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Treating Attention Deficits in Individuals with Parkinson's Disease

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TREATING ATTENTION DEFICITS IN INDIVIDUALS WITH PARKINSON'S DISEASE

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This manuscript is dedicated to my family and friends who have supported me wholeheartedly in the pursuit of my academic goals.

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TABLE OF CONTENTS

ABSTRACT

Purpose: The purpose of this study was to determine the presence and degree of treatment effects found for direct attention training on three individuals with idiopathic Parkinson's disease (PD) using the Attention Process Training, Third Edition (APT-III; Sohlberg & Mateer, 2010). APT-III was designed for use with individuals who have sustained a traumatic brain injury (TBI), and was selected for this study because of the similarities in cognitive deficits between those with TBI and those with PD.

Methods: This study was designed as a phase 2, randomized baseline, A_1-B-A_2-A_3 (baseline, treatment, post-treatment, and follow-up assessment), single-subject experimental design. The study followed the APT-III protocol (Sohlberg & Mateer, 2010) to train attention processes over the course of 6 weeks in two 60 minute sessions per week.

Results: Participants all displayed treatment effects in at least one attentional domain following this study. Results of secondary outcome measures designed to quantify level of impairment, activity, and participation were variable. All participants remained within functional limits for working memory for healthy adults their age, and all reported making progress toward functional goals.

Discussion: The results of this study suggest that direct attention training using APT-III can improve attention in people with PD (PPD), and that these improvements can be generalized to increase performance on activities of daily living and other functional activities. It also suggests that PPD may benefit from future research investigating the use of APT-III.

INTRODUCTION

Parkinson's disease (PD) is both a chronic and progressive neurodegenerative disease affecting motor control and cognition (Lai & Tsui, 2001). PD affects approximately 1% of the world's population, with over 1 million patients in the US today (Payne, 2014). Affecting both men and women, PD is typically a disease of mid to late life with an average onset age between 50 and 60 years and an expected life span after onset of 15 years (Duffy, 2013; Payne, 2014). Because of the profound toll PD has on patients and their caregivers, it is a disease that deserves further research for effective treatment and management (Payne, 2014).

PD was first described in 1817 by British doctor James Parkinson, and since that time it has been characterized by four movement disorders: tremor, rigidity, bradykinesia, and postural instability (Toma & Mihancea, 2014). Tremor, or shaking of the muscles, typically appears in the head, jaw, arms, hands, and legs (Payne, 2014). Rigidity refers to muscular stiffness throughout the body, bradykinesia to a slowing of overall movement, and postural instability to impaired balance and coordination (Payne, 2014). These motor characteristics were initially considered the only true symptoms of PD, but these days cognitive impairments and their effects on the lives of PPD are also recognized (Payne, 2014).

It's been estimated that as much as 80% of those with Parkinson's disease develop some form of cognitive impairment (Altman & Troche, 2011). PD is primarily recognized as being caused by a loss of dopamine producing cells within the substantia nigra of the basal ganglia, a deep brain structure that works in concert with various cortical areas (Rommelfanger & Weinshenker, 2007). These brain connections lead to an array of cognitive symptoms previously thought uninvolved in PD, including executive function and working memory deficits (Rommelfanger & Weinshenker, 2007; Zgaljardic, Borod, Foldi, Mattis, Gordon, Feigin &

Eidelberg, 2006). These deficits have also been linked to language impairments, including decreased fluency and difficulty with syntax (Altman & Troche, 2011). Other non-motor symptoms associated with PD include depression, apathy, anxiety, and sleep disturbances (Toma & Mihancea, 2014).

The array of cognitive deficits present in PPD is very similar to those presented by patients who have suffered traumatic brain injury (TBI), although the damage in TBI results from trauma to the frontal lobe and diffuse axonal damage, as opposed to degeneration in the basal ganglia (Calleo, Burrows, Levin, March, Lai & York, 2012; Gardner & Yaffe, 2015; Wong & Hazrati, 2013). Computerized treatment programs such as Attention Process Training (APT) software, and later APT-II and APT-III, developed by Sohlberg & Mateer are designed to help rehabilitate attention and working memory deficits in TBI patients, and research supports the use of these programs (Sohlberg & Mateer, 2010; Sohlberg & Mateer 2000; Sturm, 1997).

Given the similarities in cognitive deficits between those with TBI and those with PD, it is worth investigating whether APT-III is an effective tool for treating those with PD. A feasibility study has already been conducted and has shown that PPD are good candidates for APT (Mohlman & Chazin, 2011). In her 2013 thesis, Ferguson demonstrated treatment efficacy of APT-II in a single-subject case study. Her findings warrant further research to determine if the APT-III would lead to similar results decreasing attention deficits in improving the cognitive symptoms of PPD. This study will continue such investigations by looking at the effects APT-III has on those with idiopathic PD, a group for whom no evidence-based cognitive treatments currently exist (Calleo et al., 2012).

CHAPTER 1. LITERATURE REVIEW

The following review assess literature covering the four key aspects of this study. These include the neuropathology of PD, the cognitive deficits associated with it, current theories on attention and memory, and the evidence behind the efficacy of APT training programs.

1.1 Neuropathology of Parkinson's Disease

As stated above, PD is most widely attributed to a decrease in dopaminergic cells in the substantia nigra of the basal ganglia (Payne, 2014). This is still held as true, especially in regards to motor deficits, but some researchers have suggested more complex causes of these symptoms (Rommelfanger & Weinshenker, 2007). In their 2007 review, Rommelfanger & Weinshenker discussed a number of findings suggesting that the locus coerulius and its decreased production of norepinephrine played a substantial role in both motor and cognitive deficits of PD. While these findings are interesting, most theories about the cause of both motor and cognitive symptoms of PD center around the basal ganglia structures and their relationships with other cortical brain structures (Weber, 1990). The basal ganglia is a deep brain structure comprised of a group of cell nuclei located within the cerebral hemispheres (Weber, 1990). These nuclei are referred to individually as the caudate nucleus, the putamen, the globus pallidus, the subthalamic nucleus, and the substantia nigra (Nieoullon, 2002; Weber, 1995; Zgaljardic et al., 2006). They work closely with one another and the thalamus to communicate with cortical brain structures that influence movement and cognition (Weber, 1990).

