Combined Cognitive Behavioral Therapy and Attention Process Training Intervention for Older Adults with Parkinson's Disease: Does Order of Modules Affect Treatment Outcome?

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**Abstract**

Parkinson's Disease (PD) encompasses a wide range of non-motor disturbances such as anxiety, depression, and deficits in executive skills (ES), which are extremely common and often more disabling than motor symptoms. Anxiety and declining ES in older adults with PD are now considered prime targets for treatment optimization. Previous studies showed a combined intervention - Cognitive Behavioral Therapy (CBT) and Attention Process Training II – led to improvement in anxiety, depression, and complex cognitive abilities in older adults with PD. *The current study* sought to test the overall efficacy and compare two different versions of the combined APT-CBT treatment on anxiety and cognitive performance in older adults with PD: the CBT-first-group (n=8) and the APT-first group (n=8). The results indicated that the full sample benefited significantly from the combined APT/CBT intervention: Ham-A, Ham-D, and Trail Making Test-B (TMT-B) scores showed significant improvement; Stroop Color Word Test (StroopCW) showed near - significant improvement. The results also indicated that the order of the administration of APT or CBT did not yield significant differences on mood measures and cognitive measures. The current findings suggest that the combined APT and CBT intervention reduced the participants' anxiety and depression significantly, and that the *more complex skills* have a higher predictive power than the lower order skills of the improvement of ES, pointing to the potential benefit of incorporating cognitive remediation programs to improve ES into the psychotherapy interventions for PD older adults with depression and anxiety.

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*"And, when you want something, all the universe conspires in helping you to achieve it."*

— Paulo Coelho, *The Alchemist.*

# Combined Cognitive Behavioral Therapy and Attention Process Training Intervention for Older Adults with Parkinson's Disease: Does Order of Modules Affect Treatment Outcome?

Nearly ten million people worldwide and one million people in the U.S. are currently living with Parkinson's disease (PD). This number is expected to rise to 1.2 million in the U.S. by 2030 (Parkinson's Disease Foundation [PDK], 2024). PD is a chronic and complex neurodegenerative disorder characterized by a severe depletion of neurotransmitter dopamine. Although the primary risk factor for PD is advancing age, an estimated 4% of people with PD are diagnosed prior to age 50. In addition to the reduced mobility and productivity resulting from PD at the individual level, the disease is also very financially costly at the society level. The combined direct and indirect cost of Parkinson's is estimated to be nearly 52 billion dollars per year in the U.S. alone, indicating the vast impact of this disease on the national health care burden (PDK, 2024). The extreme costs, as well as the rapid increase in the incidence of PD, indicate that we are in urgent need of novel and effective treatment approaches, especially psychosocial interventions to be tailored to patients coping with specific disabling symptoms of PD. This would undoubtedly benefit the individual PD patient and help decrease the burden of disease at the societal level.

PD's motor symptoms such as rigidity, rest tremor, and bradykinesia, and the movement (or motoric) symptoms are the most salient and widely studied symptoms of the disease. People with bradykinesia may have difficulty initiating movements and perform tasks more slowly than usual. Although clinical diagnosis relies on the presence of bradykinesia and other salient motor features, PD is associated with many non-motoric symptoms that add to overall disability. In fact, it has been recognized that motor symptoms are just the "tip of the iceberg" of clinical

manifestations of PD (Church, 2021). PD encompasses a wide range of non-motor disturbances such as anxiety, depression, declining cognitive functioning, and dementia, which are extremely common and often *more disabling* than motor symptoms.

For example, approximately 40% of patients with PD present with impairment in cognitive domains including attention, working memory and executive functions, language, visuospatial skills, and episodic memory; and in later stages of the disease, overall cognitive decline and dementia (Papagno & Trojano, 2018). Mild cognitive impairment is present in at least 50% with a cumulative incidence of 66% for dementia after 12 years (Leentjens, 2012). PD patients who experience deficits in executive skills (ES; e.g., attentional control, self-monitoring) may also present with a range of symptoms such as visual hallucinations (Fenelon et al., 2000), decreased motor control (Di Luca et al., 2022), increased apathy (Cohen et al., 2022), personality changes (Santangelo et al., 2017), and functional disability (Still, 2021).

In addition to cognitive impairment (e.g., deficits in ES), psychiatric symptoms also affect the majority of PD patients. Symptoms of depression, anxiety and psychoses are frequent in PD patients, with symptoms of at least one of these disorders present in 64.7% of PD cases (Schneider et al., 2008). Recent epidemiological studies of psychiatric disorders and symptoms in PD patients indicate that the reported prevalence is 17% for major depressive disorder, 34% for any anxiety disorder, 17% for apathy, 14% for impulse control disorders, 88% for sleep disturbances, and 60% for sexual problems (Leentjens, 2012). Psychiatric symptoms are known to contribute to significant functional impairment and adversely affect motor and social function in PD.

To treat PD patients with refractory psychiatric symptoms, non-invasive brain stimulation (NIBS) such as repetitive transcranial magnetic stimulation (rTMS) and transcranial direct

current simulation (tDCS) have been explored. Studies have shown that significant differences were found between NIBS and placebo interventions for depression (Zheng et al., 2022). It was also shown that rTMS combined with antidepressants worked significantly better than antidepressants alone for depression and anxiety (Zheng et al., 2022). However, due to the small sample sizes, limited access, and inadequate systematic evaluation of the therapeutic effects, NIBS is not yet utilized as an accessible non-pharmacological option. Because these psychiatric disturbances result in a poor quality of life for PD patients and increased burden to the caregivers, early detection and optimal therapy for psychiatric symptoms are crucial but lacking in the management of PD (Zheng et al., 2022).

Traditional treatment of Parkinson disease is anchored on pharmacological substitution of striatal dopamine and non-dopaminergic approaches to address both motor and non-motor symptoms. Deep brain stimulation is also used for those developing intractable L-DOPA-related motor complications (Poewe, et al., 2017). Unfortunately, no disease-modifying pharmacologic treatments are available and despite the proper use of the pharmacological treatment by PD patients, chronic non-motoric symptoms related to mood, cognitive function, motor control and mobility necessitate assistance with many daily life activities. Approaches such as deep brain stimulation (DBS) and treatment can help individuals with medication-resistant tremors (Armstrong & Okun, 2020). However, a large subset of PD patients are commonly excluded from this invasive surgical procedure due to cognitive impairment and severe psychopathology. Furthermore, DBS does not result in much improvement in anxiety, depression or cognitive function in the long-term, and may worsen in some cases (Kurtis et al., 2017). Pharmacological methods do not reliably improve ES deficits and have potentially harmful side effects. Thus,

given that existing neurobiological interventions are not entirely effective or reliable, psychosocial and cognitive treatments must be further explored.

Based on the current knowledge and clinical treatment of PD, it is evident that scientific interest in the nonmotoric symptoms of PD has increased dramatically, and psychiatric symptoms are now considered prime targets for treatment optimization. The presence of anxiety is one of the main determinants of quality of life among patients with PD and anxiety treatment is one of the top unmet needs (Perepezko et al., 2021). Clinical ascertainment of anxiety in PD is complicated with on- and off-medication fluctuations, which are thought to have a dopaminergic basis (Perepezko et al., 2021). In addition, there is a clear indication that dopaminergic medications alter patterns of task activation and resting-state networks that play a role in PD anxiety across several brain imaging studies (Perepezko et al., 2021). Finally, there are no randomized, placebo-controlled clinical trials of medications or for the treatment of anxiety in PD to guide evidence-based practice (Wamelen et al., 2023). In summary, there is a pressing need to explore non-pharmacological interventions for nonmotoric symptoms of PD, and to further differentiate their impacts on improvement in mood and cognitive measures.

