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The Weekly Calendar Planning Activity to Assess Functional Cognition in Parkinson Disease

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Abstract

The Weekly Calendar Planning Activity (WCPA) may improve understanding of functional cognition in people with Parkinson disease (PwPD) without dementia. We aimed to determine if WCPA performance (a) discriminates between PwPD with and without cognitive impairment and healthy controls and (b) correlates with other indicators of cognition and daily function. This was a cross-sectional study. Parkinson disease (PD) participants without dementia were divided into normal cognition (PD-NC, $n = 25$) and possible mild cognitive impairment (PD-MCI, $n = 21$) groups. Their WCPA performance was compared with that of a normative sample ($n = 196$) and correlated with neuropsychological test performance and self-reported cognition and participation. Both the PD-MCI and PD-NC groups had impaired WCPA performance. WCPA performance correlated with executive function, processing speed, and self-reported cognition and participation. The WCPA can detect functional cognitive deficits in PwPD without dementia and can inform occupational therapy interventions to support functional cognition, occupational performance, and participation in this population.

Keywords

cognition, cognitive impairment, executive function, assessment, Parkinson's disease

Cognitive impairment is common among people with Parkinson disease (PwPD) and an important target for treatment. About one third of newly diagnosed PwPD have cognitive deficits and half develop mild cognitive impairment (MCI) within 5 years, with deficits most prominent in executive skills like working memory, planning, response inhibition, and cognitive flexibility (Broeders et al., 2013; Foltynie et al., 2004; Kudlicka et al., 2011). Executive dysfunction in PwPD without dementia contributes to poorer activities of daily living function, reduced quality of life, and restricted participation in instrumental, social and leisure activities (Foster & Doty, 2021; Foster & Hershey, 2011; Klepac et al., 2008; Kudlicka et al., 2018). There are currently no effective medical treatments for Parkinson disease (PD)–related cognitive impairment, so cognitive rehabilitation interventions that mitigate its negative functional consequences are a top priority (Burn et al., 2014; Goldman et al., 2018).

Identifying or developing cognitive interventions to support daily function in PwPD without dementia requires understanding how executive dysfunction affects the performance of meaningful everyday activities in this population. Executive dysfunction in PwPD is relatively well characterized from neuropsychological tests, which are highly controlled and aim to isolate discreet cognitive skills. In contrast, much less is known about "functional cognition" in PwPD, which requires the integration of cognitive skills (e.g., executive function, metacognition, memory) and performance skills (e.g., motor skills) to accomplish everyday activities in real-world dynamic environments (Giles et al., 2017; Wesson et al., 2016). Performance-based tests that challenge executive functions within the context of real-life-like activities may complement neuropsychological testing and enhance our understanding of functional cognition in PwPD by providing direct measures of the functional effects of PD-related executive deficits (Jaywant et al., 2021; Toglia & Foster, 2021). This information could then guide the selection of appropriate cognitive rehabilitation targets and methods for PwPD without dementia.

The Weekly Calendar Planning Activity (WCPA; Toglia, 2015) is one such test that has potential to improve understanding of functional cognition in PwPD without dementia. The WCPA was designed to investigate how executive deficits influence a person's ability to perform a complex, multistep activity. As a tabletop paper-and-pencil task, its motor

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demands (other than handwriting) are minimal relative to other performance-based tests, which should permit focused examination of the cognitive aspects of functional cognition. It involves entering a list of appointments into a weekly schedule while keeping track of and adhering to multiple task rules, managing potential conflicts, and ignoring distractions. Scheduling appointments in a calendar is a familiar real-world activity for most people, which enhances the WCPA's face validity and meaningfulness. However, even though it simulates a familiar activity, the WCPA introduces novelty, obstacles, and distractions that require executive skills and a strategic approach to manage. Successful and efficient completion of the WCPA requires planning, working memory, flexibility, inhibition, and prospective memory, all of which can be impaired in PwPD without dementia (Foster et al., 2013; Kudlicka et al., 2011). Performance on the WCPA discriminates between healthy controls (HCs) and those with conditions associated with executive dysfunction such as multiple sclerosis (Goverover et al., 2020), MCI (Lahav & Katz, 2020), and stroke (Jaywant et al., 2021). It also correlates with neuropsychological tests of response inhibition and set shifting in multiple sclerosis (Goverover et al., 2020). Thus, the WCPA may be sensitive to the functional effects of executive dysfunction in PwPD without dementia.

