t(426.26) = 4.29; **p < 0.001**

Table 2: For the two groups independently, the relationship between the demographical characteristics of Age and Education (expressed in years) and CDT score was reported. Significant results (p value < 0.001) are reported in bold.

			Age in years	Education in years
PD patients	CDT score	ρ	-0.33	0.28
n = 240		p	**< 0.001**	**< 0.001**
Controls	CDT score	ρ	-0.286	0.27
n =205		p	**< 0.001**	**0.001**

Table 3: Demographical characteristics and results at the CDT were reported for PD patients with an impaired or unimpaired score at the MMSE test. * denotes a significant difference.

	Unimpaired	Impaired	
Mini-Mental State Examination			
N	190	50	
Gender	86 F; 104 M	28 F; 22 M	$\chi^2 = 1.92$; p = 0.16
Age in years	70 (8)	70 (10)	t(238) = 0.38; p = 0.7
Education in years	8 (3)	9 (4)	t(238) = 1.74; p = 0.08
CDT score	7.23 (3.14)	6.56 (3.54)	t(238) = 1.31; p = 0.22
Frontal Assessment Battery			
N	138	102	
Gender	61 F; 77 M	52 F;50 M	$\chi^2 = 0.97$; p = 0.32
Age in years	69 (10)	70 (7)	t(238) = 0.95; p = 0.34
Education in years	9 (4)	8 (3)	Levene's test F= 7.39; p = 0.007 t(234,5) = 1.71; p = 0.08
CDT score	7.27 (3.1)	6.84 (3.4)	t(238) = 1.02; p = 0.3

Table 4: The relationship between demographical characteristics and the CDT score was reported, when participants with PD were split in two groups (impaired and unimpaired) according to the MMSE (upper part) and FAB (below part) score. Significant results (p value < 0.05) are reported in bold.

			Age in years	Education in years
Mini-Mental State Examination				
Impaired	CDT score	ρ	-0.24	0.34
n = 28		p	0.84	**0.032**
Unimpaired	CDT score	ρ	-0.33	0.29
n = 212		p	**< 0.001**	**< 0.001**
Frontal Assessment Battery				
Impaired	CDT score	ρ	-0.27	0.3
n = 102		p	**0.005**	**0.002**
Unimpaired	CDT score	ρ	-0.37	0.26
n = 138		p	**< 0.001**	**0.002**

Figure 1R

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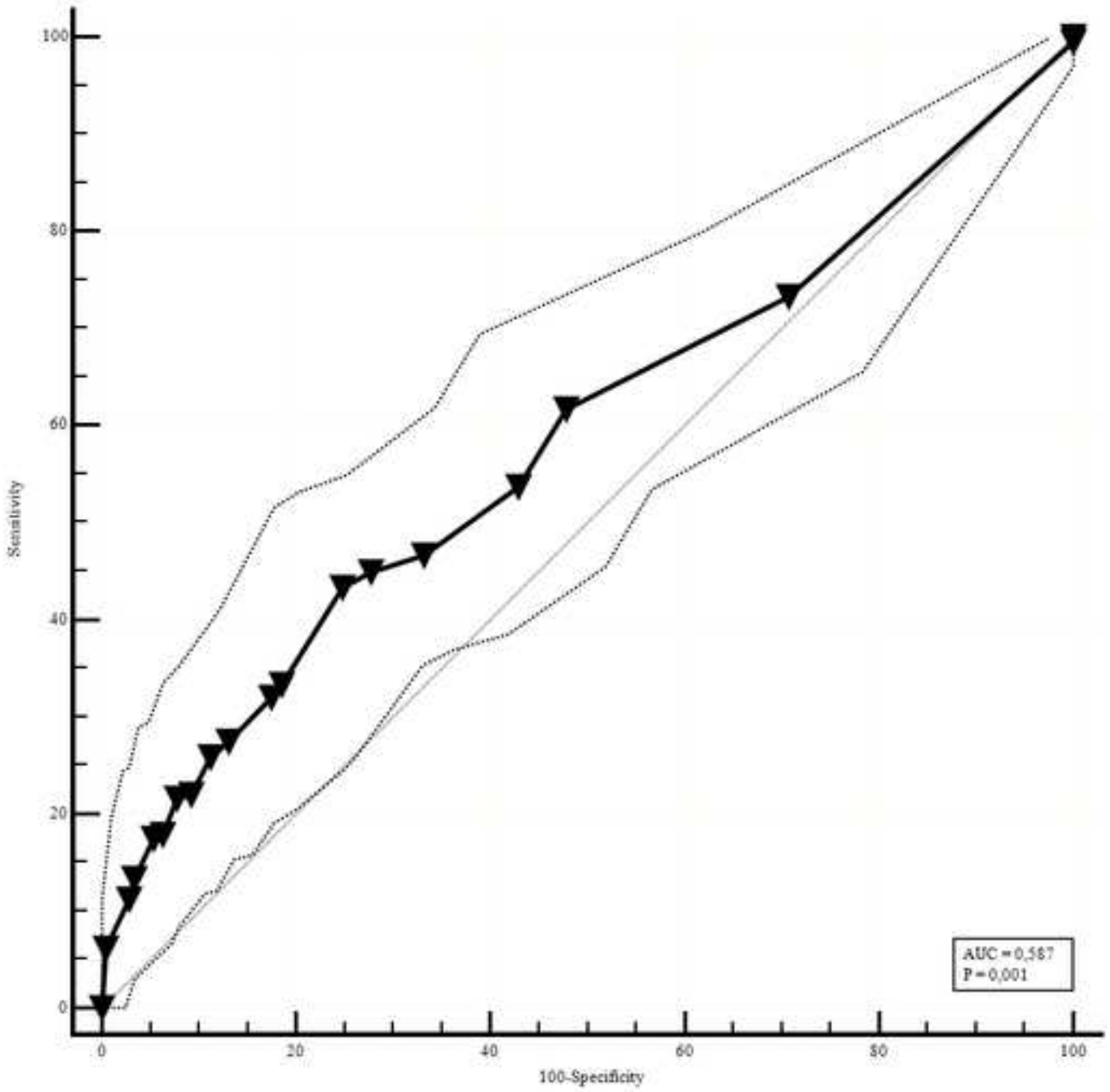

Figure 2