In a previous study that aimed to enhance ES and reduce anxiety in a 74-year-old male PD patient with anxiety and trouble with memory and attention using non-pharmacological method (Mohlman, et al., 2010), a combined intervention consisting of two components was delivered: Cognitive Behavioral Therapy (CBT), an efficacious intervention for anxiety in older adults (Mohlman & Gorman, 2005), and Attention Process Training II (APT, Sohlberg, et al., 2001), a cognitive rehabilitation intervention that targets focused, sustained, selective, alternating, and divided attention for treating ES deficits in various settings (Ray-Subramanian, 2021). The results indicated that the PD patient showed a reduction in anxiety symptoms that

was of sufficient magnitude to meet criteria for ‘responder’ status (Mohlman, et al., 2010). The feasibility and acceptance of the same intervention in 16 PD patients demonstrated promising results (Mohlman et al., 2011). Moreover, the preliminary effects of the combined CBT and APT intervention in 10 older adults with PD, an anxiety disorder, and self-reported problems with ES indicated that 50% of participants were free of diagnosed anxiety disorders following treatment, and all of them showed improvement in anxiety, depression, and complex cognitive abilities after completing CBT and APT, pointing to the potential benefit of incorporating cognitive remediation into interventions for depressed and anxious adults with PD (Mohlman, et al., 2017).

However, comparison of effective treatments for improving psychiatric and cognitive functioning in PD is limited. Currently, evidence for research findings in nonpharmacological interventions for nonmotoric symptoms in PD remains at the individual cohort level or the systematic review of cohort studies level, with no randomized controlled trials (RCTs) or systematic review or RCTs (Wamelen et al., 2023), and the role of cognitive remediation in conjunction with CBT compared to CBT only remains inconclusive. Thus, the differential responses to CBT within the ES deficits PD patients require further elucidation of the role of improving ES by APT combined with CBT.

Based on the theoretical basis for the original test of the APT and CBT combined studies, Mohlman and colleagues proposed that sound ES are necessary for older adults with GAD to derive full benefit from CBT treatment, because of the intervention’s engagement with complex cognitive exercises such as metacognition, evidence searching, and reducing avoidance require ES (Mohlman et al., 2011).

*The current study* sought to compare two different versions of the combined APT-CBT treatment described above. The order of modules was reversed in two groups of PD patients who

presented with weak ES and clinical levels of anxiety (most often GAD): the CBT-first-group (five sessions of CBT followed by five sessions of APT) and the APT-first group (five sessions of APT followed by five sessions of CBT). It was predicted that the full sample would show benefit from the intervention from BL2 (pre-treatment) to post-treatment, indicating that the intervention was effective in reducing anxiety and depression symptoms and improving ES. More specifically, it was predicted that APT followed by the CBT would yield a synergistic benefit whereby the cognitive enhancement would improve cognitive skills at both mid- and post-treatment outcome, and on psychiatric measures at post-treatment. On the other hand, the group who completed CBT followed by APT was expected to show more improvement on psychiatric measures at mid-point but not at post-treatment.

In summary, it was thus predicted that at mid-treatment, the APT-first-group would show higher scores on cognitive measures than the CBT-first-group. The CBT-first-group was expected to have lower scores on psychiatric measures at mid-point. At post treatment, the APT-first-group was expected to have higher scores on cognitive measures and lower scores on the psychiatric measures than the CBT-first-group.

## Method

*Participants*. Participants were 16 community-dwelling adults (10 male, 6 female) with mid-stage PD recruited from hospital- and community-based PD support groups to participate in the investigation. Diagnoses were corroborated by review of medical records. All were required to have intact basic cognitive functioning but weak ES, and be free of signs of dementia. Patients also reported clinical levels of anxiety symptoms, most often in the form of Generalized Anxiety Disorder (GAD). Participants ranged in age from 50 to 75 and most were on a regimen of dopamine replacement medication at the time of the study.

*Mood Measures*. Clinician-rated measures of anxiety and depression were completed throughout the study: 14-item Hamilton Scale for Anxiety (Ham-A; Hamilton, 1959), and 17-item Hamilton Scale for Depression (Ham-D; Hamilton, 1960). The internal consistency of Ham-A and Ham-D were .89 and .79 respectively; indicating strong internal consistency (Kummer et al., 2010; Broen, et al., 2015). Ham-A and Ham-D are two widely used clinician-rated scales with structured interview guides available to improve consistency and clinical judgment, designed to monitor symptom severity and treatment response. Ham-A measures both emotional (mental agitation, tension, fears) and somatic anxiety (physical symptoms). Likewise, Ham-D measures a mix of emotional and somatic symptoms (e.g. insomnia, weight loss).

*Neuropsychological Measures*. A battery of neuropsychological tests comprised of the Stroop Task (Trenerry, Crosson, DeBoe, & Leber, 1989) and Trail Making Test (Army Individual Test Battery, 1944) were administered at all time points including baseline one, baseline two, mid-point, and post treatment assessments. Only Ham-A was administered at the 3-month follow-up. Alternate forms were used for repeat administration.

*APT-II* Intervention. APT-II (Sohlberg et al., 2001) was chosen because it is readily available, easy to administer, and has empirical data to support its efficacy in patient groups. APT-II is comprised of audio CDs and written worksheets that participants can easily use at home without technical support. Because many PD patients experience motor symptoms that impair manual dexterity and make using a keyboard or mouse difficult, the use of paper worksheets and audio CDs in APT-II was considered an advantage.

## Procedure

The study was fully approved by Institutional Review Board of the Northeastern University where data were collected. Study personnel were closely supervised by a licensed psychologist (Dr. Jan Mohlman).

The CBT component of the intervention was based on published intervention for PD patients (Mohlman & Gorman, 2005). The CBT intervention targets at increasing social participation, reducing avoidance behaviors, reducing excessive fear of disease progression, reducing hopeless thoughts, as well as cognitive distortions such as catastrophizing bodily sensations coupled with disqualifying one's capacity to cope with physical challenges (Mohlman et al., 2011; Mohlman et al., 2017). The therapy protocols include the following sessions: psychoeducation, diaphragmatic breathing and progressive muscle relaxation; identifying cognitive distortions and cognitive restructuring; exposure to tasks in fear hierarchy to reverse avoidance behaviors; and reducing worrying by exposure to anxiety provoking situations (Mohlman et al., 2017). The patients were given weekly CBT worksheets to read and complete at home to extend therapeutic gain from the weekly CBT skill building sessions.

APT is a cognitive remediation program that has been shown to improve ES in a variety of populations. The primary goal of the APT program aims to improve ES by attention training in PD patients, with each session's tasks increasing in cognitive manipulation and task complexity. The four types of attention that are commonly impaired in PD include: sustained, selective, divided, and alternating attention, which are targeted for cognitive improvement in the APT component (Mohlman et al., 2011; Mohlman et al., 2017). The APT program also incorporates at-home exercises to help generalize skills to real-life activities and maintain therapeutic gains.

The APT component used audio CDs without computerized tasks, which was beneficial given that motor symptoms associated with PD can make computer use challenging.