The purpose of this study was to investigate WCPA performance among PwPD without dementia. Specifically, we aimed to determine if WCPA performance differs between PwPD without dementia and healthy age-matched adults. We further explored whether WCPA performance discriminates between PwPD identified as having normal cognitive functioning (PD-NC) and possible MCI (PD-MCI) by a cognitive screening test (Litvan et al., 2012). We hypothesized that PD participants would have lower accuracy, take more time to complete, and have poorer efficiency on the WCPA compared with HCs. We also hypothesized that PD-related performance decrements would be larger in, or driven by, participants with PD-MCI. Second, we aimed to determine if, within PwPD, WCPA performance relates to neuropsychological tests of executive function and reported everyday cognition and participation. We hypothesized that WCPA performance would moderately correlate with neuropsychological tests of executive function. This would show that WCPA performance reflects executive function ability but that it also provides unique information on cognition. We also hypothesized that WCPA performance would relate to reported everyday cognition and participation supporting its relevance to occupational performance.

Method

Participants

Participants were community-dwelling PwPD enrolled in a randomized controlled trial (RCT) of a metacognitive strategy intervention (NCT04048122) and age-matched HCs from the WCPA normative database (Toglia, 2015). PD participants were recruited from the St. Louis Metro area via the Washington University School of Medicine (WUSM) movement disorders center and research participant registry, the local chapter of the American Parkinson Disease Association, flyers posted throughout the community, and word of mouth. PD participants were males and females over the age of 50 years, diagnosed with typical idiopathic PD (Hughes et al., 1992), and Hoehn and Yahr Stage I-III (Hoehn & Yahr, 1967). PD exclusion criteria included possible dementia (as per diagnostic criteria [Emre et al., 2007], Montreal Cognitive Assessment score <21 [MoCA; Nasreddine et al., 2005], or physician or informant report), other neurological disorders, brain surgery, significant history or current psychiatric disorder, or any condition that would interfere with participation (e.g., non-English speaking). The PD study was approved by the university's institutional review board, and all PD participants provided informed consent upon enrollment.

HC data came from a previously conducted normative study (Toglia, 2015). The HC participants were independent community-dwelling adults recruited from the greater New York City area using snowballing techniques. Exclusion criteria were subjective cognitive complaints, history of a neurological condition or hospitalization for a psychiatric disorder, attention-deficit hyperactivity disorder, and inability to read or write in English. Normative data collection was granted exemption by Mercy College's institutional review board because data were recorded so that participants could not be identified. An oral consent script was read aloud and a written copy was provided to each HC participant.

Design and Procedures

This study uses a cross-sectional design using baseline data from the PD RCT and data from the WCPA normative study (Toglia, 2015). For PD participants, demographic data were collected via REDCap survey (Harris et al., 2009) and clinical characteristics were obtained from electronic medical records prior to in-person testing. In-person testing occurred over two separate 1 to 2 hr sessions that were 1 week apart in participants' homes while they were on their regular medications. Of the measures reported here, the motor examination (Unified Parkinson's Disease Rating Scale III, UPDRS-III; Goetz et al., 2007), neuropsychological tests, and questionnaires were administered in the first session, and the WCPA was administered in the second session. Participants could take breaks as needed during testing.