Initially researchers were puzzled by the way PD cognitive symptoms mirrored those associated with dysfunction in unrelated brain structures, such as the frontal lobe (Nieoullon, 2002; Zgaljardic et al., 2006). A combination of human and animal studies investigating the

individual relationships the basal ganglia and cerebellum have with the cortex served to determine that communication loops exist that allow for complex interaction between these deep brain and cortical structures (Middleton & Strick, 2000).

The interactive relationships of the basal ganglia with frontal lobe structures appear to be the source of cognitive problems in PD (Nieoullon, 2002; Owen, 2004; Zgaljardic et al., 2006). These complex relationships are referred to as frontostriatal loops and they are recognized for carrying information between the basal ganglia and the frontal lobe via the thalamus (Zgaljardic et al., 2006). Other frontostriatal loops associated with cognitive function include the dorsolateral prefrontal cortex (DLPFC), the anterior cingulate cortex (ACC), and the orbitofrontal cortex (OFC), and each is associated with a different cognitive process (Nieoullon, 2002; Owen, 2004; Zgaljardic et al., 2006; Weber, 1990). The DLPFC is responsible for regulating the executive functions of cognition, the AAC with attention processes, and the OFC with decision making, impulse control, perseveration, and mood (Middleton & Strick, 2000; Zgaljardic et al., 2006). These loops and their roles in cognitive processing provide insight as to why what was previously thought of as localized basal ganglia damage in PD affects cognitive processes associated with other brain areas.

1.2 Cognitive Deficits in Parkinson's Disease

Cognitive problems in PD frequently occur early on in the disease as mild cognitive impairment (MCI), and later in the disease as dementia (Toma & Mihancea, 2014). According to Toma & Mihancea (2014), approximately one third of newly diagnosed PPD meet the criteria for MCI, and five years after onset this number increases to 50%. A 2014 study by Gerrits, van der Werf, Hofman, Foncke, Berendse, & van den Heuvel pointed to gray matter volume as a possible explanation for the variation in cognitive abilities among PPD. His results showed a positive

correlation between decreased gray matter in specific brain areas and poor performance on related cognitive tasks for PD patients presenting with and without cognitive impairment (Gerrits et al.).

Cognitive deficits associated with PD affect many domains. Executive function and working memory are typically affected first, followed by memory, visuospatial skills, and concept formation (Altman & Troche, 2011; Nieoullon, 2002). For working memory, it has been found that tasks requiring some form of manipulation tend to be more impaired than those that require the more basic processes of storage and updating information (Altman & Troche, 2011). Impairments of executive function in PD include anticipation, planning, initiation, inhibitory processing, and switching between tasks and sets (Nieoullon, 2002; Owen, 2004; Zgaljardic et al., 2006). Impairments of working memory and executive function have been related to language problems in PD, as these functions underlie the complex task of language formation and use (Cummings, Darkins, Mendez, Hill & Benson, 1988). For example, Crosson (1985) found that early impairment of thalamic, putamen, and caudate function in PD were associated with DLPFC trouble during language production, including the DLPFC portion covering Broca's area. The frontostriatal loops responsible for set switching and inhibition in particular are thought to affect both language and cognition (Ali, Green, Kherif, Devlin, & Price, 2010). Research has also suggested that lesions in these networks caused by PD can affect how well information is processed, leading to symptoms of impaired fluency and grammatical deficits (Kolk, 1995).

Considering the neuronal connectivity between the basal ganglia and frontal lobe structures, it is understandable that some cognitive symptoms of PD mirror those of frontal lobe damage (Calleo et al., 2012). Specifically, frontal lobe damage shares many of the same executive functions and memory deficits as early forms of PD (Nieoullon, 2002; Owen, 2004;

Zgaljardic et al., 2006). For example, in 1989 Stuss, Stethem, Hugenholtz, Picton, Pivik & Richard identified deficits in information processing, divided attention, and focused attention in patients with TBI. Similarly, McNab & Klingberg in 2007 identified a similar frontostriatal loop regulating working memory to those regulating attention. Because of these similarities, and because some Parkinson's-like symptoms are caused by brain injury in the form of encephalitis, researchers have been investigating a possible causal relationship between other forms of TBI and the development of idiopathic PD (Payne, 2014;Wong & Hazrati, 2013). While results of these studies are largely inconclusive, they do attest to the degree of overlap among symptoms found in both disorders and suggest that using evidenced-based TBI treatments for PPD could be promising (Gardner & Yaffe, 2015; Wong & Hazrati, 2013).

1.3 Attention and Working Memory

A clinical model of attention that has been widely accepted and led to the creation of Attention Process Training (APT), a therapy program designed for individuals with TBI, is that of Sohlberg and Mateer. Their original framework divided attentional domains into focused, sustained, selective, alternating, and divided attention (Sohlberg & Mateer, 1987). Focused attention was considered a low-level ability to respond to specific stimuli; selective attention, the ability to activate and inhibit automatic responses while discriminating between stimuli; alternating attention, the ability to move between tasks with different cognitive requirements; and divided attention, the ability to manage multiple tasks at the same time (Sohlberg & Mateer, 1987). In this model, sustained attention was comprised of working memory, or the ability to keep information in mind while manipulating it, and vigilance, or the ability to maintain focus during a repetitive task (Kimbarow, 2016; Sohlberg & Mateer, 1987).

The 2010 revision of Sohlberg and Mateer's model reflects changes in the perceived roles of executive control, working memory, and divided attention (Kimbarow, 2016). Currently their model holds that executive control is comprised of the distinct subcategories of working memory, sustained attention, selective attention, suppression, and alternating attention which has subsumed the former category of divided attention (Kimbarow, 2016; Sohlberg & Mateer, 2010).

While it is clear that there is a relationship between attention and working memory, the cause of this relationship has not always been understood (McNab & Klingberg, 2008). In studies utilizing fMRI imaging, results have shown that not only is working memory likely controlled via a frontostriatal loop similar to those that control attention, but that dopamine plays a role in working memory also (McNab & Klingberg, 2008). Particularly, the globus pallidus of the basal ganglia is associated with working memory. This area, along with the frontal lobe, has been found to activate when filtering of irrelevant stimuli is completed prior to memory encoding (McNab & Klingberg, 2008). These findings point to attention as a closely related prerequisite to working memory function.