The intervention consisted of 10 weekly 90-minute individual sessions of CBT and APT modules. The sessions were held once a week for ten weeks, delivered by doctoral psychology students who received extensive training and practice on CBT and APT-II in a university clinic. In session, patients practiced exercises in two thirty-minute blocks, separated by a five-minute break, and then patients completed log sheets rating their experience. For the component of APT training, patients were assigned daily independent at-home practice including extensions of in-session exercise as well as exercises designed to generalize skills to patients' everyday lives (Mohlman et al., 2017). Caregivers attended 50% of the sessions to ensure completion of homework and consistent practice of therapeutic skills.

The first measurement was the initial baseline (BL1). After BL1, participants completed an eight-week waiting phase during which no contact or treatment was administered. The waiting period of eight weeks was chosen to approximate the number of weeks in CBT modality to allow for spontaneous improvement in outcome variables of interest. Following the waiting phase, all participants completed a second baseline assessment identical to the first (BL2), with alternate forms used when possible. Within one-week of BL2, they began the study treatment (Mohlman et al., 2017). At mid-point of the treatment, before they switched to CBT or APT component, they completed mid-point measures on Ham-A, Ham-D, Trail making Test A (TMT-A), Trail making Test B (TMT-B), Stroop Word Trial (StroopW), and Stroop Color Word Trial (StroopCW). After 10 weekly sessions, patients completed post-treatment measures on all mood and cognitive domains. At the 3-month follow-up, patients completed a final Ham-A.

## Data Analyses

*Preliminary Analyses.* Demographic characteristics of full sample (n=16) are summarized in Table 1, and the full sample Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW scores across all time points are summarized in Table 2. All participants were required to have intact basic cognitive functioning and be free of signs of dementia, but also had to report weak ES and impairing symptoms of anxiety. The comparison of the demographic characteristics of the APT-first group and CBT-first-group are summarized in Table 3, with no significant differences between the two groups.

*Main Analyses*. All analyses were conducted in SPSS version 29.0 (IBM Corp., Armonk, NY). First, repeated measures ANOVAs were carried out for Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW measures across all timepoints (BL1, BL2, Mid, Post, Follow-Up) to test the effects of time and order of APT and CBT (Table 4). Differences between measurement timepoints (Post-Hoc Pairwise Analysis) from repeated measures ANOVA were summarized in Table 5. Second, paired sample t-test comparing Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW scores at BL2 to post treatment, and BL1 to BL2 were summarized in Table 6 and 7 respectively. The mean scores with range of standard deviations on mood measures and cognitive domains across treatment phases were summarized in Table 8 to Table 13, along with plots illustrated in Figure 1 to Figure 6. Third, t-tests comparing the mid-point changes between the APT-first-group and CBT-first-group were summarized in Table 14.

## Results

*Demographic characteristics of participants*. The demographic characteristics of the participants are summarized in Table 1 for the full sample (n = 16); APT-first-group (n = 8) and CBT-first-group (n = 8) in Table 3.

*Homogeneity of variance*. In terms of the homogeneity of variance between the groups, Lavene's tests verified that the assumption of equal variances was valid for all the t-tests, with the *p*-values higher than a significant level of .05.

*Paired sample t-tests*. To test the hypothesis that the full sample would show benefit from the combined intervention, paired sample t-tests were conducted (see Table 2 for means and SDs for each timepoint). The t-test comparing Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW scores are summarized in Table 6 (BL2 to post treatment), and Table 8 (BL1 to BL2). From BL2 to post treatment, both Ham-A and Ham-D scores showed significant reduction; both TMT-B and StroopCW showed significant or near significant improvement in the full sample. From BL1 to BL2, no significant changes were observed, except a significant increase on Ham-A scores.

*Repeated Measures ANOVA*. To test the hypothesis that APT followed by the CBT would yield a synergistic benefit whereby the cognitive enhancement would improve cognitive skills at both mid- and post-treatment outcome, and psychiatric measures at post-treatment, repeated measures ANOVAs were carried out to assess the effectiveness of the intervention between the APT-first-group and the CBT-first-group across all timepoints: BL1, BL2, mid-point (Mid), post-intervention (Post), and follow-up (FU) as summarized in Table 4 and 5. There was no significant time*order interaction or significant difference between order groups (APT first vs. CBT first) on any of the mood or cognitive variables reported in Table 4. There was however a significant effect of time on average Ham-A scores, $F(4,44) = 14.092$, $p < .001$; Ham-A Post-hoc pairwise analysis showed a significant difference between BL1 to Post, BL2 to Post, Mid to Post, BL1 to FU, BL2 to FU, and Mid to FU. Likewise, there was a significant effect of time on average Ham-D scores, $F(3,33) = 7.295$, $p < .001$; Ham-D Post-hoc pairwise analysis showed a

significant difference between BL1 to Post, BL2 to Post, and Mid to Post. However, post-hoc pairwise analyses on cognitive measures TMT-A, TMT-B, StroopW, and StroopCW did not yield any significant differences, thus not reported in Table 5.

There were no significant differences based on order (APT first vs. CBT first) by the ANOVAs. Means and standard deviations of APT-first group and CBT-first group are summarized in Tables 8 to 13, along with comparison plots illustrated in Figures 1 to 6. The descriptive plots in Figure 1 and Figure 2 confirmed the findings from repeated measures ANOVAs and paired t-tests on Ham-A and Ham-D scores, indicating for both the APT-first-group and CBT-first-group, their Han-A and Ham-D scores reduced significantly from BL2 to post-treatment, and even in 3-month follow-up on Ham-A scores. For TMT-A, TMT-B, and StroopCW scores, the mean T-scores fell between 40 and 60, with slight increase towards post-treatment, but not significant.

*Independent sample t-test*. In order to test the hypothesis that CBT-first-group would have lower scores on psychiatric measures at mid-point compared with the APT-first-group, independent sample t-tests were carried out to compare change scores on cognitive measures and mood measures between APT-first-group and CBT-first-group from BL2 to mid-point before they switched to the other modality. The significance *p*-values are summarized in Table 14. No significant differences were shown between the changes from the two groups, consistent with the findings from the repeated measures ANOVAs.

## Discussion

The current study sought to test the overall efficacy and compare two different versions of the combined APT-CBT treatment on anxiety and cognitive performance in older adults with PD. Nonmotoric symptoms are an important and ubiquitous determinant of quality of life in PD

patients, however treatment optimization is still a major unmet goal. The most recent review of evidence suggests that a range of non-pharmacological interventions for cognitive and psychiatric symptoms are promising yet limited in understanding the role of cognitive remediation programs comparing to cognitive psychotherapy interventions (Wamelen et al., 2023). Furthermore, more research is needed on the comparison of effective treatments for improving psychiatric and cognitive functioning in PD.

First, the current study showed that the full sample benefitted significantly from the combined APT/CBT intervention. On both Ham-A and Ham-D measures, there was a significant effect of time, from BL1 to Post, BL2 to Post, and Mid to Post. Furthermore, the anxiety symptoms measured by Ham-A in the full sample continued to decrease after the completion of the intervention to the 3-month follow-up (Table 5 and 8, Figure 1), demonstrating the durable effects of the combined CBT and APT intervention. Items of the Ham-A reflect a broad range of affective, cognitive, and physiological symptoms of anxiety and may have been more sensitive to changes. Depression symptoms measured by Ham-D also improved significantly, which is not surprising, because depression and anxiety are highly comorbid in PD, sharing common underlying biological and psychological mechanisms (Khedr et al., 2020), involving dopaminergic pathways that are disrupted in PD. Additionally, anxiety symptoms can escalate in response to chronic disease stressors common in PD, highlighting a cyclical interaction between anxiety and depressive states (Upneja et al., 2021).

