Published in final edited form as:

Mov Disord. 2018 November ; 33(11): 1760–1768. doi:10.1002/mds.27487.

Validation of a Performance-Based Assessment of Cognitive Functional Ability in Parkinson's Disease

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Abstract

Background: Outcome measures that capture functional abilities related to cognition offer the potential to demonstrate real-world effectiveness of cognitive-enhancing treatments. However, distinguishing functional disability related to cognition from that attributed to motor symptoms can be difficult in PD. A performance-based functional assessment allows for direct observation of activity of daily living skills and separation of cognitive from motoric disabilities.

Objectives: Validate the University of California San Diego Performance-Based Skills Assessment in PD.

Methods: One hundred PD participants, ranging from normal cognition to dementia, completed the University of California San Diego Performance-Based Skills Assessment, a performance-based measure of cognitively demanding activities of daily living, as well as a neuropsychological battery and motor examination. Cognitive classification was determined by consensus conference, blinded to University of California San Diego Performance-Based Skills Assessment scores. Psychometric properties of the University of California San Diego Performance-Based Skills

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Relevant conflicts of interest/financial disclosures: Nothing to report.

Full financial disclosures and author roles may be found in the online version of this article.

Assessment, including internal consistency, test-retest and inter-rater reliability, and discriminant validity for dementia, were examined.

Results: The University of California San Diego Performance-Based Skills Assessment demonstrated strong internal consistency (Cronbach's $\alpha = 0.82$) and test-retest reliability ($r = 0.89$) and correlated strongly with global cognition (Mattis Dementia Rating Scale: $r = 0.80$; $P < 0.001$). University of California San Diego Performance-Based Skills Assessment regression models indicated greater contribution from cognitive explanatory variables (marginal partial: $R^2 = 0.33$) than motor variables (marginal partial: $R^2 = 0.05$), controlling for age, education, disease duration, and L-dopa equivalent dose. Additionally, the University of California San Diego Performance-Based Skills Assessment exhibited strong discriminant validity for dementia (area under the curve = 0.91).

Conclusions: The University of California San Diego Performance-Based Skills Assessment is a valid measure of functional abilities related to cognition rather than motor symptoms in PD. Furthermore, it reliably distinguishes demented from nondemented participants. The University of California San Diego Performance-Based Skills Assessment may be considered as an outcome measure that combines cognitive and functional abilities in treatment trials for cognitive impairment in PD.

Keywords

Parkinson's disease; dementia; mild cognitive impairment; outcome measures; functional assessment

Parkinson's disease (PD) is the second-most common neurodegenerative disease after Alzheimer's disease (AD), with prevalence increasing significantly with the aging of the population.^{1,2} Up to 80% of people living with PD will develop dementia during the course of their illness.³ Dementia in PD (PDD) results in poorer quality of life, increased morbidity and mortality, caregiver burnout, and nursing home placement.^{4,5} Effective treatments for cognitive impairment in PD are urgently needed; yet, reliable methods to evaluate the efficacy of new treatments must first be better established.⁶ To date, clinical trials for pharmaceutical agents targeting PDD have utilized cognitive scales as primary outcome measures, namely the Mini-Mental State Examination⁷⁻¹¹ or the cognitive subscale of the Alzheimer's Disease Assessment Scale.¹¹⁻¹⁵ Although these trials variably reported statistically significant improvements on such tests, their clinical significance is not well defined. Less attention has been paid to functional abilities (i.e., the ability to perform activities of daily living independently) as an outcome measure, even though this is of greater relevance to patients and caregivers. Furthermore, the U.S. Food and Drug Administration (FDA) has recommended that future clinical trials for cognitive impairment, especially at early stages, incorporate both cognitive, and functional primary outcome measures in order to demonstrate efficacy and gain approval.¹⁶

Difficulty performing instrumental activities of daily living (iADLs), such as managing finances or medication regimens, is strongly linked to cognitive deficits in PD,¹⁷⁻¹⁹ though motor symptoms, such as tremor and bradykinesia, may also play a role. A major barrier to the use of functional outcome measures in PDD clinical trials is the lack of a validated scale

that can reliably distinguish cognitive from motoric functional impairment. Recently, two PD-specific questionnaire-based cognitive functional scales, the Penn Daily Assessment Questionnaire^{20,21} and the Parkinson's Disease-Cognitive Functional Rating Scale,²² were developed and validated for this purpose. Whereas both scales demonstrate strong psychometric properties, they rely on the report of a knowledgeable informant and can therefore be subject to bias from caregiver burden or mood.^{23,24} In addition, some patients do not have caregivers or have caregivers who do not know them or their daily routines well enough to comment on their level of disability. Moreover, the relative contribution from motor symptoms to functional disability may be inadequately assessed without more direct functional evaluation.

