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Feasibility of a cognitive strategy training intervention for people with Parkinson disease

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Abstract

Purpose—To investigate the feasibility of a novel client-centered cognitive strategy training intervention for people with Parkinson disease (PD).

Materials and Methods—This was a case series of 7 people with PD without dementia but with subjective cognitive decline. The intervention involved 5 treatment sessions at the participant's home. Participant acceptance and engagement were assessed by the Credibility/Expectancy Questionnaire (CEQ), Client Satisfaction Questionnaire (CSQ), enjoyment and effort ratings, and homework completion. Logistical information was tracked, and the Canadian Occupational Performance Measure (COPM) was an exploratory outcome measure. Data analysis was descriptive.

Results—CEQ scores were positive and increased over time. CSQ scores were high ($M = 30.8$, $SD = 0.75$), with all participants rating all items positively. Almost all (95%) effort and enjoyment ratings were 3 (Much), and homework completion rates averaged 84% ($SD = 18$). Intervention duration was 6–15 weeks ($M = 9.2$, $SD = 2.8$), with treatment sessions averaging 1.7 hours ($SD = 0.5$). Group and most individual COPM ratings improved 2 points.

Conclusions—These findings support the feasibility of the intervention for people with PD. It was acceptable, engaging, and promising in terms of its effect on self-identified functional cognitive problems.

Keywords

Parkinson's disease; cognition; rehabilitation; intervention; strategy training; feasibility

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Introduction

Cognitive impairment is considered a major unmet need and important target for treatment in Parkinson disease (PD) [1]. Clinical diagnoses of cognitive impairment in people with PD include PD-dementia [2] and mild cognitive impairment in PD (PD-MCI), which requires noted cognitive decline with measurable cognitive deficits that do not significantly interfere with daily function but that may be associated with subtle functional difficulties [3]. In addition, as has been characterized in Alzheimer's disease [4], people with PD can have "subjective cognitive decline" even though they have unimpaired cognitive test performance [5, 6]. The line between subjective cognitive decline and PD-MCI is somewhat blurred by factors such as variability in the sensitivity of cognitive and functional assessments, application of different cutoff criteria for impairment, compensation, high prior functioning, awareness, and psychological factors like depression, anxiety and apathy. Regardless, PD-related cognitive decline in the absence of dementia is associated with poor functional outcomes including limitations in instrumental activities of daily living [7, 8, 9], reduced health-related quality of life [10], and reduced participation in instrumental, leisure, and social activities [11]. Pharmacologic and surgical treatments for PD do not prevent or treat cognitive decline and may even exacerbate some deficits [1, 12, 13], so interventions to mitigate its negative functional consequences are needed.

Cognitive rehabilitation approaches for people with PD have begun to emerge in the past decade. Restoration of deficient cognitive processes through cognitive training has been the focus of almost all of these interventions [14, 15, 16, 17, 18, 19]. This involves repetitive practice of tasks that require a targeted cognitive process with the goal of strengthening that cognitive process and, as a result, functional performance more generally. Although studies have demonstrated small, specific, and short-term improvements on cognitive tests in response to these interventions, the improvements do not translate into improved everyday function [14, 15, 18]¹. The goal of cognitive rehabilitation is to support people with cognitive dysfunction in maintaining or improving performance of and participation in everyday activities and roles [20, 21]. Current restorative interventions appear to be falling short of this goal for people with PD.

In contrast to the restorative approach, a strategy-based approach to cognitive intervention provides ways for accomplishing desired tasks and activities despite the presence of cognitive deficits and may help to improve daily function in people with PD. This type of approach involves training people to use metacognitive, problem-solving, or other compensatory strategies (e.g., external aids) in everyday life to cope with daily cognitive challenges. Strategy training is recommended as a Practice Standard (highest strength of evidence) for rehabilitation of memory, attention and executive function deficits after brain injury [22], and evidence suggests it is effective for early dementia as well [23]. Since