Notably, the full sample patients presented with elevated anxiety scores upon pre-intervention assessment using the Ham-A, demonstrating a significant increase from BL1 to BL2 (Table 7). It's commonly observed that PD patients experience heightened anxiety stemming from disease uncertainty and the anticipated impact of treatment (Bloem et al., 2021; Elefante et

al., 2021). This anxiety can be compounded by the emotional and psychosocial challenges of living with PD, further illustrating why initial assessments often yield elevated anxiety scores (Roper et al., 2024). Other than anxiety scores, the differences between BL1 and BL2 were not significant (Table 7), while the pre-treatment to post-treatment differences were significant (Table 6), indicating the effects were not due to background noise during the waiting period from BL1 to BL2.

On the cognitive measures, repeated measures ANOVAs did not indicate significant changes from BL2 to Post, however, paired t-tests showed that TMT-B had significant ($p$ = .014) and StroopCW had near significant ($p$ = .061) increases from the combined intervention (Table 6).

The current results indicated that the combined intervention helped PD patients improve their set shifting skills on TMT-B scores, regardless of the order of the modules. The Trail Making Test, particularly Part B, is widely recognized as an effective tool for assessing executive ES and cognitive flexibility in patients with PD. TMT-B is specifically designed to measure set shifting, which is essential for executing complex tasks that require planning and organizational skills. TMT-B requires individuals to alternate between numbers and letters, thus demanding cognitive flexibility, inhibitory control, and sustained attention. These cognitive abilities are critical for effective problem-solving and decision-making, and deficits in these areas can significantly impact daily functioning. TMT-B's ability to discriminate among different levels of cognitive impairment makes it especially relevant for monitoring changes over time in PD patients (Schmitt et al., 2010). Furthermore, TMT-B can effectively delineate domains of attention and working memory relevant to ES, reinforcing its utility as a diagnostic tool (Martini

et al., 2019). Patients with PD typically exhibit slower processing speeds in TMT-B, which reflects their difficulties with ES rather than mere motor symptoms.

The results also indicated that the full sample did not show significant improvement in TMT-A by ANOVAs or paired t-tests. Unlike TMT-B which assesses ES, such as cognitive flexibility and task-switching abilities, which are vital for adapting to new situations and solving problems, TMT-A, on the other hand, mainly evaluates psychomotor speed and visual attention and does not include the cognitive complexities involved in TMT-B, thus providing only a limited view of ES in PD patients (Chou, et al., 2010). Research indicates that performance on TMT-B correlates with the ability to perform instrumental activities of daily living in PD patients, however, TMT-A does not adequately capture these complex functional implications (Higginson et al., 2013). Additionally, studies highlight TMT-B's effectiveness in revealing cognitive impairments among PD patients, particularly regarding broader aspects of executive functioning compared to TMT-A, which primarily focuses on processing speed without incorporating the essential cognitive flexibility required in TMT-B.

Similarly, the current results showed that the more complex cognitive measurement StroopCW showed a near significant ($p$ = .061) improvement from BL2 to Post (Table 6). Studies show StroopCW provides insights into critical domains such as inhibitory control, cognitive flexibility, attention, working memory, and conflict monitoring. Specifically, when a patient with PD is required to perform StroopCW, they must effectively inhibit their automatic response (reading the word) and instead focus on a task that requires more controlled processing (naming the ink color). This task performance is indicative of their capacity for cognitive control, which is a core aspect of executive functioning. The cognitive flexibility required in the StroopCW becomes challenging as individuals struggle to suppress competing responses and

manage task-switching demands. This impairment is exacerbated by PD's neurobiological effects, particularly on the prefrontal cortex and basal ganglia regions, which are crucial for executive function tasks (Bucur & Papagno, 2022).

Not surprisingly, the current results showed that StroopW scores of the full sample did not improve significantly from BL2 to Post (Table 6). The Stroop Color Word test introduces a higher cognitive load due to the requirement of processing both verbal and visual elements that compete for the participant's attention. This complexity is reflective of real-life situations in which patients must ignore distractions and focus on relevant tasks. In contrast, the Stroop Word Test, which requires only the identification of words printed in black ink, does not engage the same level of cognitive conflict or inhibition, thus offering a more limited perspective on the patient's executive functions.

In terms of the neurobiological correlates, the neuropsychological mechanisms underlying the TMT-B tasks relate to inhibition of automatic responses and cognitive control, both of which are significant in understanding PD's impact on cognitive functions; and StroopCW serves as a significant diagnostic tool for assessing ES in PD patients, highlighting issues related to cognitive flexibility, selective attention, and the inhibitory control necessary to navigate conflicting information. The dysfunction of the striatum and associated dopaminergic pathways in PD patients can adversely affect executive functioning, suggesting that TMT-B performance can provide insights into the extent of executive impairment in this population (Seo et al., 2025). The significant correlation between cognitive function and density of nigrostriatal dopamine transporters, show that striatal dopaminergic pathways — primarily the executive striatal subregion — are related to impaired cognitive processing in PD (Stögbauer et al., 2020).

Similarly, StroopCW is designed to allow for a clear assessment of cognitive functions associated with frontal lobe activity, which is affected in PD (Scarpina & Tagini, 2017).

Taken together, due to an overlap of cognitive functions assessed, both TMT-B and StroopCW which engage higher levels of complexity and cognitive load than TMT-A and StroopW, showed a significant and near significant improvement from the combined intervention respectively in this study. Furthermore, the pre-intervention assessments at BL-2 indicated that the full sample had relatively higher scores on TMT-A and StroopW, and lower scores on TMT-B and StroopCW (Table 2), which could also explain the lack of improvement reflected by TMT-A and StroopW at post-intervention. By offering more limited perspectives on the patient's ES, TMT-A and StroopW could not reflect areas of cognitive improvement in PD patients brought by the interventions in this study.

The results indicated that the order of the administration of APT or CBT did not yield significant differences on mood measures and cognitive measures (Table 4 and 5), by repeated measures ANOVAs comparing means between groups (CBT-first-group versus APT-first-group). In other words, the APT-first-group showed equivalent improvement on mood and ES at mid-point, while CBT intervention improved cognitive scores as much as APT did at mid-point. The plot curves tracing test scores across all timepoints comparing the APT-first-group and CBT-first-group were illustrated in Figure 1 through Figure 6. Of note, the profile plots indicated that overall, the APT-first-group started with slightly higher scores on Ham-A and Ham-D, and slightly lower scores on cognitive measure on TMT-A, TMT-B, StroopW, and StroopCW. Even though the differences were not statistically significant, they could indicate a slightly lower overall level of functioning at pre-treatment in APT-first-group. Thus, the improvement of cognitive functions at mid-point by APT was attenuated by the slightly lower overall functioning

to begin with. Second, the APT training may not have necessarily mapped onto measurable score improvements at mid-point, because the selected measurements may not distinguish the key nuanced cognitive improvements by APT-first training.

The interpretation of the data requires understanding of APT and the role it plays in cognitive remediation. Previously studied, at least one randomized controlled trial demonstrated the beneficial effects of APT in patients with brain injuries (Markovic et al., 2020). The rationale underlying APT is that learning specific skills may help improve some of the cognitive problems, e.g. EF deficits. Recent research has supported that cognitive enhancement strategies can improve both cognitive skills and treatment outcome in anxious older adults (De Vito et al., 2022). Furthermore, ES and complex cognitive abilities (e.g., set switching, inhibitory control, cognitive flexibility) and their relation to anxiety and therapeutic outcome emerge as major themes in treating anxiety in older adults (Mohlman, 2013). Learning-based psychotherapies such as CBT may be contingent upon sound memory and ES, thus it is possible that impairments or deficits in working memory and ES limited the efficacy of CBT interventions (Mohlman, 2013). The current findings suggest that the combined APT and CBT intervention reduced the participants' anxiety and depression significantly, and that the *more complex skills* have a higher predictive power than the lower order skills of the improvement of ES, measurable by TMT-B and StroopCW scores, indicating that cognitive remediation effects from APT improved the cognitive processes that are crucial to the declined ES in PD patients.