Assessments

WCPA. The WCPA is a standardized, observer-rated, performance-based test of functional cognition (Toglia, 2015). This study used the Level II Adult/Older Adult WCPA, in

which participants are presented with a randomly-ordered list of 17 appointments that they need to enter into a 1-week schedule (paper calendar). Some appointments have a specific day and time (e.g., dentist on Thursday at 3:00 p.m.) while others have options of days and/or times (e.g., dinner with co-workers Thursday or Friday evening), with some options resulting in scheduling conflicts. The participant needs to plan, problem solve, and make decisions to avoid potential conflicts. In addition, there are five rules to follow while completing the task, which are provided verbally prior to task performance and printed on paper for reference during the task (e.g., Tell the examiner when it is [7 min into task performance], Leave Wednesday free). The participant is provided with a clock, scratch paper, and writing utensils to support performance. During the test, the examiner observes performance and records rule adherence, strategy use (e.g., underlines keywords, crosses off appointments entered, makes a draft plan), order of appointment entry, and other relevant observations. In an after-task interview the participant reports additional strategies they used that may not have been observed (e.g., internal self-talk). To accommodate handwriting difficulties among PwPD, the examiner reviewed all calendar entries and verified and re-wrote any illegible responses.

The WCPA scores used in these analyses include total number of appointments entered, correctly entered appointments (accuracy), missing appointments, incorrectly entered appointments (errors), rules followed, strategies used (observed plus reported), time to enter the first appointment (planning time, in seconds), and time for task completion (total time, in minutes). Proportion of self-recognized errors was calculated by dividing the number of self-recognized errors by total errors. Efficiency scores were calculated using accuracy and time, with lower efficiency scores indicating better efficiency (i.e., higher accuracy in less time). Per scoring guidelines, efficiency scores were not calculated for people with accuracy <7. A number of studies support the reliability and validity of the various versions of the WCPA across ages, cultures, and clinical populations (Goverover et al., 2020; Lussier et al., 2019; Marks et al., 2021; Toglia et al., 2017). To our knowledge, this is the first WCPA study in PwPD.

National Institutes of Health Toolbox Cognition Battery (NIHTB-CB). The NIHTB-CB is a computerized neuropsychological test battery that has been normed and determined reliable, sensitive, and valid across the lifespan (Weintraub et al., 2013). It includes tests of executive function (Flanker Inhibitory Control, List Sorting [working memory], Dimensional Change Card Sort [cognitive flexibility]), memory (Picture Sequence Memory), and processing speed (Pattern Comparison), which make up the Fluid Cognition Composite. Tests of language and reading (Picture Vocabulary, Oral Reading Recognition) make up the Crystallized Cognition Composite. Age-adjusted scaled scores (100 ± 15) were used; higher scores indicate better performance.

Neuro-QOL measures. Neuro-QOL is comprised of self-report measures of physical, mental, and social functions for adults with neurological conditions that have good reliability and validity in PwPD (Nowinski et al., 2016). We used the eight-item short forms of the *Cognitive Function* and *Ability to Participate in Social Roles and Activities* scales to assess everyday cognition and participation, respectively. The Cognitive Function questionnaire includes items about the frequency of cognitive difficulties (e.g., "My thinking was slow," "I had trouble concentrating") and extent of difficulty in cognitive situations (e.g., reading and following complex instructions; managing your time to do most of your daily activities). The Ability to Participate questionnaire asks about ability to manage social situations and roles (e.g., "I can keep up with my family responsibilities," "I am able to socialize with friends"). *T*-scores (50 ± 10) were used; higher scores indicate better-reported cognition and participation.

Statistical Analysis

PD data were stored and managed using REDCap electronic data capture tools hosted at WUSM (Harris et al., 2009) and HC data were entered and stored in an IBM SPSS Statistics database. Data were analyzed using IBM SPSS Statistics 28. Descriptive statistics were calculated for all variables, and data were visually inspected for normality. Due to differences in group sizes and non-normality of WCPA variables, non-parametric tests were used. Mann–Whitney *U* and chi-square tests were used to compare the full PD and HC groups. Kruskal Wallis tests were used to compare the PD-MCI, PD-NC, and HC groups on WCPA performance, and Mann–Whitney *U* tests were used for pairwise comparisons where the omnibus indicated significant group differences. Mann–Whitney *U* tests were used to compare the PD-NC and PD-MCI groups on neuropsychological test performance, reported everyday cognition, and participation. Spearman's rho was used to examine the relationships between WCPA performance and neuropsychological test performance, reported everyday cognition, and participation within the entire PD sample (due to small sample size and to reduce the number of statistical tests performed). All tests were two-tailed; *p*-values $<.05$ were considered significant.