1.4 Attention Process Training

Despite the research indicating the presence of cognitive deficits in PPD, there is little research specifically addressing treatment of these deficits. However, a body of research exists showing the value of training specific attention domains in TBI patients which may provide a bridge to treating these deficits in PPD. Most of these studies specifically address APT and have looked at its use among patients who have suffered brain injury due to both vascular and blunt-force origin.

In a 1997 study that did not look at APT but rather another computer program, Sturm, Willmes & Orgass showed that training specific attentional deficits via computer software was an effective way to improve patient performance. The study involved 38 subjects with right or left vascular brain injuries and looked specifically at alertness, vigilance, selective, and divided attention (Sturm et al.). His results showed a positive training effect for tonic alertness and vigilance as well as reduced response times for alertness and selective attention tasks (Sturm, 1997).

In 2000 Sohlberg and Mateer tested their APT program on a group of 14 TBI patients who demonstrated attention and memory deficits. Their study utilized a cross-over design that gave patients 10 weeks of APT and 10 weeks of brain injury education which included supportive listening and relaxation training (Sohlberg & Mateer). Their results showed a number of things, including that practice was the best source of improvement for both treatments (Sohlberg & Mateer). They also found better improvement after each session for the APT group compared to the brain injury education group, as measured by results on the Paced Auditory Serial Addition Task (PASAT) (Gronwell, 1977), a measure of attention (Sohlberg & Mateer). For working memory, both groups showed similar improvement results with the exception of working memory for location, which was proven to be better for the APT group (Sohlberg & Mateer).

In 2006 Pero, Incoccia, Caracciolo, Zoccolotti, & Formisano, looked at the effects of training two TBI patients with the APT program. Both patients' injuries resulted from vehicular accidents (Pero et al., 2006). From pre-test to post-test, one patient showed an increased ability to manage dual task stimulation while the other showed improvement on vigilance, selective attention, and divided attention (Pero et al., 2006). In a 2009 randomized clinical trial, Barker-

Collo, Feigin, Lawes, Parag, Senior, and Rodgers compared the effects of APT training versus a standard care program in 78 stroke patients. Results showed an improvement at 6 months post-stroke in auditory and visual effects of attention as measured by the Integral Visual Auditory Continuous Performance Test (IVA-CPT) (Barker-Callo, et al.).

Only one published study to date has investigated the use of APT on PPD, and this study addressed feasibility of treatment rather than treatment effects. Mohlman and Chazin's 2011 feasibility study investigated how well 16 PPD with no signs of dementia could manage using the APT-II program (Sohlberg & Mateer, 2001). The study measured patient fatigue, effort, progress and enjoyment in participating in four, 90 minute training sessions over the course of a month (Mohlman & Chazin). Results indicated that tasks required moderate to high levels of effort from patients, but that patients enjoyed the treatment and were able to successfully complete it (Mohlman & Chazin). These results held true in light of the fact that alternating and selective attention tasks produced considerable fatigue (Mohlman & Chazin). Despite this, patients made improvements in these domains (Mohlman & Chazin).

In her 2013 unpublished thesis, Ferguson investigated treatment efficacy of APT-II on one patient with PD. Her multiple baseline single-subject study consisted of one, 2 hour treatment session per week for a total of 6 weeks (Ferguson). Results showed improvement in sustained attention for percent accuracy and timed performance, as well as improvements for percent accuracy and timed performance in selective and divided attention, two domains that were not specifically targeted in treatment (Ferguson).

Given the positive results of Ferguson's study and the proven feasibility of treating PPD with APT, we wished to further investigate the effects of APT training on individuals with idiopathic PD. This study aimed to replicate the results of Ferguson's study using a larger sample

size. Since the Ferguson study the APT-III has become available. It is computerized and does not require participants to complete paper-pencil tasks. To alleviate the possible difficulty paper-pencil tasks might cause participants with PD, we chose to use the APT-III. We hypothesized that we would see positive effects for APT-III training, and that these results would also be apparent on measures of functional attention and working memory. This study asked the following experimental questions:

1. What is the treatment effect of APT-III when given to participants with PD and attention deficits over the course of 6 weeks in two 60-minute sessions per week?

2. What improvements are shown in the following three measures of attention deficits and functional attention: Continuous Performance Test (CPT-II) (Connors, 2004), Test of Everyday Attention (TEA) (Robertson, Ward, Ridgeway & Nimmo-Smith, 1994), and APT-II Attention Questionnaire (Sohlberg, Johnson, Paule, Raskin & Mateer, 2001)?

3. What changes of working memory are shown on automated working memory tasks Size Judgment Span task (Cherry, Elliot, & Reese, 2007) following APT-III treatment?

4. What evidence of generalization of training on APT-III is demonstrated by progress on functional goals?

If positive, the results of this study would provide evidence for the use of APT-III in the treatment of attention and working memory deficits in PPD.

CHAPTER 2. METHODS

2.1 Design

This study was designed as a phase 2, randomized baseline, A_1-B-A_2-A_3 (baseline, treatment, post-treatment, and follow-up assessment), single-subject experimental design (SCED). Rehabilitation scientists have advocated for the systematic study of treatment efficacy using small N or single-subject-designed studies such as this one (Robey, 2004; Rodriguez & Gonzalez-Rothi, 2008). These early phase studies allow the investigator not only to establish treatment efficacy, but also to identify optimal treatment participants and refine the treatment protocol as needed. The study was approved by the Louisiana State University Institutional Review Board. The participant received informed consent prior to starting the study.

2.2 Participants

Three PPD were recruited from local PD support groups. Participants met the following inclusion criteria: PD as diagnosed by a physician, a Hoehn & Yahr PD Severity Rating of 1-3 (Hoehn & Yahr, 1967), no other prior or existing neurological or neurodegenerative diseases, no language disorders, no dementia as measured by the Montreal Cognitive Assessment (MoCA) (Nasreddine, 2015), no depression as measured by the Geriatric Depression Scale (GDS) Short Form (Sheikh & Yesavage, 1986), no apathy as measured by The Lille Apathy Rating Scale (Sockeel, Dujardin, Devos, Deneve & Defebvre, 2006), a minimum high school education, vision deemed adequate based on the results of the Rosenbaum Pocket Vision Screener, hearing deemed adequate based on conversation and following directions in the testing environment, a stable cycle of PD medications, at least one attention deficit as identified on the APT-II Attention Questionnaire (Sohlberg et al., 2001). All particiapnts were considered ideal at the time of pre-

treatment having met all inclusion criteria. Participants were also roughly similar across age, level of education, Hoehn & Yahr severity scores, and scores on the screening measures used to qualify them for the study. Participants included one male and two females. Table 1 summarizes participant characteristics and screening results.