*Limitations*. The small sample size in the current study may have led to unreliable findings and reduced power to detect between-group differences. The current study of 16 older PD patients were recruited from a less diverse population, which may have restricted the generalizability of the findings. Additionally, the 16 PD patients came with varied levels of ES

deficits, which may have affected the treatment response. Medication cycles were not closely tracked in the study, introducing a potential source of uncontrolled variability in mood and cognitive abilities. Lastly, the follow up assessment consisted only of Ham-A only, and thus lacked measurements of durability of effects on cognitive domains and other mood improvement.

*Clinical Implications*. The current study contributes to the limited literature of the evidence and efficacy of CBT and APT interventions for treating nonmotoric symptoms of PD. This is the first study comparing the effects of CBT and APT in a combined and reversed design. The APT component did not lead to statistically significant benefits over CBT alone, however, given that PD is a progressive disorder of the brain, showing sustained cognitive and mood measures could be regarded as positive results. These findings indicate the potential benefit of incorporating cognitive remediation programs to improve ES into the psychotherapy interventions for PD older adults with depression and anxiety.

*Future Directions*. Whereas this pilot study did not implicate any particular order of modules for this intervention, both CBT-first-group and APT-first-group led to post-treatment improvement. The need for research on nonpharmacological interventions for nonmotoric symptoms in PD is evident and has become a pressing need in the past decade. Further research should move towards determining if CBT/APT or APT/CBT could be classified as an empirically-evidence-based non-pharmacological intervention for older PD patients with anxiety.

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**Table 1**

*Full sample characteristics at BL1 (n = 16)*

| Variables | Mean, SD, % | Range, Proportion |
|---|---|---|
| Age | 62.71 (7.32) | 50 - 75 |
| Income ($K) | 90.40 (61.550) | 11 - 200 |
| Female | 38% | 6/16 |
| Married | 69% | 11/16 |
| Retired | 62.5% | 10/16 |
| Graduate Degree | 62.5% | 10/16 |
| Caucasian | 94% | 15/16 |

*Note*. Income displayed in thousands; SD=Standard Deviation.

**Table 2**

*Full sample Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW scores at all time points*

| Variables | BL1 Mean (SD) | BL2 Mean (SD) | Mid Mean (SD) | Post Mean (SD) | FU Mean (SD) |
|---|---|---|---|---|---|
| Ham-A | 22.384 (6.305) | 24.384 (5.852) | 20.769 (6.559) | 15.307 (6.968) | 13.076 (6.563) |
| Ham-D | 12.923 (6.836) | 12.461 (6.345) | 11.307 (5.513) | 6.846 (3.760) | |
| TMT-A | 59.630 (14.018) | 63.246 (11.844) | 62.000 (10.832) | 63.923 (10.672) | |
| TMT-B | 53.453 (10.357) | 51.538 (6.186) | 57.461 (11.155) | 60.000 (10.984) | |
| StroopW | 176.153 (61.508) | 177.384 (56.994) | 191.692 (57.504) | 189.615 (64.729) | |
| StroopCW | 48.461 (15.278) | 49.276 (16.574) | 47.530 (14.130) | 54.692 (9.869) | |

*Note*. Ham-A = Hamilton Anxiety Rating Scale; Ham-D = Hamilton Depression Rating Scale; TMT-A = Trail making Part A; TMT-B = Trail making Part B; StroopW = Stroop Word Trial;

StroopCW = Stroop Color Word Trial; BL1 = Baseline 1; BL2 = Baseline 2; Mid = mid-point before the switch to APT/CBT; Post = Post-intervention after finishing all ten sessions; FU = Follow-up three months after post-intervention. TMT-A, TMT-B, and StroopCW scores are T scores. T-scores have a mean of 50 and a standard deviation of 10. A higher T-score indicates better performance. StroopW score indicated the number of correctly named words in 3 minutes.

**Table 3**

*Demographic characteristics of participants in the two groups*

| Baseline 1 | APT-first-group (n = 8) | | CBT-first-group (n = 8) | |
|---|---|---|---|---|
| Characteristics | Mean, SD, % | Range, Proportion | Mean, SD, % | Range, Proportion |
| Age | 62.25 (7.07) | 54 – 75 | 65.50 (8.23) | 58-75 |
| Income ($K) | 74.88 (55.77) | 11 – 200 | 82.88 (54.29) | 35 – 190 |
| Female | 37.5% | 3/8 | 37.5% | 3/8 |
| Married | 62.5% | 5/8 | 75.0% | 6/8 |
| Retired | 50.0% | 4/8 | 75.0% | 6/8 |
| Grad Degree | 50.0% | 4/8 | 75.0% | 6/8 |
| Caucasian | 87.5% | 7/8 | 100% | 8/8 |
| Latinx | 12.5% | 1/8 | 0% | 0/8 |

*Note*. No significant differences between the two groups on the displayed variables.

**Table 4**

*Repeated measures ANOVA for Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW across all measurement timepoints (BL1, BL2, Mid, Post, Follow-Up)*

| Measure | Within-Subjects Effects / Between-Subjects Effects | | | Effect Size |
|---|---|---|---|---|
| | df | F | *p* | (Partial Eta Squared) |

| | | | | | |
|---|---|---|---|---|---|
| Ham-A | Time | 4 | 14.092 | <.001** | .562 |
| | Order | 1 | .727 | .412 | |
| | Time*Order | 4 | .176 | .950 | |
| Ham-D | Time | 3 | 7.295 | <.001** | .399 |
| | Order | 1 | .229 | .642 | |
| | Time*Order | 3 | .295 | .829 | |
| TMT-A | Time | 3 | 1.370 | .269 | |
| | Order | 1 | .828 | .382 | |
| | Time*Order | 3 | .702 | .557 | |
| TMT-B | Time | 3 | 3.318 | .032** | .232 |
| | Order | 1 | 1.443 | .255 | |
| | Time*Order | 3 | .173 | .914 | |
| StroopW | Time | 3 | .465 | .708 | |
| | Order | 1 | .727 | .412 | |
| | Time*Order | 3 | .383 | .766 | |
| StroopCW | Time | 3 | 2.791 | .056* | .202 |
| | Order | 1 | .225 | .645 | |
| | Time*Order | 3 | .047 | .986 | |

*Note.* *$p < .1$; **$p < .05$

**Table 5**

*Differences between measurement timepoints (Post-Hoc Pairwise Analysis) from repeated measures ANOVA for Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW across all measurement timepoints (BL1, BL2, Mid, Post, Follow-Up)*

| Measure | Differences between measurement timepoints (Post-Hoc Pairwise Analysis) | | | |
|---|---|---|---|---|
| | | Difference | Std. Error | *p* |
| Ham-A | BL1- Post | 7.167 | 1.786 | .020** |
| | BL2- Post | 9.071 | 1.667 | .002** |
| | Mid- Post | 5.488 | 1.019 | .002** |
| | BL1- Follow-up | 9.333 | 2.430 | .027** |
| | BL2- Follow-up | 11.238 | 2.364 | .006** |
| | Mid- Follow-up | 7.655 | 1.798 | .014** |
| Ham-D | BL1- Post | 6.024 | 1.566 | .016** |
| | BL2- Post | 5.512 | 1.432 | .016** |
| | Mid- Post | 4.417 | 1.535 | .090* |