Results

Participant Characteristics

Characteristics of the final sample are in Table 1. One PD participant was excluded because they reached 30 min before entering any appointments, so their WCPA could not be scored. Due to differences in the way race and ethnicity were

Table 1. Participant Characteristics, $N = 242$.

Variable	All PD	HC
n	46	196
Age (years)	70.7 (7.2)	68.2 (8.1)
Male/female ratio, *n*	21/25	76/119
Education, *n**		
12 years	2	50
13–15 years	14	42
16 or more years	30	104
MoCA	25.4 (2.5)	NA
Duration of diagnosis (years)	6.7 (5.1)	NA
UPDRS III (on medication)	25.7 (10.4)	NA
Hoehn & Yahr Stage, *n*		NA
2	21	
2.5	13	
3	12	
Work status, *n*		NA
Working for pay	4	
Retired or on disability	42	
Living status, *n*		NA
Living with someone	38	
Living alone	8	

Note. Values are mean (standard deviation) or number of participants where indicated. PD = Parkinson disease; HC = healthy control; MoCA = Montreal Cognitive Assessment; NA = not available; UPDRS III = Unified Parkinson's Disease Rating Scale, Motor Examination subscale.
*PD and HC groups differ, $\chi^2 = 10.1$, $p = .007$.

collected across studies, these characteristics were not compared across PD and HC. Within the HC group, 136 participants identified their ethnicity as Caucasian, 35 as Black/African American, five as Hispanic, five as Asian/Pacific Islander, 14 as Other, and one was missing. Within the PD group, 44 participants identified their race as White and two as Asian; 45 PD participants identified their ethnicity as not Hispanic/Latino and one declined to state. Using the MoCA cutoff of 25/26 (Dalrymple-Alford et al., 2010), 21 PD participants met Level I diagnostic criteria for possible MCI (PD-MCI) and 25 had normal cognition (PD-NC; Litvan et al., 2012).

Group Comparisons of WCPA Performance

The PD and HC groups' WCPA scores are in Table 2. The entire PD group had lower accuracy, more rule breaks and errors, more strategies, less planning time, more total time, and poorer efficiency compared with the HC group. When comparing the three groups, the PD-MCI group entered fewer appointments, had lower accuracy, more missing appointments and errors, and more rule breaks than the two other groups. The PD-NC group used more strategies than the two other groups and had longer total time than the HC group. The HC group used more planning time and had better efficiency than the two other groups.

Relationships Between WCPA Performance and Neuropsychological Tests, Everyday Cognition, and Participation Within PD

The PD groups' NIHTB-CB and Neuro-QOL Cognitive Function and Ability to Participate scores are in Table 3. All PD-NC group means were within 1 *SD* of population average. The PD-MCI group had below average Pattern Comparison, Flanker Inhibitory Control, Fluid Cognition Composite and Neuro-QOL Cognitive Function scores. Bivariate correlations between the primary WCPA variables and these measures are in Table 4. Better WCPA accuracy, rules followed, and efficiency correlated with better Fluid Cognition Composite, Flanker Inhibitory Control, List Sorting, and Dimensional Change Card Sort performance. Shorter WCPA total time and better efficiency correlated with faster Pattern Comparison and better Neuro-QOL Cognitive Function. Better WCPA accuracy correlated with better Neuro-QOL Ability to Participate.

Better Fluid Cognition Composite, Flanker Inhibitory Control, List Sorting, Dimensional Change Card Sort and Pattern Comparison correlated with better Neuro-QOL Cognitive Function (r_s = .31–.52, p .04). Neuro-QOL Ability to Participate did not correlate with any NIHTB-CB tests ($p \geq 0.10$). WCPA performance did not correlate with UPDRS-III ($p \geq .13$).