¹A possible exception to this statement – that restorative cognitive training programs have not produced improvements in PD participants' daily function – is the study by Reuter et al. [64]. Goal Attainment Scaling was used to define individual goals based on cognitive difficulties determined by baseline testing. As such, goals were related to cognitive functions like dual tasking, planning, and shifting. In the group that received cognitive training (A), 69% reported at least some improvement on their goals. This could indicate improvement in daily function; however, due to the nature of the goals, the reference point (i.e., cognitive tests, cognitive training tasks, or daily cognitive performance) for measuring improvement is unclear. Of note, the group that received "transfer training" in addition to cognitive training (B) had a larger percentage (85%) reporting improvement in individual goals.

people with PD have similar cognitive deficits and cognitive rehabilitation goals as these populations, strategy training may also be appropriate for them [24, 25]. Critically, strategy-based interventions should incorporate features to support the transfer of learned strategies from the training context to real-world activities and environments [26].

We have developed an individualized cognitive strategy training intervention for people with PD. In terms of the broad approach and format, it is client-centered, addresses client-identified functional cognitive problems, uses real-life like activities, takes place in the client's home and/or community, and can involve significant others. These are general rehabilitation practices that foster relevance and meaning to the client's life which, in turn, enhance motivation, engagement in the intervention, real-world application of learning, and follow-through [27, 28].

In terms of specific training techniques, the intervention employs some components from the Multicontext Treatment Approach [28], which focuses on improving occupational performance by enhancing strategy use. First, it emphasizes metacognitive processes (e.g., self-monitoring and self-evaluation) to build awareness of cognitive performance and task demands. Awareness of one's own functioning and the ability to recognize when strategies may be helpful are prerequisites for self-initiated generation and application of strategies [26, 29, 30]. This is relevant to PD in which reduced awareness, and particularly the ability to monitor performance of cognitively challenging tasks, is thought to be associated with reduced cognitive strategy use in daily life [31, 32]. Second, it encourages self-generation of strategies. Self-generated information is more likely to be remembered than that which is supplied by others [33, 34, 35], and this effect likely also applies to strategy use [30]. Third, it explicitly focuses on the similarities between activities and contexts to help clients understand the general conditions under which particular strategies are appropriate, thus enhancing the likelihood of transfer [36, 37]. By using a metacognitive approach and explicitly training for transfer, we hypothesize that our intervention will positively impact everyday cognitive performance and, therefore, will represent an improvement over current restorative cognitive intervention approaches taken with PD.

Because this is a novel and complex intervention, we need to understand and optimize key issues related to its process and feasibility before evaluating its outcomes [38, 39, 40]. Therefore, the primary aim of the current study was to examine participant acceptance, engagement and adherence. In addition, we evaluated the practicality and utility of the initially planned delivery characteristics and protocol.

Materials and Methods

Participants

Participants were recruited through the clinical research database of the Washington University (WU) Movement Disorders Center. Inclusion criteria were a diagnosis of typical idiopathic PD, over the age of 50, and Hoehn & Yahr stage I–III [41]. In addition, participants had to have subjective cognitive decline (as defined by a positive answer to either of these questions: Do you feel like your thinking skills or memory are becoming worse or are worse than others your age? Do you have problems with your thinking skills or

memory?) [4, 42] and express an interest in learning ways to address it. Participants were excluded if they had possible dementia based on Movement Disorders Society criteria [2] or a Montreal Cognitive Assessment (MoCA) score of < 21 [43], medication changes during the course of the study, other neurological disorders (e.g., stroke, brain injury), brain surgery, history of a psychotic disorder, or significant current psychiatric disorder. This study was approved by the Human Research Protection Office at WU. All participants gave written informed consent before testing.

Intervention

This study used a simple case series design with pre and post testing. The intervention was initially planned to consist of six weekly one hour treatment sessions. Treatment sessions were administered by the principal investigator (E.R.F.) in individual face-to-face meetings at the participant's home. The intervention was tailored to each participant's self-identified functional cognitive problems while employing a standardized approach for all participants across and within the treatment sessions. The first treatment session was preparatory and consisted of a review of the neuropsychological test results from pre testing (for awareness-building), an explanation of the intervention's purpose and general process, completion of a modified version of the Canadian Occupational Performance Measure [44] for functional cognitive problem identification, completion of the pre Credibility Expectancy Questionnaire (described below) [45], and provision of the first homework assignment (record and reflect on any cognitive lapses that occur). Actual strategy training occurred during the subsequent treatment sessions, all of which consisted of a recap of the previous session, review of homework, treatment activities (structured activity performance and/or discussion, described below), provision of homework, and completion of feasibility measures. Significant others were welcome to participate in the treatment sessions; however, only the spouse of Case 6 did so for two sessions and the spouse of Case 7 for one session.