Table 1. Participant characteristics and screening results

Participant	Sex	Age	Occupation	Years with PD	Years of Ed.	H & Y	MoCa	LARS	M.F.
101	M	72	Professional	6	16	2	25	-20	18.5
102	F	70	Professional	10	16	3	25	-35	14.5
103	F	69	Professional	11	18	3	25	-30	22

Note: H & Y = Hoehn and Yahr (1967), MoCa = Montreal Cognitive Assessment (Nasreddine et al., 2015), LARS = Lille Apathy Rating Scale (Sockeel et al., 2006), M.F. = Mental Fatigue (Johansson & Ronnback, 2014)

2.3 Outcome Measures

The primary outcome measures were the percent accuracy of treatment probes given at the end of each session. The most difficult task for each APT-III attention domain was used to develop treatment probes. Ten sets of 10 randomly selected items from each domain were developed and used as probes which were randomly administered to obtain baselines, measure treatment after each session, and determine post-treatment and follow-up results. Selected probes were randomized to prevent learning bias.

Valid and reliable secondary outcome measures were chosen to measure attention impairment, functional attention, self-reported attention problems; and working memory (as were

done in previous APT-III research). The investigator used pre-treatment test results to determine appropriate attention exercises for treatment, help establish functional goals and aid in selection and training of metacognitive strategies.

These measures were also chosen to assess the various domains of the World Health Organization ICF since the American Speech-Language-Hearing Association Scope of Practice requires that speech language pathologists assess and treat communication disorders across the ICF domains of impairment, activity and participation (American Speech-Language-Hearing Association, 2016). The CPT-II was selected to measure impairment. The CPT-II defines inattention as t-scores greater than 60. Participants each received a clinical impairment score which placed over 100 indicates the percent chance that a "significant attention problem exists" (Conners, 2004).

The TEA was selected to measure the ICF activity domain. Results from the TEA generate scaled scores with a mean of 10 and a standard deviation of +/-3. The TEA measures visual selective attention, alternating attention, sustained attention and auditory visual working memory using a number of subtests. Map Search and Telephone subtests factor into visual selective attention; the Visual Elevator subtest correspondes to alternating attention; the Lottery, Elevator Counting, and Telephone Search subtests correspond to sustained attention; and the Elevator Counting and Elevator Counting with Distractors subtests correspond to auditory and visual working memory (Robertson, Ward, Ridgeway & Nimmo-Smith, 1994).

The APT-II Attention Questionnaire was given to generate a self-reported measure of participation in accordance with the ICF. Results of the APT-II Attention Questionnaire rate how much the participant perceives attention deficits to interfere with activies of daily living (ADLs). The APT-II Attention Questionnaire generates scores that correspond to the following ratings

and their disruption of ADLs: little-mild disruption, moderate disruption, severe disruption, and profound disruption.

The Size Judgment Span (SJS) task, selected to measure working memory for this older population, has established validity and reliability for a range of ages, education levels and occupations (K. E. Cherry & Park, 1993). Researchers have also reported that the SJS task has demonstrated validity and reliability for even the oldest old (K. Cherry, Elliott, & Reese, 2007), which would suggest that it could be useful for PPD. The SJS task requires participants to rearrange stimulus items in accordance to their size; for example, if given "football-tadpole," the correct response would be "tadpole-football." The task becomes increasingly difficult as the stimulus size increases. Because the SJS task contains elements of verbal and visuospatial processing, the participant can take different approaches to complete SJS tasks; this is what makes SJS a useful tool for assessing WM (Cherry et al., 2007). However, SJS has not been used in the PD literature as a measure of WM. The SJS has a mean of 3.53 and a standard deviation of 72 for individuals from 64 to 74 years of age (K. Cherry et al., 2007).

2.4 Procedures

The study was primarily conducted in the LSU Department of Communication Sciences and Disorders therapy rooms. When participants were not able to come to LSU due to transportation difficulties, the research assistant and/or investigator traveled to their homes to render treatment or gather assessment data. In both locations, all probes and treatments were administered in a quiet room free from distractions. The investigator recruited, screened, and assessed participants for the study. To ensure blinding of participant type and severity of attention deficits, the research assistant administered the APT-III. The three participants were enrolled in the study sequentially with the first participant receiving 5 baseline probes to

establish stable initial performance. Participant 2 received 8 baseline probes, and participant 3 received 12 baseline probes. The number of probes assigned to each participant was determined by random number generating software and the stabilization of baseline probes.

Treatment followed the APT-III protocol, which calls for the use of specific attention exercises based on the participants' functional level in the different attentional domains; the identification, training, and review of applicable metacognitive strategies; and the identification and review of functional goals and generalization activities through Goal Attainment Scaling (GAS) (Sohlberg & Mateer, 2010). Refer to Appendix B for example metacognitive strategies and Appendix C for examples of goals addressed through GAS. Following is an outline of the procedures for each treatment phase.

A_1-Baseline Phase: The CPT-II, TEA, and the APT-II Attention Questionnaire (Sohlberg et al., 2001) were administered to assess pre-treatment attention. The Size Judgment Span task (Cherry et al., 2007) was given to assess working memory. Ten sets of probe questions with 10 randomly selected tasks from each training domain were developed. One set was administered for each baseline and at the end of each treatment. With the exception of participant 3, they were randomly presented to participants to eliminate the learning effect. For participant 3, working memory probes were presented last in the majority of treatment and post-treatment sessions to reduce the level of participant distraction caused by switching between computer-based probes and the auditory-based working memory probes. The attentional probes were still presented in random order. Descriptions of probes can be found in Appendix A.

B-Treatment Phase: Each participant received 12 total hours of treatment delivered in two, 60-minute treatment sessions over 6 weeks following the APT-III protocol. For each participant, treatment began at the point where attention deficits were detected in the initial

assessment. The APT-III attention domains include sustained attention and executive control with the subdomains of working memory, selective attention, suppression, and alternating attention. The APT-III protocol does not standardize mastery; the investigator initially set the criteria for moving to the next harder task at 80% accuracy for 3 trials and criteria for decreasing complexity at 50% or lower accuracy for 2 trials. It became clear in treatment, however, that this criteria led to excessive task repetition which in turn led to frustration and demotivation of participants. To maintain participant morale and prevent unnecessary redundancy, the research assistant followed the direction of the APT-III manual which encourages the use of clinician judgment when increasing complexity of attentional tasks.