Discussion

We examined WCPA performance among PwPD without dementia, including its association with neuropsychological tests and self-reports of everyday cognition and participation. As hypothesized, we found PD-related deficits in WCPA performance, many of which were specific to the PD-MCI group but some of which were present in the PD group with "normal cognition" according to cognitive tests. In addition, within PD, WCPA performance moderately correlated with neuropsychological tests of executive function and processing speed and self-reported everyday cognition and participation. These findings provide support for the WCPA as an assessment of functional cognition in PwPD without dementia and demonstrate that it contributes valuable information to the characterization of cognitive function and occupational performance in this population.

The PD group had poorer scores on almost all WCPA outcomes compared with the HC group. The PD-related deficits in accuracy, errors, and rule breaks were driven by impaired performance in the PD-MCI group. These findings are consistent with studies in multiple sclerosis and community-dwelling older adults (Goverover et al., 2020; Lahav & Katz, 2020; Marks et al., 2021). They indicate that the PD-MCI group had difficulty keeping track of appointments, avoiding scheduling conflicts, attending to appointment details, inhibiting inappropriate responses, managing distractions, monitoring time, and prospective memory

Table 2. Comparison of PD and HC Groups' WCPA Performance.

WCPA Variable	All PD	PD-MCI	PD-NC	HC	All PD vs. HC *Z, p*	PD-MCI vs. PD-NC vs. HC *H, p*
n	46	21	25	196		
Appointments entered	15.5 (3.0)	14.8 (3.4)	16.1 (2.5)	16.1 (1.1)	−0.16, 0.88	5.93, 0.05[a,b]
Accuracy	10.7 (3.7)	9.0 (3.4)	12.2 (3.4)	13.1 (2.8)	−3.98, <0.001	24.89, <0.001[a,b]
Rules followed	3.7 (1.1)	3.2 (1.1)	4.1 (1.0)	4.1 (0.9)	−2.09, 0.04	13.36, 0.001[a,b]
Strategies used	6.9 (3.6)	5.6 (3.5)	7.9 (3.4)	4.2 (2.1)	−4.68, <0.001	28.15, <0.001[a,c]
Planning time (in seconds)	70.3 (172.3)	50.9 (63.6)	85.8 (225.0)	121.6 (172.2)	−2.59, 0.01	6.76, 0.03[b,c]
Total time (in minutes)	18.1 (6.9)	17.3 (8.1)	18.7 (5.8)	15.0 (6.6)	−2.68, 0.007	8.84, 0.01[c]
Efficiency[^]	139.4 (59.4)	148.4 (50.8)	133.1 (65.1)	105.5 (93.1)	−4.50, <0.001	21.75, <0.001[b,c]
Errors	5.0 (3.1)	6.3 (3.2)	3.9 (2.7)	3.0 (2.4)	−4.05, <0.001	22.53, <0.001[a,b]
Proportion self-recognized errors	0.2 (0.3)	0.2 (0.4)	0.2 (0.2)	0.2 (0.3)	−0.46, 0.65	0.22, 0.90
Missing	1.52 (3.0)	2.2 (3.4)	0.9 (2.5)	0.9 (1.1)	−0.15, 0.88	6.18, 0.04[a,b]

Note. Values are mean (standard deviation). Higher scores are better for Appointments entered, Accuracy, and Rules followed. Lower scores are better for Efficiency and Errors. PD = Parkinson disease; HC = healthy control; WCPA = Weekly Calendar Planning Activity.; PD-MCI = PD with mild cognitive impairment; PD-NC = PD with normal cognition.
Superscript letters indicate the following significant pairwise comparisons (Mann–Whitney *U, p* < .05): [a]PD-MCI different from PD-NC; [b]PD-MCI different from HC; [c]PD-NC different from HC.
[^]Efficiency score not calculated for those with Accuracy < 7, so PD-MCI *n* = 16, PD-NC *n* = 23, HC *n* = 191.