Each session's treatment activities were selected by the therapist based on the functional cognitive problem the participant wanted to address during that session. Consistent with the Multicontext Treatment Approach [28, 30], treatment was initially planned to involve the performance of structured simulated functional activities, some of which were existing standardized activities developed by the co-author (J.T.) [for examples, see 30] and some of which were developed by the authors to directly target the participant's functional cognitive problems or real-world occupations. For example, one participant had difficulty reading and remembering articles about science-related current events, and this was interfering with his participation in dinner conversations with his peers. A structured activity developed to address this problem involved reading and discussing science articles with the therapist. During the structured activities, the therapist used pre- and post-activity questioning to guide participants through a process of anticipating performance problems or challenges (e.g., What challenges might you run into as you do this activity?), generating and using strategies to support performance (e.g., Is there anything you could do to make it easier?), and evaluating performance and strategy use (e.g., How did it go? Did [strategy] help? Is there anything you would do differently next time?). Post-activity discussions highlighted connections between the activities and strategies and the participant's real-life activities and functional cognitive problems, and homework assignments reinforced these connections.

Although we initially planned for structured simulated functional activities to be used in all treatment sessions, it transpired that some treatment sessions primarily involved in-depth discussion of these issues rather than actual activity performance. This occurred if the particular activity or functional cognitive problem could not be replicated during the treatment session, or the participant had sufficient awareness, strategy generation capacity and an understanding of generalization to render simulations unnecessary. For example, one participant's functional cognitive problem was related to inefficiency in completing home repair jobs. In response to therapist questioning (i.e., What do you think is causing this problem? What could you do to prevent it?), the participant realized that he was making multiple trips to/from job sites to gather the needed materials and that he could prevent this by organizing his tools and materials into bins according to job type (e.g., plumbing, electrical). He implemented this strategy effectively as homework, so there was no need for him to perform or practice it during the treatment session. In both instances (structured activity performance and discussion), the therapist used mediation techniques (e.g., questioning) rather than direct instruction to promote metacognition and strategy self-generation on the part of the participant.

Homework was assigned at the end of each session and reviewed at the beginning of the subsequent session. It consisted of action plans for implementing the strategies generated and practiced during the treatment session in specific everyday life situations. Participants recorded instances of implementation along with their reflections on strategy effectiveness and potential modifications. In this way, homework not only facilitated strategy application and practice, but also reinforced self-monitoring and self-evaluation, problem-solving, and strategy self-generation and optimization.

Assessment

The primary outcome measures for this study assessed aspects of feasibility. They were administered at various time points during the study and are described in more detail in the following section. Pre and post testing took place at the university and through the use of a web-based survey (for patient-reported measures) [46]. Participants were on their regular antiparkinsonian medication (Case 8 did not take antiparkinsonian medications).

Feasibility measures—The Credibility/Expectancy Questionnaire (CEQ) [45] was used to measure how believable, convincing and logical the participants found the intervention to be (credibility) and their expectations for improvement in response to the intervention (expectancy). It consists of 6 items (3 per construct) with 0–10 response scales. Item scores for the respective construct were averaged to yield overall credibility and expectancy scores, with higher scores indicating higher credibility or expectancy. The CEQ was administered to participants at pre-treatment (during treatment session 1 after the description of the intervention approach) and mid-treatment (treatment session 3 or 4) by the treating therapist, and at post-treatment by a web-based survey.

The Client Satisfaction Questionnaire (CSQ-8) [47, 48] was administered at post-treatment by a web-based survey to assess participants' satisfaction with and perceived value of the treatment. It consists of 8 items with 4-point response scales (e.g., 4 = Excellent, 1 = Poor; 4

= Almost all of my needs have been met, 1 = None of my needs have been met); item scores 3 indicate a positive response, item scores of 2 indicate a neutral response, and items scores of 1 indicate a negative response. The measure produces a total score range of 8–32, with higher scores indicating higher satisfaction.