Performance-based cognitive functional assessments, in which individuals are directly observed and scored while performing iADL tasks, could avoid the potential biases of informant-based scales. One such assessment, the University of California San Diego (UCSD) Performance-Based Skills Assessment (UPSA), was initially developed for use in schizophrenia²⁵ and has been validated in AD.²⁶ In mild cognitive impairment attributed to AD, a significant correlation between overall cognitive scores and UPSA performance was demonstrated, with the UPSA exhibiting a greater magnitude of contrast between cognitively normal and cognitively impaired subjects than a coadministered informant-based functional questionnaire.²⁶ The goal of the current study was to validate the UPSA in PD, across a broad range of disease severity, by determining (1) its psychometric properties, (2) its correlation with a well-validated PD cognitive measure in comparison to a motor measure, and (3) its ability to discriminate demented from nondemented PD participants.

Patients and Methods

Participants

One hundred patients with idiopathic PD were recruited from the Movement Disorders Center at the University of Colorado (Aurora, CO) and community movement disorders specialists to participate in this cross-sectional validation study between January 2016 and June 2017. Participants with a range of cognitive and motor symptom severity were included to improve generalizability of results. Inclusion criteria were as follows: diagnosis of PD by Queen's Square Brain Bank criteria,²⁷ age 40 to 90 years, and English as a primary language. Exclusion criteria included active or severe depression or anxiety (defined as a Hospital Anxiety and Depression Scale [HADS]-Anxiety or HADS-Depression subscore > 11), atypical or secondary parkinsonism, and comorbid neurologic conditions (i.e., multiple sclerosis, epilepsy, and traumatic brain injury). The study was approved by the Colorado Multiple Institutional Review Board and all participants provided written informed consent.

Administered Assessments

Clinical Scales—Participant demographic information, educational and occupational history, current medications, and medical history were collected. Levodopa equivalent daily dose (LEDD) was calculated using standardized formulae.²⁸ Motor examination and disease staging in the "ON" PD medication state was performed by a movement disorders neurologist (S.K.H), using the UPDRS Part III²⁹ and the H & Y scale,³⁰ respectively. An

interview was performed with each participant by a neurologist experienced in dementia evaluations (S.K. H.) to assess for current functional impairments, guided by the Lawton iADL scale,³¹ and blinded to results from the UPSA.

Cognitive Functional Assessment—Participants performed the UPSA,²⁵ completing cognitively demanding real-world daily activities through role-playing, in their best “ON” PD medication state. Research personnel completed in-person training on administration and scoring of the UPSA with research staff in the UCSD Department of Psychiatry. Participants were assessed on all five domains of the UPSA, including (1) Finances; (2) Communication; (3) Planning/Organization; (4) Travel; and (5) Household Chores. Participants received a score ranging from 0 to 20 in each domain, with the five domain scores summed to create a total UPSA score (total score range = 0-100; Table 1). A standardized script and scoring manual were used, as well as a standardized set of props (i.e., U.S. currency, utility bill, telephone, bus map and schedule, and pantry stocked with nonperishable goods). Examples of tasks assessed include calling the doctor’s office to reschedule an appointment and making a shopping list based on a recipe and the goods present in a pantry. The UPSA evaluator was blinded to the participant’s cognitive classification and neuropsychological testing scores at the time of administration. Thirty-three participants were randomly chosen to repeat testing with the UPSA, after a median interval of 4 weeks, to evaluate test-retest reliability of the scale.