Table 3. PD Group's Scores on Neuropsychological Tests and Questionnaires of Everyday Cognitive Function and Participation.

Variable	All PD	PD-MCI	PD-NC	PD-MCI vs. PD-NC *Z, p*
NIH toolbox cognitive battery[a]				
Crystallized cognition composite	109.6 (10.7)	105.6 (9.8)	113.1 (10.4)	−2.19, 0.03
Picture vocabulary	108.3 (10.8)	104.1 (11.3)	112.0 (9.1)	−2.19, 0.03
Oral reading	109.9 (11.7)	107.3 (10.6)	112.2 (12.4)	−1.03, 0.31
Fluid cognition composite	92.3 (15.5)	83.9 (16.3)	99.6 (10.4)	−3.30, <0.001
Flanker inhibitory control	85.4 (10.3)	80.4 (9.7)	89.7 (8.9)	−2.65, 0.008
List sorting	103.9 (14.8)	96.3 (13.1)	110.5 (13.3)	−3.27, 0.001
Dimensional change card sort	101.3 (15.5)	96.2 (15.2)	105.8 (14.6)	−2.05, 0.04
Pattern comparison	86.1 (20.1)	78.1 (19.9)	93.1 (18.8)	−2.84, 0.005
Picture sequencing	96.8 (12.0)	92.9 (12.9)	100.3 (10.2)	−2.21, 0.03
Neuro-QOL cognitive function[b]	40.2 (6.2)	38.8 (5.8)	41.4 (6.4)	−1.06, 0.39
Neuro-QOL ability to participate in social roles and activities[b]	46.4 (5.0)	45.8 (5.2)	46.8 (4.8)	−0.77. 0.44

Note. Values are mean (standard deviation). PD = Parkinson disease; PD-MCI = PD with mild cognitive impairment; PD-NC = PD with normal cognition; NIH = National Institutes of Health.
[a]Age-adjusted scaled scores, higher scores indicate better performance; All PD *n* = 45 and PD-NC *n* = 24 because one participant fell outside the age range for standardization (>85 years old). [b]*T*-scores, higher scores indicate more of the construct (i.e., are better).

during the task. The PD-MCI group also entered fewer appointments overall compared with the other two groups, meaning they had more missing appointments. Whereas errors in appointment entry indicate the person can handle the amount of information presented but misses details or does not plan or manage conflicts effectively, completely omitting appointments indicates an inability to handle the amount of information presented. Both PD groups had shorter time to first appointment entry than the HC group; in conjunction with reduced performance on the task, this suggests that neither planned adequately before initiating the task. Both PD groups also had poorer efficiency than the HC group. However, impaired efficiency in the PD-MCI group was due to reduced task accuracy, while impaired efficiency in the PD-NC group was due to increased task completion time. Taken together, these results demonstrate that the WCPA is sensitive to cognitive decline in PwPD without dementia and further reveals different patterns of functional cognitive impairment between those with and without impairment on cognitive tests.

Table 4. Bivariate Correlations (Spearman's ρ) Between WCPA Scores and Neuropsychological Tests and Questionnaires of Everyday Cognitive Function and Participation Within the PD Group ($N = 46$).

	WCPA variable[a]					
Variable	Accuracy	Rules followed	Strategies used	Planning time	Total time	Efficiency
NIH toolbox cognitive battery[b]						
Crystallized cognition composite	0.27	0.20	0.13	−0.05	−0.07	−0.26
Picture vocabulary	0.28	0.28	0.13	−0.08	−0.07	−0.28
Oral reading	0.17	0.07	0.18	0.03	−0.14	−0.22
Fluid cognition composite	0.38**	0.32*	0.19	−0.10	−0.21	−0.47**
Flanker inhibitory control	0.34*	0.30*	0.10	0.12	0.08	−0.44**
List sorting	0.38**	0.45*	0.07	−0.10	−0.24	−0.53**
Dimensional change card sort	0.36*	0.33*	0.08	0.07	−0.19	−0.31*
Pattern comparison	0.28	0.21	0.03	−0.19	−0.39**	−0.30*
Picture sequencing	0.11	0.17	0.19	−0.06	−0.14	−0.11
Neuro-QoL cognitive function[c]	0.21	0.16	−0.24	−0.20	−0.30*	−0.30*
Neuro-QoL ability to participate in social roles and activities[c]	0.38**	0.10	0.18	0.04	0.00	−0.18