At the end of each treatment session, participants rated their levels of effort and enjoyment in that session on 6-point response scales (0 = None, 1 = A little, 2 = Some, 3 = Much, 4 = Very much, 5 = Extreme) [16] with the therapist present. Participant adherence was assessed by trained research assistants using homework completion rates. Each homework assignment was judged as Complete, Partially complete, or Did not do and scored 1, 0.5 or 0 points, respectively. These scores were summed and divided by the total number of homework assignments to yield a homework completion rate for each participant. Finally, logistical information (e.g., scheduling, duration) was also recorded to explore delivery characteristics.

Baseline characteristics—Demographic and clinical characteristics (e.g., medication use, disease stage, years since diagnosis, motor dysfunction severity [Unified Parkinson's Disease Rating Scale, Motor Subscale [49]]) were obtained through interview or medical records by trained research assistants. A trained research assessment conducted pre testing, during which the Wechsler Test of Adult Reading (WTAR) [50] was administered as an estimate of premorbid intelligence, the MoCA [51] was administered as a global cognitive screen, and the Beck Depression Inventory-II (BDI-II) [52] was administered to assess the presence and severity of depressive symptoms. Selected neuropsychological tests were also administered during the pre-treatment testing session to provide a picture of participants' cognitive strengths and limitations to guide treatment. Executive function processes were assessed with the Trailmaking, Verbal Fluency, and Color-Word Interference tests from the Delis-Kaplan Executive Function System (D-KEFS) [53]. Memory was assessed with the California Verbal Learning Test 2nd ed. (CVLT-II) [54].

Exploratory outcome measure of treatment effect—The Canadian Occupational Performance Measure (COPM) [44] was administered by the therapist during the first treatment session and by a web-based survey at posttest. The COPM interview was modified slightly to emphasize the identification of occupational performance problems related to cognition, which were then rated on 10 point scales for perceived Performance and Satisfaction (higher scores are better). Pre- and post-treatment Performance and Satisfaction scores were used in the current study as an exploratory measure of treatment effect.

Statistical Analysis

Study data were stored and managed using REDCap electronic data capture tools hosted at WU [46]. Descriptive statistics (e.g., mean, standard deviation, frequency) and graphs were used to investigate and visualize trends in the data.

Results

Participants

Table 1 shows the participants' demographic and clinical characteristics, and table 2 shows their cognitive test scores. One participant (Case 2) discontinued participation after the pre-treatment testing session because she decided she had no functional cognitive problems to address. Her information is included in Tables 1 and 2 for comparison purposes. The final sample consisted of 7 participants. All had Hoehn and Yahr stage II PD, identified as white, had high educational levels, and were married and living with their spouse. Cases 1, 4, and 7 had BDI-II scores indicative of mild depression (14–19) [52], and Cases 4, 6, 7, and 8 had MoCA scores indicative of possible PD-MCI (< 26) [3, 43]. Almost all of the participants' neuropsychological test scaled scores were within or above normal range except for Case 4 (table 2).

Feasibility

Credibility and Expectancy—Individual and group Credibility and Expectancy data are in figure 1. All participants' ratings stayed the same or increased from pre- to post-treatment except for Case 4's Credibility and Expectancy scores and Case 8's Expectancy score. Group averages increased over the course of the study as well. Credibility scores (pre: $M = 7.2$, $SD = 1.4$; mid: $M = 8.1$, $SD = 1.1$; post: $M = 8.7$, $SD = 0.8$) tended to be higher than Expectancy scores (pre: $M = 5.8$, $SD = 1.9$; mid: $M = 6.0$, $SD = 1.3$; post: $M = 6.4$, $SD = 1.3$).

Satisfaction—CSQ scores ranged from 30–32 ($M = 30.8$, $SD = 0.75$) indicating high satisfaction with the intervention. All participants rated all items positively (3).