*Note.* *$p < .1$; **$p < .05$

**Table 6**

*Paired sample t-test comparing Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW scores at BL2 and Post treatment*

| Comparisons | Mean | SD | t | df | Two-Sided *p* | Cohen's d |
|---|---|---|---|---|---|---|
| BL2_Ham-A | 24.384 | 5.852 | 5.705 | 12 | <.001** | 2.886 |
| Post_Ham-A | 15.307 | 6.968 | | | | |
| BL2_Ham-D | 12.461 | 6.345 | 3.951 | 12 | .002** | 1.096 |
| Post_Ham-D | 6.846 | 3.760 | | | | |
| BL2_TMT-A | 63.246 | 11.844 | -.275 | 12 | .788 | |
| Post_TMT-A | 63.923 | 10.672 | | | | |
| BL2_TMT-B | 51.538 | 6.186 | -2.862 | 12 | .014** | -.794 |
| Post_TMT-B | 60.000 | 10.984 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| BL2_StroopW | 177.384 | 56.994 | -.639 | 12 | .535 | |
| Post_StroopW | 189.615 | 64.729 | | | | |
| BL2_StroopCW | 49.276 | 16.574 | -2.065 | 12 | .061* | -.573 |
| Post_StroopCW | 54.692 | 9.869 | | | | |

*Note.* *$p < .1$; **$p < .05$

**Table 7**

*Paired sample t-test comparing Ham-A, Ham-D, TMT-A, TMT-B, StroopW, and StroopCW scores at BL1 and BL2*

| Comparisons | Mean | SD | t | df | Two-Sided *p* | Cohen's d |
|---|---|---|---|---|---|---|
| BL1_Ham-A | 21.125 | 6.280 | -2.287 | 15 | .037** | -.572 |
| BL2_Ham-A | 25.437 | 5.988 | | | | |
| BL1_Ham-D | 11.800 | 7.052 | .052 | 14 | .959 | |
| BL2_Ham-D | 11.733 | 6.284 | | | | |
| BL1_TMT-A | 60.075 | 13.047 | -.771 | 15 | .453 | |
| BL2_TMT-A | 62.012 | 11.848 | | | | |
| BL1_TMT-B | 54.331 | 9.711 | 1.282 | 15 | .219 | |
| BL2_TMT-B | 52.125 | 5.795 | | | | |
| BL1_StroopW | 174.000 | 58.965 | -.505 | 15 | .621 | |
| BL2_StroopW | 182.687 | 56.499 | | | | |
| BL1_StroopCW | 48.750 | 14.951 | -.451 | 15 | .658 | |
| BL2_StroopCW | 49.725 | 15.986 | | | | |

*Note.* *$p < .1$; **$p < .05$

**Table 8**

*General Linear Model repeated measures ANOVA of Hamilton Anxiety Rating Scale scores across all measurement timepoints*

| Ham-A | Time | Mean | SD |
|---|---|---|---|
| BL1 | APT-CBT | 22.857 | 5.459 |
| | CBT-APT | 21.833 | 7.678 |
| | Total | 22.384 | 6.305 |
| BL2 | APT-CBT | 26.000 | 3.366 |
| | CBT-APT | 22.500 | 7.791 |
| | Total | 24.384 | 5.852 |
| Mid | APT-CBT | 22.000 | 5.830 |
| | CBT-APT | 19.333 | 7.607 |
| | Total | 20.769 | 6.559 |
| Post | APT-CBT | 16.857 | 6.414 |
| | CBT-APT | 13.500 | 7.739 |
| | Total | 15.307 | 6.968 |
| Follow-up | APT-CBT | 13.857 | 8.234 |
| | CBT-APT | 12.166 | 4.490 |
| | Total | 13.076 | 6.563 |

**Figure 1**

*Hamilton Anxiety Rating Scale scores over measurement timepoints; a comparison between the APT-first-group and the CBT-first-group*

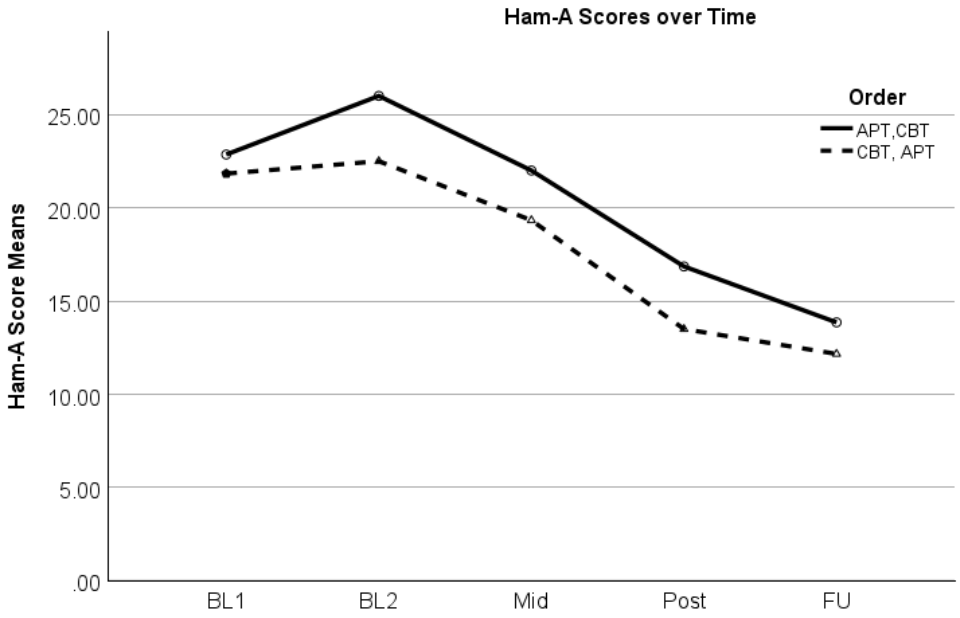


**Table 9**

*General Linear Model repeated measures ANOVA of Hamilton Depression Rating Scale scores across all measurement timepoints*

| Ham-D | Time | Mean | SD |
|---|---|---|---|
| BL1 | APT-CBT | 13.571 | 5.996 |
| | CBT-APT | 12.166 | 8.232 |
| | Total | 12.923 | 6.836 |
| BL2 | APT-CBT | 13.714 | 7.064 |
| | CBT-APT | 11.000 | 5.656 |
| | Total | 12.461 | 6.345 |
| Mid | APT-CBT | 11.857 | 6.914 |
| | CBT-APT | 10.666 | 3.829 |
| | Total | 11.307 | 5.513 |
| Post | APT-CBT | 6.857 | 3.579 |
| | CBT-APT | 6.833 | 4.308 |
| | Total | 6.846 | 3.760 |

**Figure 2**

*Hamilton Depression Rating Scale scores over measurement timepoints; a comparison between the APT-first-group and the CBT-first-group*