Prior to beginning APT-III training, the participants and research assistant used goal attainment scaling (GAS) to identify functional goals that each client wanted to achieve as treatment progressed. Examples of functional goals for the different areas of attention can be found in Appendix C. Participants were given a log to monitor their progress toward goals and briefly discussed their progress with the research assistance prior to beginning treatment each session.

For each treatment session, results were recorded on score sheets provided in the APT-III program to help identify error patterns and monitor the effectiveness of metacognitive strategy use. Score sheets identify both participant progress over time and a detailed picture of performance on the five most recent attempts at a specific task. At the beginning of each session, participants discussed with the research assistant the use of metacognitive strategies to be applied in that treatment session. Metacognitive strategies are self-management practices that help individuals assess and adjust their behavior to better function on a task or in a certain environment. These strategies were included in training to help participants compensate for their

attentional deficits on APT-III tasks and also to help them compensate outside of the clinic setting. Examples of metacognitive strategies can be found in Appendix B.

A_2-Post-treatment Phase: The research assistant collected three treatment probes in the sessions following the completion of the treatment. Post-treatment assessments were conducted by the investigator and included the CPT-II, the TEA, the Attention Process Training-2 Questionnaire, and the SJS task.

A_3-Follow-up Phase: Approximately 30 days after the completion of post-treatment testing, participants returned to LSU for follow-up assessments which again included the secondary outcome measures detailed above as well as three baseline measures.

2.5 Reliability and Treatment Fidelity

The investigator observed 15 minutes of every 4th session, post-session debriefing, and problem solving discussion to ensure treatment fidelity. Inter-rater reliability was not addressed because probe data was collected and scored via computer program, precluding human error. Intra-rater reliability was addressed by double checking that all data was transferred accurately from the computer program to the research assistant's data log for analysis.

2.6 Data Analysis

This study utilized a combination of visual analysis traditionally used in single-case research and one statistical analysis to determine effect size **(**Kratochwill et al., 2010; Olive & Franco, 2008). For the visual analysis, three judges who were not familiar with the study were asked to inspect the plotted data from baseline to post-treatment, and treatment withdrawal/follow-up and to decide whether or not performance had improved (Kratochwill et al., 2010; McReynolds & Kearns, 1983). The statistical analysis was completed using standard

mean difference (SDM) to calculate effect size (Olive & Franco, 2008). SDM is calculated using the formula below. Once a value was found for *d*, it was interpreted using Cohen's measure of effect size, where 0.2 represents a small effect, 0.5 represents a moderate effect, and 0.8 represents a large effect (Cohen, 1988). Using the Cohen's *d* interpretation of effect size has become an accepted practice in single subject design when there is not enough evidence to establish a treatment's effect size (Olive & Franco, 2008). The formula used for calculating effect size using standard mean difference was as follows: $d = M_{A1} - M_{A2}/SD_{A1,}$ where M_{A2} is the mean of post-treatment probes, M_{A1} is the mean of baseline probes, and SD_{A1} is the standard deviation of baseline probes.

CHAPTER 3. RESULTS

This study asked the following experimental questions:

1. What is the treatment effect of APT-III when given to participants with PD and attention deficits over the course of 6 weeks in two 60-minute sessions per week?

2. What improvements are shown in the following three measures of attention deficits and functional attention: Continuous Performance Test (CPT-II) (Connors, 2004), Test of Everyday Attention (TEA) (Robertson, Ward, Ridgeway & Nimmo-Smith, 1994), and APT-II Attention Questionnaire (Sohlberg et al., 2001)?

3. What changes of working memory are shown on automated working memory tasks in the Size Judgment Span task (Cherry et al., 2007) following APT-III treatment?

4. What evidence of generalization of training on APT-III is demonstrated by progress on functional goals?

To answer Q1, primary outcome meaures included probe exercises completed at the end of each treatment session. To answer Q2, secondary outcome measures including the CPT-II, TEA, APT-II Questionnaire were taken. For Q3, the SJS task was measured. The investigators used these measures, along with baseline probe scores to establish a baseline, determine appropriate attention exercises for treatment, establish goals, and design and facilitiate metacognitive strategies. In addition to answering Q4, progress on functional goals was reported. Answers to the experimental questions are presented below by participant.

All participants completed the planned 6 week treatment, its post-treatment assessment sessions, and 1 month follow-up sessions. Results for all domains were analyzed using visual

analysis and effect size calculations. Visual analysis graphs are shown for each participant in Figures 1, 2, and 3.

The graph for the trained domain is pictured first followed by the probes for untrained domains. Each graph shows percent accuracy on the vertical axis and the session number on the horizontal axis. For the treated domain, data points labeled with a *B* indicate baseline measures, those with a *T* indicate treatment sessions, those with a *P* indicate post-treatment, and those with an *F* indicate follow-up. In some cases, vertical axes vary in scaling as a reflection of differences in percent accuracy obtained. Judges were first asked whether baseline measures were stable, and then asked to identify the trend of treatment probes, post-treatment probes, and follow-up probes. Effect sizes were calculated for both 1 week post-treatment assessment and 1 month follow-up assessment and are detailed in below in Table 2. The trained domain for each participant appears in the first column.

3.1 Participant 1

Q1. Participant 1 completed sustained attention tasks during the treatment phase. His treatment did not target selective attention, working memory, suppression, nor alternating attention. However, these domains were probed continuously throughout the study in the event that treatment could progress to the next domain, and to observe whether changes in the treated domain (sustianed attention) led to improvement in other domains. Participant 1 used a number of metacognitive strategies that included specifically identifying aspects of the task that were easy and/or difficult, predicting easy or difficult task components before beginning training on a new task, and repeating instructions to himself prior to beginning a task to ensure comprehension.