Note. WCPA = Weekly Calendar Planning Activity; PD = Parkinson disease; NIH = National Institutes of Health.
[a]Higher scores are better for accuracy and rules followed. Lower scores are better for efficiency and errors. [b]Age-adjusted scaled scores, higher scores indicate better performance; $n = 45$ because one participant fell outside the age range for standardization (>85 years old). [c]*T*-scores, higher scores indicate more of the construct (i.e., are better).
*$p < .05$. **$p < .01$.

Despite normal performance on the MoCA and NIHTB-CB, the PD-NC group demonstrated functional cognitive deficits on the WCPA. Specifically, the PD-NC group used less planning time and more strategies but had a longer total time and poorer efficiency than the HC group. This pattern of results reflects differences in the way the groups approached the task rather than differences in task outcome (i.e., accuracy, rule breaks). It appears that the PD-NC group initiated the task quickly, without planning, and then used many strategies during task performance, which supported task accuracy but increased overall time and decreased efficiency. Prior studies using performance-based tests of cognitive instrumental activities of daily living have found that PD-NC participants take more time (Davis et al., 2019; Foster, 2014) and are less efficient despite good accuracy (Davis et al., 2019). PD-NC participants may have purposefully taken longer or gone slower during the task to maintain accuracy, but using more time at the beginning to assess the task and plan out the most appropriate approach may have been more effective in terms of overall efficiency. In addition, although using more strategies is often associated with better performance, using too many or ineffective strategies can interfere with task performance (Toglia, 2015; Toglia et al., 2017). Increases in strategy use and time taken to complete the WCPA have not been found in other neurological conditions or older adult populations (Goverover et al., 2020; Jaywant et al., 2021; Marks et al., 2021; Toglia et al., 2017). It suggests that PD-NC participants are aware of or anticipate potential task difficulties and try to use methods to support performance; however, they may not select the most appropriate or optimal mix of strategies or implement them effectively. Therefore, strategy selection and optimization in complex, multi-step activities may be important targets for occupational therapy (OT) intervention with this population.

The pattern of correlations between the PD group's WCPA and neuropsychological test performance supports the use of the WCPA as a performance-based test of cognition in this population. WCPA accuracy, rules followed, and efficiency correlated with NIHTB-CB measures of working memory, cognitive flexibility, and inhibitory control, executive skills commonly affected among PwPD without dementia. Reduced processing speed also correlated with increased total time and, thus, poorer efficiency on the WCPA. This may mean that taking longer to complete the task stemmed from the slowed cognitive processing commonly associated with PD (i.e., bradyphrenia) instead of, or in addition to, being a purposeful strategy used to maintain accuracy as discussed above. Although these correlations show that the WCPA reflects underlying cognitive deficits associated with PD, they are only moderate in strength and so support the notion that the WCPA and neuropsychological tests are not completely overlapping or redundant. Motor function did not correlate with WCPA performance, which is consistent with a prior study using a different tabletop performance-based assessment of a complex, cognitively demanding activity (Complex Task Performance Assessment; Davis et al., 2019). Taken together, these findings suggest that such assessments can minimize motor demands and allow investigators to focus on the functional effects of PD-related cognitive decline.