Neuropsychological Battery—The Mattis Dementia Rating Scale (DRS-2)³² was administered to participants as a measure of global cognition; a measure recommended for use in PD by the International Parkinson and Movement Disorder Society (MDS) Rating Scales Review Committee.³³ A neuropsychological battery was performed, comprised of 10 tests, two in each of the five cognitive domains: (1) Executive Function: Trail Making Test-B³⁴ and Controlled Oral Word Association Test³⁵; (2) Memory: California Verbal Learning Test-II³⁶ and Visual Reproduction recall and recognition from the Wechsler Memory Scale-Revised³⁷; (3) Language: Boston Naming Test³⁸ and Category Fluency: Animal Naming³⁹; (4) Attention: Brief Test of Attention⁴⁰ and Symbol Digit Modalities Test⁴¹; and (5) Visuospatial Function: Judgment of Line Orientation⁴² and Intersecting Pentagons.⁴³ This battery was chosen based on input from neuropsychologists, as well as previous work validating MDS Task Force diagnostic criteria for PD with mild cognitive impairment (PD-MCI).⁴⁴

Cognitive Classification

Cognitive classification, being normal cognition (PD-NC), mild cognitive impairment (PD-MCI), or dementia,⁴⁵ was determined by consensus conference, attended by a neurologist (S.K.H.) and two neuropsychologists (L.D.M. and B.H.) with experience in PD cognition. Before consensus conference meetings, raw scores were transformed to z-scores based on normative data for each of the individual neuropsychological tests, drawn from either testing manuals^{32,34,36,37,41,42} or additional normative studies.^{46–49} MDS Task Force Level II diagnostic guidelines for PDD⁵⁰ and PD-MCI⁵¹ were applied, requiring impairment on two tests in one cognitive domain (PD-MCI) or one test in each of two cognitive domains (PD-MCI, PDD) for classification as cognitively impaired. Impairment was defined as

performance of 1.5 standard deviations (SDs) below age- and education-matched norms.⁵² PD-MCI was differentiated from PDD based on the results of the neurologist's functional interview: If significant functional impairment related to cognitive symptoms was present based on clinical impression, a participant was classified as PDD. If all scores were 1.5 SDs below norms, the participant was classified as PD-NC. All members of the consensus conference were blinded to UPSA scores.

Statistical Analysis

Psychometric properties of the UPSA in PD, including internal consistency (Cronbach's alpha), test-retest reliability, inter-rater reliability, and floor and ceiling effects, were examined. Clinical features of the PD-NC, PD-MCI, and PDD groups were analyzed and compared using one-way analysis of variance, adjusted for different within-group residual variances. To investigate respective contributions from cognitive and motoric impairment to functional disability as measured by the UPSA, Pearson correlations with DRS-2 scores and UPDRS Part III scores were calculated. Spearman correlations were considered if graphical checks found evidence of major nonlinearity in the relationships. DRS-2 was chosen as the primary cognitive measure for comparison with UPSA because it is a well-validated and recommended measure of global cognition in PD.^{6,33} Likewise, UPDRS Part III score is the most commonly used and reliable measure of motor severity in PD.^{29,53,54} Partial correlations were controlled for covariates chosen a priori, including age, years of education, PD disease duration, and LEDD, because we hypothesized that participants who were older, less educated, with longer disease durations, and higher L-dopa requirements would perform worse on the UPSA. Statistical significance was set at $P = 0.05$. In addition to tests for statistical significance ($H_0: r = 0$), a *negligible* correlation was defined as a correlation coefficient with an absolute value of 0.0 to 0.29 (0.0 to -0.29), *weak* as 0.3 to 0.49 (-0.3 to -0.49), *moderate* as 0.5 to 0.69 (-0.5 to -0.69), and *strong* as greater than 0.7.⁵⁵

Sensitivity, specificity, and receiver operating curves (ROCs) with the area under the curve (AUC) were determined for diagnostic classification of PDD using UPSA scores. Linear regression models, with UPSA score as the dependent variable, were used to examine the effects on marginal and partial R^2 of adding either DRS-2 or UPDRS Part III scores as explanatory variables, controlling for our predetermined covariates. Complete data were used for the correlations and modeling to maintain consistency. Statistical analyses were performed using the SAS statistical software package (version 9.4; SAS Institute Inc., Cary, NC). Study data were collected and managed using REDCap electronic data capture tools hosted at the Colorado Clinical & Translational Sciences Institute.⁵⁶

Results

Clinical Characteristics

Table 2 displays the demographic and clinical features of our PD cohort, separated into cognitive classifications as determined by consensus conference. Fifty-six participants were categorized as PD-NC, 19 as PD-MCI, and 25 as PDD. Cognitively impaired participants were significantly older ($t = -6.35$; $P < 0.001$) and had higher LEDD ($t = -2.33$; $P = 0.022$). Disease duration did not differ significantly between PD-NC and PD-MCI ($t = -0.17$; $P =$

0.86), but was significantly longer for PDD than the nondemented groups ($t = -2.73$; $P = 0.008$). There were also more male participants in the cognitively impaired groups ($t = -3.25$; $P = 0.016$).