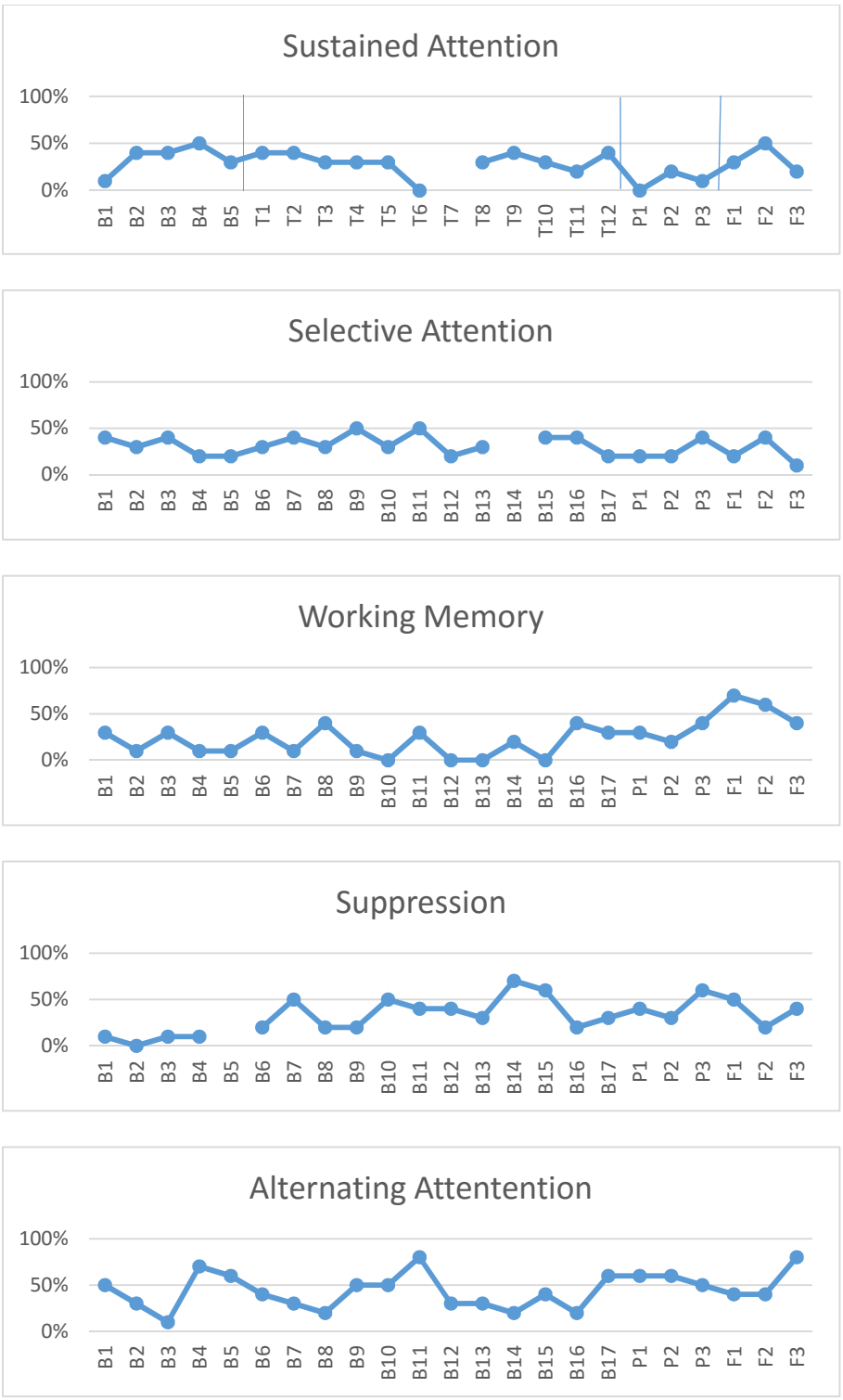

Figure 1. Particpant 1 visual analysis graphs

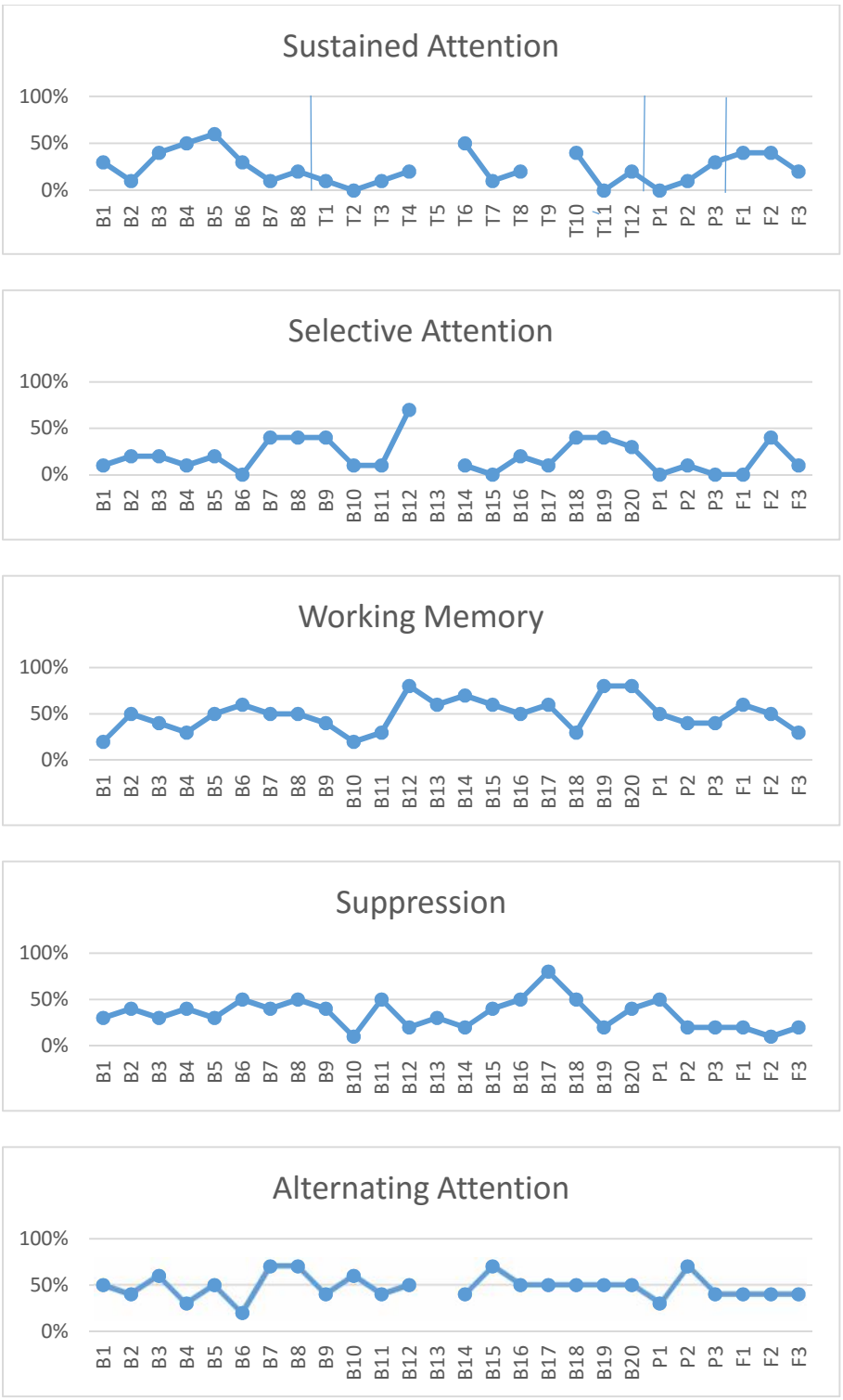

Figure 2. Participant 2 visual anlysis graphs

Figure 3. Participant 3 visual anlysis graphs

Table 2. Effect sizes comparing pre-treatment to post-treatment and follow-up for all participants

Participant 1					
	Sustained Attention	Selective Attention	Working Memory	Suppression	Alternating Attention
Post-Tx	-1.534	-0.333	1.20	3.083	0.526
Follow-up	-0.045	-0.667	3.867	5.834	0.388
Participant 2					
	Sustained Attention	Selective Attention	Working Memory	Suppression	Alternating Attention
Post Tx	-0.991	-1.179	-0.032	-1.048	-0.115
Follow-up	0.115	-0.236	0.224	-2.644	-0.484
Participant 3					
	Selective Attention	Sustained Attention	Working Memory	Suppression	Alternating Attention
Post Tx	-0.246	-0.686	0.533	0.441	-0.474
Follow-up	-1.138	-0.394	0.311	1.544	-0.869

All three judges agreed that participant 1 had stable baselines in his treated domain prior to commencing the APT-III. While judges 1 & 2 agreed that there was no change for this domain in the A_1-A_2 phase, judge 3 saw a modest improvement. All judges agreed that improvement occurred between the A_2-A_3 phases. For selective attention, all agreed that between the A_1-A_2 and A_2-A_3 phases, there was no change in performance. Working memory was judged improved between A_1-A_3, and suppression between A_1-A_2 and A_1-A_3. For alternating attention, judges agreed that improvement occurred between A_1-A_3. See Figure 1.

Effect size calcuclations showed a decrease in performance in the results between A_1-A_2 and A_1-A_3 analyses for sustained attention, most likely due to the variability on probe task performance throughout training, although the participant progressed from simple to more

complex APT-III computerized tasks. For the untrained attention domains, working memory and supression improved significantly, as evidenced by the large effect sizes indicated at both post-treatment and follow-up. See Table 2. Results for the alternating attention domain maintained a small to medium increase from post-treatment to follow-up. Selective attention performance declined between post-treatment and follow-up, with a negative small and then negative medium effect size. In summary, for particpant 1, a treatment effect was demonstrated for the untrained domains of working memory, suppression, and alternating attention.

Q2. At pre-treatment, particpant 1 had a CPT-II clinical profile score of 50, indicating that there was 50/100 chance that a significant attentional deficit was present. All other CPT-II attentional categories for particpant 1 were consisdered within normal limits. At post-testing, partipant 1's CPT-II clinical impairment score remained at 50. His score for response style had improved to the mildly atypical level. Scores for omissions had dropped to the level of inattention with the t-score increasing from 46.05 to 61.43. Hit reaction time also dropped to the category of inattention, but only by a small interval from 57.68 to 58.48. All other scores remained the same. At follow-up, clinical impairment score remained at 50. Response style continued to improve to the normal range, and omissions had returned to normal limits, dropping in t-score from 61.43 to 42.97. Hit reaction time remained about the same with a t-score of 58.34, down from 58.48. Hit reaction time standard error, however, dropped from t-score 55.13 to 49.07, moving particpant 1 back to the level of inattention. Refer to Appendix D for all secondary outcome results.