Performance on the WCPA also related to everyday indicators of functional cognition. Increased total time and

poorer efficiency on the WCPA correlated with worse reported everyday cognition. This finding dovetails with the now consistent qualitative and quantitative evidence showing that PwPD without dementia struggle with cognitive slowness in everyday activities (Davis et al., 2019; Foster, 2014; Kudlicka et al., 2018; Thordardottir et al., 2014; Vlagsma et al., 2016). Accuracy, arguably the main goal of the WCPA and primary indicator of task competency (Marks et al., 2021), correlated with reported participation, arguably the main goal of OT intervention. This relationship supports the relevance of WCPA performance to important functional and rehabilitation outcomes. It must be noted that although the WCPA was better associated with participation than the NIHTB-CB, it related less well to everyday cognition than expected. These were initial exploratory analyses in a small sample and while statistically significant, the correlations were low to moderate in strength. In addition, self-report measures of cognition and daily function among PwPD are subject to both over- and underestimation of ability depending on a variety of factors (Burn et al., 2014; Foster & Doty, 2021). Thus, the predictive validity of the WCPA for real-world cognitive and occupational performance and participation warrants further investigation with a broader array of functional outcome measures.

Our conclusions are limited by a relatively small and homogeneous sample of PwPD. There was a considerable size discrepancy between the PD and HC groups, but we opted to use the full HC sample to maximize reliability of the normative data and our statistical power (Faresjo & Faresjo, 2010). Due to the small PD subgroups, we may have had reduced statistical power to detect differences in WCPA performance between PD-MCI and PD-NC, and we did not conduct correlations in the PD-MCI and PD-NC groups separately. We also did not correct for multiple comparisons, which can increase the potential for type I error. Larger prospective studies with more diverse samples are warranted to understand the full range of WCPA performance among PwPD without dementia. Such future studies should use comprehensive evaluation to enhance diagnostic certainty of PD-MCI (Level II criteria; Litvan et al., 2012).

Our study has implications for OT practice with PwPD. It indicates that PwPD who perform within the normal range on cognitive tests should still be assessed for functional cognition because they may have difficulties performing everyday activities that are not detected by structured tests of individual cognitive skills. A tool like the WCPA can detect subtle declines because it requires one to initiate, plan, multitask, and cope with unexpected obstacles. In addition, the WCPA provides direct measurement and in-depth analysis of how a person manages a complex and challenging daily activity, including strategy use and self-awareness. Such information is useful for treatment planning. For example, the performance patterns revealed in this study suggest that clients with PD-MCI may benefit from treatment that helps them recognize task challenges and plan ahead, use task simplification methods, and increase initiation or use of strategies to manage and keep track of information within a multiple-step activity. In contrast, PD-NC clients could focus on methods to improve efficiency such as pre-planning and selecting, practicing, and optimizing task-appropriate strategies.

Conclusion

WCPA performance is sensitive to functional cognitive impairment associated with executive function among PwPD without dementia. It discriminates between PD participants with and without cognitive impairment according to a cognitive screener, and it can further detect specific performance deficits among those deemed to have normal cognition according to a cognitive screener and neuropsychological test battery. These deficits are not revealed by traditional performance outcomes (e.g., accuracy) but instead by indicators of the way the person goes about doing the task (e.g., planning time, strategy use). Importantly, they negatively impact overall task efficiency, which is a known occupational performance and participation problem among PwPD without dementia (Foster, 2014; Kudlicka et al., 2018; Thordardottir et al., 2014), and they may herald future, more overt decline in task outcomes. Our findings highlight the importance of early functional cognitive testing in populations at risk for cognitive decline and support the use of the WCPA in OT practice with PwPD without dementia. In addition to detecting subtle functional cognitive deficits in this population, the WCPA provides information on the process and quality of performance, strategy use, and self-awareness, which can inform treatment and discharge planning. Therefore, it has the potential to guide targeted and effective OT interventions that address functional cognition to improve occupational performance and participation among PwPD without dementia.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: J.T. is the author of the Weekly Calendar Planning Activity, published by AOTA Press, and receives royalties for its sales. All other authors declare that they have no conflicts of interest.

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Ethical Approval

Washington University in St. Louis Institutional Review Board ID #: 201906062; ClinicalTrials.gov number: NCT04048122.

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