Effort and enjoyment—Group average effort and enjoyment ratings for each of the treatment sessions ranged from 3.4 to 4.5. Almost all (95%) effort and enjoyment ratings were 3 (Much) except Cases 1 and 4 each rated their enjoyment as a 2 (Some) for one session, Case 4 rated her enjoyment as 2.5 for one session, and Case 5 rated his effort as a 1 (A little) for one session.

Homework adherence—Homework completion rates ranged from 58–100% ($M = 84\%$, $SD = 18\%$). Case 5 had the lowest completion rate (58%), and Cases 3, 6 and 8 had the highest (100%).

Delivery characteristics—The initial plan of six weekly treatment sessions was appropriate for 1 participant (Case 3). Cases 1 and 4 received six sessions per the approved protocol but likely would have benefitted from more because they still had functional cognitive problems to address. To account for this possibility in subsequent participants, the human subjects protocol was modified to allow for up to 12 sessions. Cases 5 and 8 required only five sessions to address their problems, whereas Cases 6 and 7 required seven and eight sessions, respectively. Intervention duration ranged from 6–15 weeks ($M = 9.2$, $SD = 2.8$). Variability in time between sessions (> 1 week) occurred for all but Case 3 due to cancellations (Cases 6 and 7), lack of therapist or participant availability (Cases 1, 4, 5),

participant forgetting the appointment (Case 7), or purposeful scheduling (e.g., the participant wanted more time to practice a strategy in real life; Cases 1, 5–8). The average length of the first treatment session, which included the explanation of the intervention and the COPM, was 2 hours ($SD = 0.3$). Subsequent treatment sessions averaged 1.5 hours ($SD = 0.5$).

Potential effect of intervention

Pre and post COPM Performance and Satisfaction scores are in table 3. All participants' average Performance and Satisfaction ratings improved at least 2 points except for Case 4. Average group change was 2.4 ($SD = 0.97$) for Performance and 2.9 ($SD = 1.5$) for Satisfaction. The number of functional cognitive problems identified by the participants ranged from 3 (Case 3) to 10 (Case 7). Participants had a variety of functional cognitive problems, some overlapping. Some were more cognitively-oriented (e.g., remembering names, Cases 1, 3, 8) while others were activity-focused (e.g., managing medications; Cases 4, 5, 7, 8). Some were general (e.g., multitasking while cooking, shopping and teaching, Case 6) while others were specific (e.g., remembering to lock the door, Case 7).

Discussion

We have developed client-centered intervention to support people with PD in learning strategies and applying them in their everyday lives to improve their cognitive and occupational performance. The purpose of this study was to evaluate aspects of its feasibility, namely participant responsiveness and delivery characteristics, a necessary first step in determining whether it may eventually be effective in clinical practice. We conducted a case series of seven PD participants without dementia but with subjective cognitive decline and self-identified functional cognitive problems. We found that participants were satisfied with the intervention, it made sense to them, and they could engage with it at an appropriate level. We also encountered issues that need to be addressed in future phases of development and testing.

The CSQ and CEQ data indicate that participant acceptance of our intervention was good. Satisfaction with the intervention was very high, with all participants rating its quality and value positively. To our knowledge, there are no normative data or criteria for categorizing CEQ scores; however, scores in the range of ours have been called “high” for Credibility and “moderate” for Expectancy [55]. These results are encouraging because credibility and expectancy are positive predictors of intervention outcomes and, in fact, are proposed as a mechanism for treatment-related improvement by motivating investment and engagement in the treatment [45, 55, 56]. The observed trend for increasing credibility and expectancy over the course of the intervention is also promising, as it could reflect increasing self-efficacy from successful experiences with the strategies [56]. Credibility and expectancy have been studied primarily in the context of psychological interventions like cognitive behavioral therapy, but they could be highly salient for rehabilitative interventions that require active participation and behavior change. In addition, understanding clients' thoughts about and expectations for an intervention can facilitate client-centered care and client-therapist communication [57]. Investigation into the influence of these constructs on the process and

outcomes of this and other rehabilitative interventions is a potentially fruitful area of research.