For the TEA, results indicated deficits of 1 SD or more in the following domains: selective attention and divided attention. On the TEA, participant 1 remained at the mean (10) for Elevator Counting at both post-treatment and follow-up. His scores for Lottery remained

within one SD above or below the mean from A_1-A_2-A_3. Both Elevator Counting and Lottery correlate to sustained attention and these results show that particpant 1's sustained attention abilities remained steady throughout treatment. Scores for the Map Search decreased steadily from A_1-A_2-A_3, going from 6 at pre-treatment to 3 at follow-up, suggesting that paritcpant 1 experienced a drop in selective attention abilities. On the contrary, Telephone Search results went from 5 at A_1 to 4 at A_2 to 9 at A_3 which suggest an increase in selective attention abilities. Elevator Couting with Distractors went from 13 in A_1 to 5 in A_2 to 10 in A_3 indicating a dip at post-treatment in selective attention and working memory. The Telephone Search Counting scores went from 2 at A_1 to 6 at A_2 back to 2 at A_3, indicating variable performance in alternating attention.

Pre-treatment results of the APT-II Attention Questionnaire indicated a severe effect of attentional deficits on ADLs. Scores improved consistently from pre-treament to post-treatment and follow-up. His initial score of 32 indicated a severe attentional disruption to ADLs while his post-treatment score of 17 indicated moderate disruption. His follow-up score of 12 demonstrated further improvement to the level of little-mild disruption.

Q3. On the SJS, improvement was seen for particpant 1 from pre-treatment to post-treatment and this improvement remained at follow-up. Particpant 1 scored 3 at pre-treatment, which is less than 1 SD below the mean. At post-treatment and again at follow-up, participant 1 scored 4. Refer to Appendix D for all results.

Q4. Participant 1 initially identified 2 separate functional goals to be addressed in treatment. The first was recalling where he'd placed his keys and the second was remembering where he'd placed his eyeglasses. By mid-treatment participant 1 was effectively using a system of putting these items in specific places and, when unable to do so, taking a moment to commit

to memory exactly where he was placing them and why. New goals were discussed mid-semester and after taking into account feedback from his spouse, participant 1 agreed to add the goal of maintaining a conversational topic for 7 minutes at a time. Participant 1 appeared less concerned about this goal than the previous two, and provided less reliable feedback on his progress throughout the remainder of treatment. It appeared that because participant 1 maintained his rich, pre-morbid social life, he didn't see his conversational abilities as affected by his attention, despite the reports of his spouse.