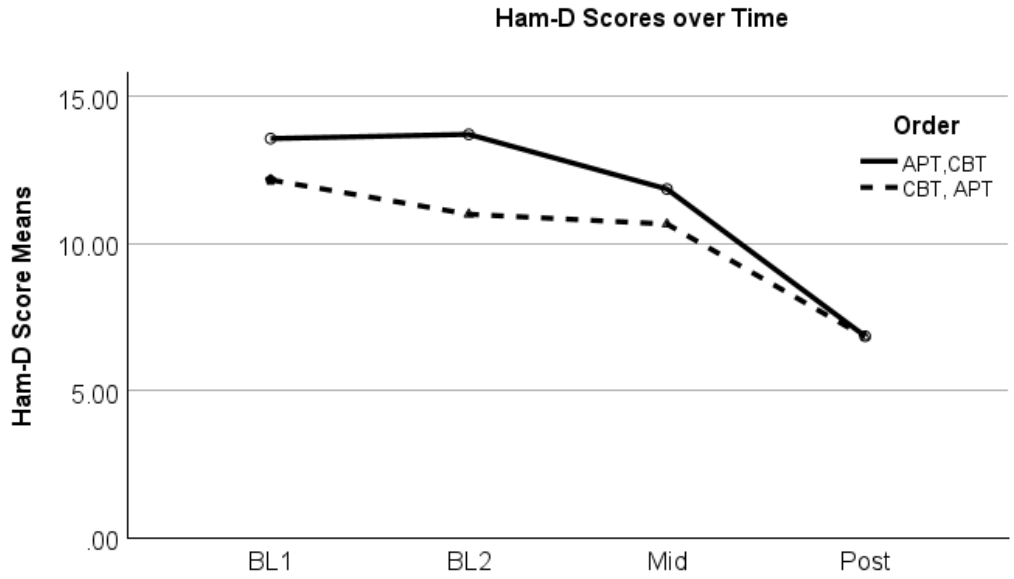


**Table 10**

*General Linear Model repeated measures ANOVA of Trail making Part A T- scores across all measurement timepoints*

| TMT-A | Time | Mean | SD |
|---|---|---|---|
| BL1 | APT-CBT | 56.857 | 14.870 |
| | CBT-APT | 62.866 | 13.524 |
| | Total | 59.630 | 14.018 |
| BL2 | APT-CBT | 62.428 | 15.672 |
| | CBT-APT | 64.200 | 6.318 |
| | Total | 63.246 | 11.844 |
| Mid | APT-CBT | 58.285 | 13.262 |
| | CBT-APT | 66.333 | 5.354 |
| | Total | 62.000 | 10.832 |

| | | | |
|---|---|---|---|
| Post | APT-CBT | 61.000 | 12.476 |
| | CBT-APT | 67.333 | 7.788 |
| | Total | 63.923 | 10.672 |

*Note.* T-scores have a mean of 50 and a standard deviation of 10. A higher T-score indicates better performance.

**Figure 3**

*Trail making Part A T- scores over measurement timepoints; a comparison between the APT-first-group and the CBT-first-group*

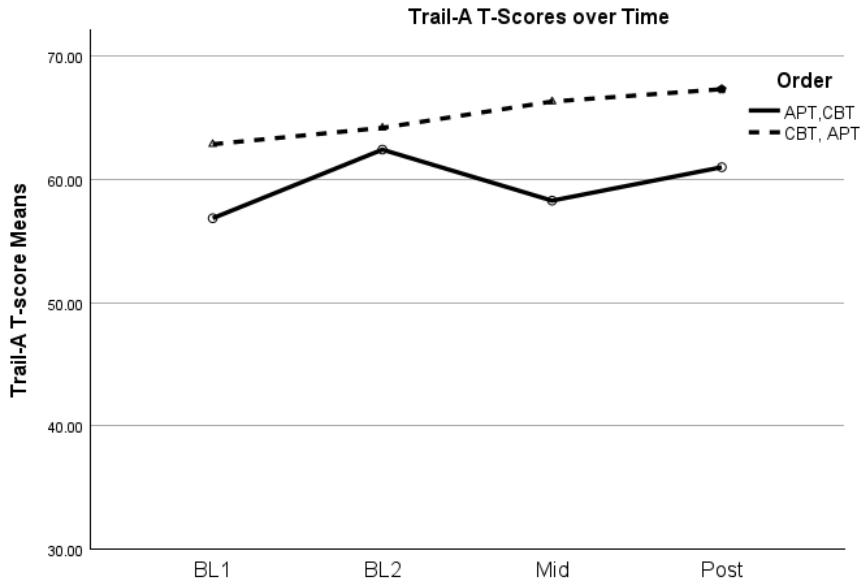


**Table 11**

*General Linear Model repeated measures ANOVA of Trail making Part B T- scores across all measurement timepoints*

| TMT-B | Time | Mean | SD |
|---|---|---|---|
| BL1 | APT-CBT | 50.571 | 12.313 |
| | CBT-APT | 56.816 | 7.093 |
| | Total | 53.453 | 10.357 |

| | | | |
|---|---|---|---|
| BL2 | APT-CBT | 48.428 | 5.996 |
| | CBT-APT | 55.166 | 4.400 |
| | Total | 51.538 | 6.186 |
| Mid | APT-CBT | 56.000 | 12.124 |
| | CBT-APT | 59.166 | 10.759 |
| | Total | 57.461 | 11.155 |
| Post | APT-CBT | 58.142 | 14.123 |
| | CBT-APT | 62.166 | 6.306 |
| | Total | 60.000 | 10.984 |

*Note.* T-scores have a mean of 50 and a standard deviation of 10.

**Figure 4**

*Trail making Part B T- scores over measurement timepoints; a comparison between the APT-first-group and the CBT-first-group*

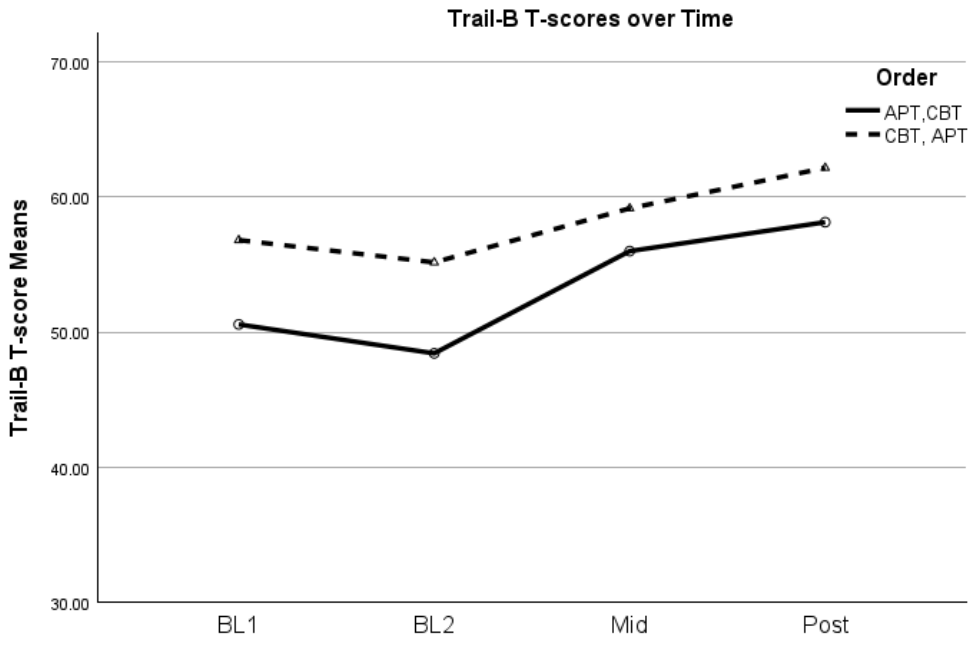

**Table 12**

*General Linear Model repeated measures ANOVA of Stroop Word Trial raw scores across all measurement timepoints*

| StroopW | Time | Mean | SD |
|---|---|---|---|
| BL1 | APT-CBT | 171.142 | 62.589 |
| | CBT-APT | 182.000 | 65.595 |
| | Total | 176.153 | 61.508 |
| BL2 | APT-CBT | 158.571 | 67.635 |
| | CBT-APT | 199.333 | 35.115 |
| | Total | 177.384 | 56.994 |
| Mid | APT-CBT | 186.142 | 56.555 |
| | CBT-APT | 198.166 | 63.281 |
| | Total | 191.692 | 57.504 |
| Post | APT-CBT | 175.857 | 48.817 |
| | CBT-APT | 205.666 | 81.374 |
| | Total | 189.615 | 64.729 |

*Note.* The raw scores indicated the number of correct items within three minutes.