All participants maintained high levels of effort and enjoyment during treatment sessions, and most of them had high homework adherence (4 of the 7 participants' homework completion rates were 93%). Rehabilitation participation and homework adherence are positively associated with functional outcomes [58, 59], so our results are reassuring and suggest that non-demented people with PD can engage in the intervention in a way that should benefit them if it is truly effective. Executive dysfunction and depressive symptoms, both of which are common in people PD, have been negatively associated with rehabilitation participation in stroke [60]. In the current study, Cases 4 and 7, who had relatively low MoCA and high depression scores, also had lower than average homework completion rates (67 and 71%, respectively). This finding highlights the importance of protocol features to promote participation and the need for continued monitoring of participation as this intervention is tested in more diverse and potentially more cognitively impaired samples of individuals with PD.

Although this study was not designed to test intervention effect, group and almost all individual COPM Performance and Satisfaction change scores were 2 points, which is considered to be clinically important [44]. These findings support our intervention's potential efficacy for addressing self-identified functional cognitive problems among people with PD. Further, they support the use of the COPM as an outcome measure in future trials, as it appears to be responsive to intervention-related change.

Complex behavioral intervention development requires a phased, incremental and iterative approach to ensure that the resources required for clinical trials are not wasted on inadequately designed interventions [38, 39, 40]. Whyte and colleagues [40] recommend this be accomplished by closely observing intervention delivery to a small number of participants and using this experience to guide systematic modification to enhance the fit between the intervention and its target population and to produce a treatment protocol that can be applied by clinicians in a realistic manner. Consistent with this approach, the current case series revealed several issues that require consideration as we continue to develop our intervention. The first is related to target population. Although all of our participants had subjective cognitive decline and several met Level I diagnostic criteria for "possible" PD-MCI [3, 43], only Case 4 had consistently impaired neuropsychological test performance and she was also the only participant whose COPM scores did not improve. In the next study, we will recruit more cognitively impaired participants, administer a comprehensive assessment to determine PD-MCI status with higher certainty [3], and examine it as a potential effect modifier. This will help us understand whether our intervention is beneficial for people with PD-MCI, needs modifications to that end, or is best suited for the "preclinical" stage of cognitive impairment (e.g., subjective cognitive decline without objective cognitive impairment or only subtle objective deficits). Second, we found that the structured simulated activities were not useful or necessary for all participants depending on factors such as their level of awareness, ability to generate strategies, or functional cognitive problems. Decision rules for whether and when to use structured simulated activities are in development. Finally, many of the participants had complex problems that took several

treatment sessions to understand before they could begin to be addressed, and a longer time (than 1 week) between sessions was often required to give participants a chance to practice their strategies in real life or to accommodate people's schedules. We modified the human subjects protocol to account for these realities during the study and will continue to try to understand optimal dosing of our intervention in future studies.

This study has several limitations that could impact the generalizability of our feasibility results. All participants were well educated, had relatively high socioeconomic status and intelligence, and were motivated to learn ways to address their cognitive concerns. These factors could have positively influenced their willingness to engage in a complex, mentally challenging intervention. In addition, other than Case 2 who dropped out of the study, the participants were not working or had flexible work schedules and so could easily accommodate the treatment schedule. It may be more difficult for someone who is employed full-time to participate, but due to the flexible, community-based and client-centered nature of our intervention, we anticipate being able to match a variety of people's scheduling needs. Finally, all treatment sessions were conducted by one therapist, and some of the feasibility measures (pre- and mid CEQ, effort, enjoyment) were completed with the therapist present. Thus, it is possible that participants' ratings of the intervention were biased by their personal relationship with the therapist or observer effect. Future studies will use blind independent raters and multiple trained therapists, which will also allow us to test intervention fidelity, another critical aspect of a complex behavioral intervention's feasibility [61, 62, 63].

In conclusion, interventions for managing PD-related cognitive decline are in high demand from clients, families, practitioners and scientists in the PD community. We have shown that our novel client-centered strategy training intervention is feasible to administer, acceptable to people with PD, and promising in terms of its effect. This study is an initial step toward future clinical trials of its efficacy and effectiveness. The potential long term impact of this work could be an intervention that effectively mitigates the negative functional consequences of cognitive decline in people with PD, which ultimately could lead to better performance, participation and quality of life for this population.

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Figure 1.

Pre-, mid-, and post-treatment Credibility (A) and Expectancy (B) scores for each participant (solid black lines) and the group average (dotted red line; error bars represent ± 1 SE).