Psychometric properties of the UPSA in PD

There were no significant floor or ceiling effects for the UPSA, with total scores ranging from 30 to 96 for the cohort (Fig. 1). All 100 participants were able to complete the UPSA, even those with severe motor (H & Y stages 4 and 5; $n = 7$) and cognitive (DRS-2 < 123; $n = 12$) impairment. By qualitative observation, participants were able to finish the UPSA in approximately 30 minutes. The mean UPSA score for the entire cohort was 76.4 (SD, 14.4). The mean UPSA score for the PD-NC category was 84.4 (SD, 7.2) and was 75.0 (SD, 10.2) for PD-MCI and 59.7 (SD, 14.6) for PDD. The UPSA demonstrated strong internal consistency (Cronbach's $\alpha = 0.82$) and test-retest reliability ($r = 0.89$). The majority of the variance in UPSA scores was related to participant characteristics, with the participant fraction of variance estimated at 0.86 (95% confidence interval [CI]: 0.78, 0.94). The rater fraction of variance for UPSA score was negligible, estimated at 0.002 (95% CI: 0.000, 0.029), indicating good inter-rater reliability.

External validity of the UPSA in PD

Correlational Analysis—Total UPSA scores correlated strongly with global cognition, as measured by total DRS-2 score ($r = 0.80$; $P < 0.0001$), a correlation that remained strong when adjusting for age, education, disease duration, and LEDD (partial $r = 0.70$; $P < 0.001$). There was a weak correlation between UPSA total score and motor severity, as measured by UPDRS Part III score ($r = -0.46$; $P < 0.001$), which was attenuated by adjusting for the aforementioned covariates (partial $r = -0.26$; $P = 0.01$). When separating the cohort into cognitive classifications, the adjusted correlation coefficient between total UPSA score and DRS-2 score remained moderate to strong for the PD-MCI ($r = 0.67$; $P = 0.006$) and PDD ($r = 0.77$; $P < 0.001$) groups, but not for the PD-NC group (partial $r = 0.14$; $P = 0.33$). For UPDRS Part III, adjusted correlation with total UPSA score was significant only for the PD-MCI group ($r = -0.72$; $P = 0.002$), but not for PD-NC ($r = 0.11$; $P = 0.43$) or PDD ($r = -0.14$; $P = 0.57$).

Regression Analysis—Comparative linear regression models were built, with total UPSA score as the dependent variable. The reduced model, including predetermined covariates of age, years of education, disease duration, and LEDD, explained a significant amount of variability in total UPSA score alone ($R^2 = 0.34$; $P = 0.01$). Adding the global cognitive explanatory variable (DRS-2 score) improved the performance of the regression model ($R^2 = 0.66$; marginal $R^2 = 0.33$; partial $R^2 = 0.49$; $P < 0.001$). Alternatively, inclusion of the motor severity explanatory variable (UPDRS Part III score) did not add substantially to the reduced model ($R^2 = 0.38$; marginal $R^2 = 0.05$; partial $R^2 = 0.07$; $P = 0.01$).

Discriminant Validity of the UPSA

Total UPSA score discriminated participants with dementia from those without (PD-NC and PD-MCI), with an AUC of 0.91 (95% CI: 0.84, 0.98; Fig. 2). A cut-off score of 72 on the UPSA detected PDD with a sensitivity of 80% and specificity of 89%. Total UPSA score

could also distinguish any cognitive impairment (PD-MCI or PDD) from normal cognition, with an AUC of 0.87 (95% CI: 0.80, 0.95; Fig. 3). A cut-off score of 78 detected any cognitive impairment with a sensitivity of 84% and specificity of 80%. Discrimination of PD-MCI from PD-NC by total UPSA score was also possible, with an AUC of 0.78 (95% CI: 0.65, 0.91; Fig. 4). A cut-off score of 83 identified PD-MCI with a sensitivity of 79% and specificity of 64%.