**Figure 5**

*Stroop Word Trial raw scores over measurement timepoints; a comparison between the APT-first-group and the CBT-first-group*

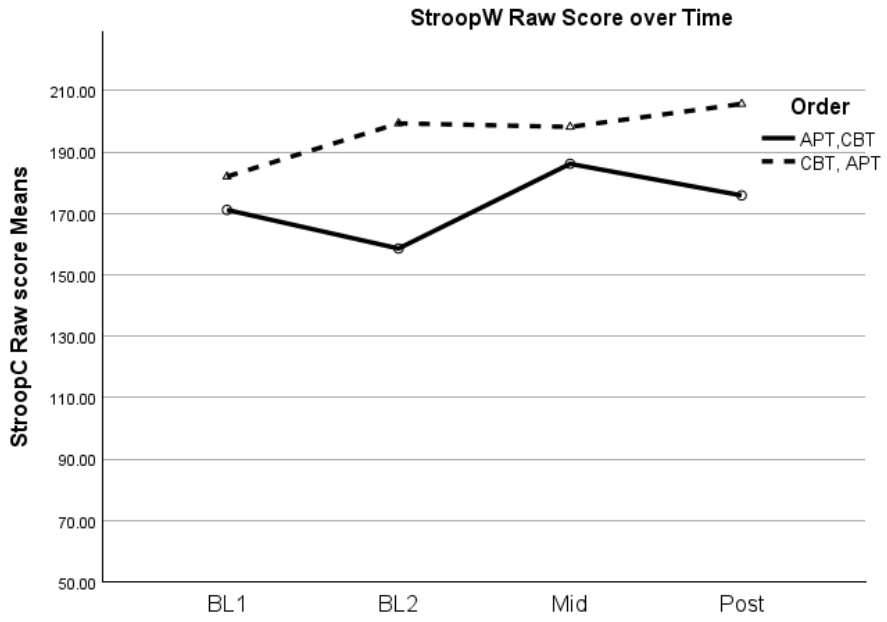


**Table 13**

*General Linear Model repeated measures ANOVA of Stroop Color Word Trial T-scores across all measurement timepoints*

| StroopCW | Time | Mean | SD |
|---|---|---|---|
| BL1 | APT-CBT | 47.285 | 13.792 |
| | CBT-APT | 49.833 | 18.104 |
| | Total | 48.461 | 15.278 |
| BL2 | APT-CBT | 47.657 | 19.511 |
| | CBT-APT | 51.166 | 13.948 |
| | Total | 49.276 | 16.574 |
| Mid | APT-CBT | 45.928 | 14.320 |
| | CBT-APT | 49.400 | 15.012 |
| | Total | 47.530 | 14.130 |
| Post | APT-CBT | 52.571 | 12.299 |
| | CBT-APT | 57.166 | 6.210 |
| | Total | 54.692 | 9.869 |

*Note.* T-scores have a mean of 50 and a standard deviation of 10. A higher T-score indicates better performance.

**Figure 6**

Stroop Color Word Trial T- scores over measurement timepoints; a comparison between the APT-first-group and the CBT-first-group.

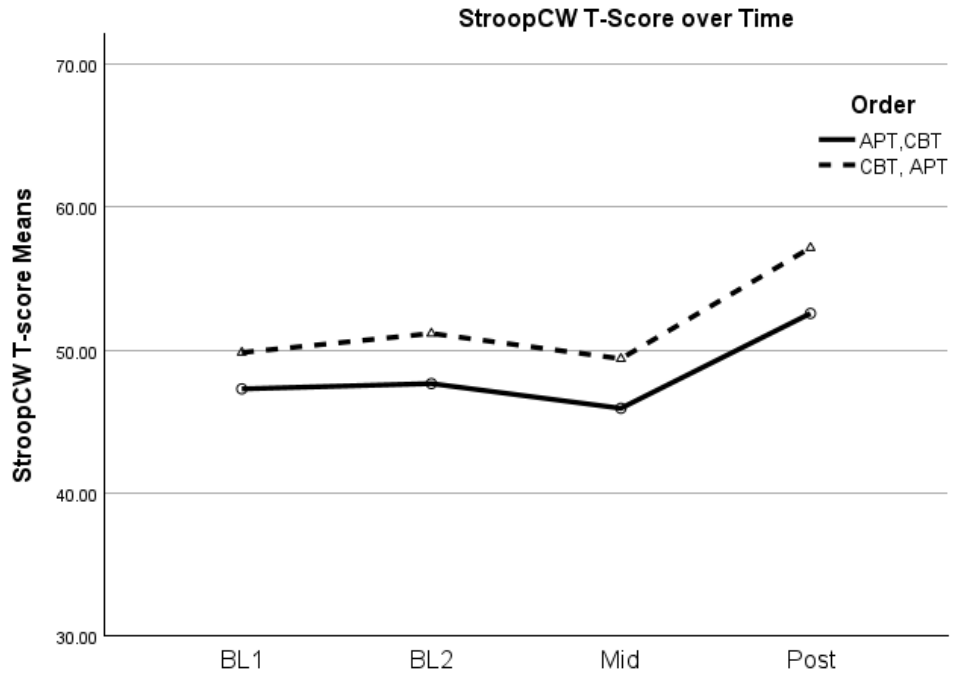


**Table 14**

*Independent t-tests comparing the mid-point changes from BL2 to Mid-point between the APT-first-group and CBT-first-group*

| Mid-point Changes | t | df | One-sided *p* (t-test) | Two-sided *p* |
|---|---|---|---|---|
| Mid-Ham-A | .256 | 12 | .401 | .802 |
| Mid-Ham-D | -.727 | 12 | .241 | .481 |
| Mid-TMT-A | -1.926 | 12 | .039 | .078 |

| | | | | |
|---|---|---|---|---|
| Mid-TMT-B | .847 | 12 | .207 | .414 |
| Mid-StroopW | 1.011 | 12 | .166 | .332 |
| Mid-StroopCW | -.291 | 12 | .388 | .776 |

*Note*. Mid-Ham-A = midpoint measure - Baseline 2 measure of Hamilton Anxiety Rating Scale; Mid-Ham-D = midpoint measure - Baseline 2 measure of Hamilton Depression Rating Scale; Mid-TMT-A = midpoint measure - Baseline 2 measure of Trail making Part A; Mid-TMT-B = midpoint measure - Baseline 2 measure of Trail making Part B; Mid-StroopW = midpoint measure - Baseline 2 measure of Stroop Word Trial; Mid-StroopCW = midpoint measure - Baseline 2 measure of Stroop Color Word Trial.