Table 1

Participant characteristics.

	Case 1	Case 2*	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Age	67	58	66	68	53	74	62	74
Sex	Male	Female	Male	Female	Male	Female	Male	Female
Education level	Post graduate degree	College graduate	Post graduate degree	College graduate	Some college	Post graduate degree	College graduate	Post graduate degree
Occupation	Healthcare consultant	Receptionist	Professor of Biochemistry	Public relations consultant	Structural Design Draftsman	Teacher	Maintenance Team Leader	Teacher
Work status	Semi-retired	Employed	Retired	Self-employed, part time	Disabled	Retired	Retired	Retired
WTAR	113	102	117	114	102	110	107	116
Duration of PD (years)	4	6	3	5	7	7	7	1
UPDRS-M	8	10	12	12	12	12.5	18.5	32.5
BDI-II	15	17	5	15	8	8	17	3

* Did not receive the intervention.

BDI-II = Beck Depression Inventory II; PD = Parkinson's disease; UPDRS-M = Unified Parkinson's Disease Rating Scale, Motor subscale; WTAR = Weschler Test of Adult Reading, scaled score.

Table 2

Neuropsychological test scores for each participant.

Variable	Case 1	Case 2 [*]	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
MoCA	30	28	29	24	29	24	25	24
D-KEFS scaled scores (M=10, SD=3)								
Trailmaking: Number-Letter Switching	13	13	NA	7 [^]	11	11	13	8
Color-Word Interference								
Inhibition	14	12	8	7 [^]	5 [^]	8	13	8
Inhibition Switching	11	14	11	2 [^]	8	3 [^]	11	9
Verbal fluency								
Letter Fluency: Total Correct	19	9	15	9	11	16	13	6 [^]
Category Fluency: Total Correct	19	10	13	10	8	15	13	9
CVLT-II scaled scores								
Immediate Recall (T score)	73	42	71	40 [^]	54	45	46	47
Short Delay Free Recall (Z score)	2	-1 [^]	1.5	-2 [^]	1	0	0	0
Long Delay Free Recall (Z score)	2	0	2	-2 [^]	0	0	0	-0.5

^{*} Did not receive the intervention.

[^] Score is 1 SD below the mean.

CVLT-II = California Verbal Learning Test (2nd ed.); D-KEFS = Delis-Kaplan Executive Function System; MoCA = Montreal Cognitive Assessment

Table 3

Mean ($\pm$ SD) pre- and post- treatment COPM Performance and Satisfaction scores for each case and for the entire group.

	Pre	Post
Individual scores		
Case 1		
Performance	4.0 $\pm$ 1.0	6.4 $\pm$ 1.0
Satisfaction	5.2 $\pm$ 1.2	7.0 $\pm$ 1.5
Case 3		
Performance	4.3 $\pm$ 2.9	6.5 $\pm$ 1.2
Satisfaction	5.3 $\pm$ 3.3	7.0 $\pm$ 1.0
Case 4		
Performance	5.4 $\pm$ 2.4	6.1 $\pm$ 2.4
Satisfaction	4.6 $\pm$ 2.9	4.1 $\pm$ 2.5
Case 5		
Performance	5.0 $\pm$ 2.4	7.3 $\pm$ 1.7
Satisfaction	3.8 $\pm$ 2.2	7.5 $\pm$ 2.1
Case 6		
Performance	4.9 $\pm$ 1.2	6.9 $\pm$ 1.6
Satisfaction	3.2 $\pm$ 1.2	7.6 $\pm$ 2.1
Case 7		
Performance	5.0 $\pm$ 2.3	8.8 $\pm$ 1.0
Satisfaction	5.1 $\pm$ 2.4	8.6 $\pm$ 1.2
Case 8		
Performance	6.0 $\pm$ 1.0	8.9 $\pm$ 0.8
Satisfaction	4.8 $\pm$ 1.5	9.1 $\pm$ 0.8
Group Average		
Performance	5.0 $\pm$ 0.6	7.2 $\pm$ 1.2
Satisfaction	4.6 $\pm$ 0.8	7.3 $\pm$ 1.6