Discussion

Before embarking on large-scale clinical trials for cognitive impairment in PD, outcome measures for determining the real-world effectiveness of treatments must be better defined. Patients, families, clinicians, and the FDA support that an effective treatment must improve not only cognition, as measured by paper-and-pencil neuropsychological testing, but also related functional abilities and levels of independence. By improving the ability to perform cognitively demanding activities of daily living independently, an effective therapy would promote self-sufficiency, decrease caregiving needs and burden, and avoid nursing home placement for people with PD. Through this validation study, we provide evidence that the UPSA, a performance-based cognitive functional assessment, demonstrates greater association with cognition than with motor symptoms and thus may serve as a combined cognition and functional outcome measure in PD.

Overall, performance on the UPSA worsened as the severity of cognitive impairment increased. Severity of motor symptoms, as measured by the UPDRS Part III score, was only weakly correlated with performance on the UPSA. Considerably more variability in total UPSA score was explained by global cognition than by motor severity in our linear regression models. Whereas an individual may struggle in their ability to use a telephone or make a shopping list because of tremor or bradykinesia, the iADLs tested by the UPSA are more cognitively based than motorically dependent. Interestingly, the correlation between UPSA performance and UPDRS Part III score was strongest in the PD-MCI group and nonsignificant in the PD-NC and PDD groups. UPSA scores were still moderately correlated with DRS-2 scores in the PD-MCI group, indicating that impairment in iADLs at the PD-MCI stage may be related to a combination of cognitive and motor symptoms, which become more strongly cognitively based as the transition to dementia occurs. Additionally, total UPSA score could discriminate PD-MCI from PD-NC, though with less reliability than it could distinguish PDD from nondemented PD. Although the reliable diagnosis of dementia in PD is of importance, based on objective functional impairments in addition to cognitive decline, the early detection of even subtle signs of incipient cognitive decline is paramount. Based on our results, the UPSA is valid for use throughout the spectrum of cognitive impairment in PD, though most powerful in detecting PDD.

Previous studies^{57–60} have investigated alternative performance-based functional measures in PD, including the Medication Management Ability Assessment (MMAA),⁶¹ the Performance Assessment of Self-Care Skills (PASS),⁶² and the Multiple Object Test (MOT).⁶³ However, most of these studies focused on nondemented PD populations. A strength of the current study is the inclusion of a wide range of cognitive abilities, which allowed for the exploration of the use of the UPSA as a diagnostic tool for dementia in PD by determining

its discriminant ability from PD-NC and PD-MCI. We found that the UPSA allows for the reliable detection of PDD. Furthermore, the UPSA can also be used to detect PD-MCI, and our results indicate that functional impairments related to cognition are present before the onset of dementia.

Pirogovsky and colleagues⁵⁷ evaluated iADL abilities in 97 nondemented PD participants using two shorter performance-based functional measures, the MMAA and the financial subscale of the UPSA. Surprisingly, neither functional measure correlated significantly with cognitive nor motor outcomes in their cohort, even though PD-MCI participants displayed functional impairments on the MMAA. Our study found that UPSA performance was correlated with global cognition in the PD-MCI and PDD groups, but not in the PD-NC group, indicating that the full version of the UPSA, despite the longer time of administration, may better evaluate the cognitive contribution to functional disability by utilizing all five UPSA domains. Foster and colleagues⁵⁸ utilized the PASS, an assessment used primarily in occupational therapy, comprised of 26 self-care tasks. Ten tasks with cognitive emphasis were evaluated in this study, including balancing a checkbook, using an oven, and repairing a flashlight. Even this shortened version of the PASS required an average of 80 minutes for PD participants to perform, and evaluation and scoring of performance is much more detailed than the UPSA. Although this study provided thorough information on iADL abilities in nondemented PD, it would be impractical to use the PASS as an outcome measure in PD given its length and complicated scoring scheme.

Glönnegger and colleagues⁵⁹ did include participants with PDD in their study using the MOT, but the effect of motor symptoms on functional performance was less clear. Although errors determined qualitatively to be attributed to “clumsiness” were excluded, performance on all MOT parameters remained significantly correlated with UPDRS Part III scores ($r = -0.23$; $P < 0.001$). This may be attributed to the MOT being comprised of more basic, motorically dependent tasks, such as lighting a candle and opening a padlock. Although performance on the UPSA was also correlated to UPDRS Part III scores in our study, it was more strongly related to DRS-2 score. Furthermore, our UPSA regression models demonstrated greater relative contribution from the cognitive explanatory variable than from motor. When compared to the MOT, the UPSA assesses more cognitively challenging everyday tasks (i.e., planning a trip, interpreting a utility bill) and is therefore better suited to assessing functional abilities related to cognition in PD.

Additional strengths of the current study are inclusion of a broad range of disease severity (H & Y stages 1.5–5), which improves the generalizability of our results. Our neuropsychological battery allowed for comprehensive assessment, meeting Level II MDS diagnostic criteria. Limitations of the study include the high proportion of male, white, and highly educated participants, which may limit generalizability to other populations. Only 1 participant in the PDD group was female, which likely represents biases in recruitment rather than the true prevalence of dementia in women with PD. Although male sex confers a higher risk of dementia in PD,⁶⁴ women are also affected by cognitive decline and often lack the same level of informal caregiving as their male counterparts.⁶⁵ This may lead to barriers to inclusion in clinical research studies for women with PDD, and targeted recruitment efforts should be made in response. Additional limitations of this study include the fact that

the UPSA was not specifically developed for PD and the lack of a medication management task on the UPSA (which is of particular importance for people with PD, who are often prescribed complicated medication regimens). Although the UPSA is a performance-based assessment, it still takes place in an artificial laboratory setting, rather than in the real world of an individual's everyday life. A potential remedy for this limitation may be the development of a wearable tracker or app-based assessment of cognitive functional abilities in real time. The UPSA also lacks alternate full versions, though there are brief⁶⁶ and computerized⁶⁷ versions of the test, and it has been translated into Spanish,⁶⁸ Portuguese,⁶⁹ and Japanese.⁷⁰ Finally, given the cross-sectional design of this study, we were unable to explore the psychometric properties of responsiveness and minimal clinically important difference for the UPSA. Longitudinal data collection is currently underway to address this limitation.

Future directions in this line of research include characterization of cognitive functional ability changes over time in nondemented PD. In accord with previous studies,^{57,58} we found observable cognitive functional impairments in both PD-NC and PD-MCI participants. Similar findings have been demonstrated in AD, with poorer functional abilities at the normal cognition and MCI stages portending a more rapid decline to dementia,⁷¹ even when controlling for baseline cognitive scores.⁷² Following the progression of these impairments in nondemented PD will allow for better characterization of the continuum of cognitive decline in PD, including the poorly characterized pre-MCI stage. Importantly, no participant achieved a perfect score on the UPSA, even those with completely normal neuropsychological testing results. This lack of a ceiling effect could allow for the detection of the subtle, early signs of cognitive decline, even before objective neuropsychological impairments are present, leading to earlier diagnosis and initiation of treatment. It is possible that objective cognitive functional impairment could be utilized as a biomarker for dementia in PD, identifying those patients at highest risk for future cognitive decline.

In addition to such observational research, our findings support the incorporation of performance-based cognitive functional outcome measures into future clinical trials for PD cognitive impairment. In support of this, a recent clinical trial using rivastigmine in PD-MCI⁷³ found significant improvements on a performance-based cognitive functional outcome measure, the Everyday Cognition Battery,⁷⁴ in the treatment group, despite the lack of significant improvements on neuropsychological test outcomes. By focusing on practical and independence-determining abilities, such as managing finances or planning activities, utilization of cognitive functional assessments as primary outcome measures in treatment trials would ensure personally meaningful and empowering benefits for people living with PD.

Acknowledgments

We thank Thomas Patterson, PhD, Elizabeth Twamley, PhD, Barbara Johnson, MA, and Brian Kelly, MA, in the Department of Psychiatry at the UCSD School of Medicine for their advice, assistance, and direct training in the administration and interpretation of the UCSD Performance-Based Skills Assessment. We thank Abigail Simpson and Brittany Schurr for their work administering and scoring assessments, as well as scheduling and coordinating participant visits. We thank our participants and their care partners for their time and energy in contributing to our research.

Funding agencies: This work was supported by the Michael J. Fox Foundation for Parkinson's Research (Grant No.: 10879), NIH/NCATS Colorado CTSI (Grant No.: UL1TR002535), and NIH/NINDS Loan Repayment Program Award (Grant No.: L30 NS103315). Its contents are the authors' sole responsibility and do not necessarily represent official NIH views.

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FIG. 1.
UPSA by DRS-2 by cognitive classification.

FIG. 2. ROC curve for UPSA for PDD diagnosis. [Color figure can be viewed at wileyonlinelibrary.com]

FIG. 3. ROC curve for UPSA for any cognitive impairment (PD-MCI or PDD) diagnosis. [Color figure can be viewed at wileyonlinelibrary.com]

FIG. 4. ROC curve for UPSA for PD-MCI diagnosis. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1.

UCSD performance-based skills assessment

Domain	Assessed Skills	Possible Points
Financial	Counting change Interpreting a utility bill	20
Communication	Calling information to request a phone number Calling the doctor to reschedule an appointment	20
Planning/organization	Planning a trip to a water park	20
Travel	Reading a bus route map Interpreting a bus schedule	20
Household chores	Reading a recipe Completing a shopping list	20
Total possible points: 100		

TABLE 2.

Participant characteristics by cognitive classification

Characteristic	Entire Cohort (n = 100)	Retest Cohort (n = 33)	PD-NC (n = 56)	PD-MCI (n = 19)	PDD (n = 25)
Age (y)	70.5 (8.2), 53-90	71.4 (8.4), 53-87	66.7 (7.4), 53-85	73.8 (4.4), 64-83	76.6 (7.4), 63-90
Sex (n [%] female)	27 (27)	6 (18)	22 (39)	4 (21)	1 (4)
Education (y)	16.5 (2.9), 10-21	16.8 (2.8), 12-21	16.9 (2.7), 10-21	15.6 (3.1), 10-21	16.4 (2.8), 12-21
PD disease duration (y)	6.5 (6.7), 0.25-42.00	7.4 (6.6), 0.5-20.0	5.4 (6.3), 0.5-42.0	5.7 (5.7), 0.25-20.00	9.6 (7.6), 0.25-32.00
LEDD (mg/day)	533.7 (410.3), 0-1,782	588.6 (422.5), 0-1,782	450.7 (389.2), 0-1,724	508.6 (400.3), 0-1,490	738.7 (408.5), 0-1,782
UPSA	76.4 (14.4), 30-96	76.2 (15.3), 40-96	84.4 (7.2), 68-96	75.0 (10.2), 51-95	59.7 (14.6), 30-87
DRS-2	136.6 (7.8), 110-144	134.9 (8.5), 110-144	140.6 (2.8), 130-144	134.6 (7.8), 116-144	128.3 (9.1), 110-139
UPDRS Part III	30.4 (12.2), 9-64	29.5 (10.8), 9-51	25.1 (10.7), 9-64	34.6 (9.7), 15-47	39.0 (11.0), 13-62
H & Y stage	2.5 (0.7), 1.5-5	2.6 (0.7), 1.5-4	2.2 (0.6), 1.5-5	2.6 (0.4), 1.5-3	3.1 (0.7), 2.5-3
H & Y 1.5 (n [%])	7 (7)	2 (6)	6 (10.7)	1 (5.3)	0 (0)
H & Y 2 (n [%])	38 (38)	14 (42.4)	34 (60.7)	2 (10.5)	2 (8)
H & Y 2.5 (n [%])	17 (17)	3 (9.1)	4 (7.1)	7 (36.7)	6 (24)
H & Y 3 (n [%])	31 (31)	10 (30.3)	11 (19.6)	9 (47.4)	11 (44)
H & Y 4 (n [%])	5 (5)	4 (12.1)	0 (0)	0 (0)	5 (20)
H & Y 5 (n [%])	2 (2)	0 (0)	1 (1.8)	0 (0)	1 (4)
Cognitive classification (n [%])					
PD-NC	56 (56)	15 (45.4)			
PD-MCI	19 (19)	6 (18.2)			
PDD	25 (25)	12 (36.4)			

Data presented as mean (SD), range.