Regardless, participant 1's self-report indicated that his progress on this goal was satisfactory. During week 5 and 6 of treatment, he repeatedly reported being able to stay on topic in group and one on one conversations for 8-10 minutes at a time, although he did admit that he may not have realized every time he drifted off topic. In contrast, the initial two goals of recalling where participant 1 had placed his eyeglasses were inarguably met by the fourth week of treatment. Refer to Table 3 below for participant 1's goals and outcomes.

Table 3. Participant 1 summary of functional goal progress

Functional Goal	Pre-treatment Rating and Interpretation	Post-treatment Rating and Interpretation
1. Participant will recall where keys were last placed by using key hook every time he enters the house. If he cannot put keys on the hook, he will repeat to himself where he is placing keys before walking away.	-2 Able to recall where he placed keys 70% or less of the time over the course of a week and not using repetition strategy.	+1 Able to recall where he placed his keys 90% of the time or more over the course of a week with repetition strategy.

Table 3. continued

Functional Goal	Pre-treatment Rating and Interpretation	Post-treatment Rating and Interpretation
2. Participant will recall where he placed his glasses by repeating to himself where he is placing them before walking away	-2 Able to find glasses less than 60% of the time over the course of a week and not using repetition strategy.	+1 Able to find glasses 80% or more of the time over the course of a week with repetition strategy.
3. Participant will maintain the topic in a 7 minute conversation by cueing self to "tune in" and ask for clarification as needed.	-2 Able to maintain topic in a 3 minute conversation but will forget to "tune in" or by asking for clarification.	+1 Able to maintain topic in a 10 minute conversation by cueing self to "tune in" or by asking for clarification when needed.

3.2 Particpant 2

Q1. Participant 2 followed the same schedule described above for participant 1. She was given both a slow and fast version of each task and was required to achieve a score of 80% or higher to proceed to the next task. On tasks in which she excelled, this meant that as few as 2 trials at 80% were required to move on. For the most part, criteria was met at the initial presentation of slow speed, not met at the initial presentation at the fast speed, but met immediately afterward on the second presentation at the fast speed. In these cases, participant 2 was still allowed to proceed to the next task. Similarly for decreasing complexity, participant 2 reverted back to the previously mastered task after achieving two consecutive scores below 80% accuracy, rather than training the same task indefinitely. Participant 2 also used a number of metacognitive strategies to improve her performance, including identifying aspects of the task that were easy and/or difficult; predicting easy or difficult task components before beginning training on a new task, and repeating instructions to herself prior to beginning a task to ensure comprehension. She also utilized breathing and postural techniques which included taking 10

deep breaths before beginning training on APT-III tasks, using “body alert” posture (an APT-III term) which involved sitting comfortably with a straight back and with the body oriented directly forward toward the computer screen. The deep breathing strategy proved so useful that the Participant 2 often employed it before commencing treatment probes at the end of each session.

It should be noted that participant 2 commenced treatment after 8 baseline measures were taken but before her baseline for sustained attention had stabilized. However, treatment probe results for sustained attention following her initial treatment session decreased by 10%, indicating that no learning effect had occurred. Two judges did not consider participant 2 as having a stable baseline in her treated domain, sustained attention, prior to treatment. Judges 1 and 2 saw improvement between A_1-A_2 and all three judges saw improvement between A_1-A_3. Selective attention was ruled as improved between A_2-A_3 and working memory was ruled by judges 2 and 3 as decreasing between A_2-A_3. All judges saw a decreasing trend for suppression between A_1-A_3. No agreement was found for alternating attention. Below are the graphs used during visual analysis. See Figure 2.

Most notably for participant 2 is the across the board decrease in performance for each domain at the post-treatment assessment. Sustained attention showed a small improvement at follow-up. A similar trend was seen for working memory, where a decrease in performance at post-treatment became a small improvement at follow-up. In summary for participant 2, small improvement occurred at follow-up for the trained domain of sustained attention and the untrained domain of working memory. See Table 2.

Q2. Pre-treatment results of the CPT-II indicate a CI score of 55.54, meaning there was a 55.54/100 chance that a significant attention impairment was present. Other CPT-II pre-treatment results showed inattetion in the categories of omission, hit reaction time, hit reaction

standard error, and variability. Response style was rated as markedly atypical and perseverations indicated impulsivity. At post-treatment, participant 2 had increased her CI score to 57.13 and at follow-up she increased it again more dramatically to 73.39, well beyond the cutoff of CI score 60 for a severe attentional imapirment. CPT-II post-treatment results indicated improvement in omissions from inattention to normal limits and improvement in variability from inattention to normal limits. Response style had improved from markedly atypical to mildly atypical, and preseverations had improved from impulsive to normal limits. Hit reaction time and hit reaction time standard error remained unchanged. These results remained largely unchanged at follow-up with the exceptions of hit reaction time block change and hit standard error block change. Both of these categories fell from within normal limits to poor vigilence. T-scores scores for hit reaction time block change increased from 50.58 at post-treatment to 60.1 at follow-up and from 46.45 at post-treatment to 58.1 at follow-up for hit standard error block change. Refer to Appendix D for all secondary outcome results.

Pre-treatment TEA results indicated that participant 2 scored 1 or more SD below the mean for sustained attention, auditory slective attention, and auditory verbal working memory. Results of the Elevator Counting subtest varied from pre-treatment to post-treatment to follow-up, dropping from 10 to 4 and returning ultimately to 10. Lottery results improved steadily from pre-treatment to post-treatment, going from 6 to 8 to 13 at each phase. Combined results of both Elevator Counting and Lottery subtests suggest that sustianed attention improved, or at least remained stable throughout treatment. Results for the Map Search remained steady from pre-treatment to post-treatment at 7, but dropped at follow-up to 5. The Telephone Search subtest dropped from 7 at pre-treatment to 4 at post-treatment where it remained at follow-up. Given the results for these two subtests, no real improvement for selective attention can be gleaned from

treatment. Visual Elevator and Telephone Search Counting both remained within 1 SD below the mean or 1 or more SDs above the mean throughout A1-A2-A3 phases indicating that particpant 2 maintained strenghts in alternating attention throughout treament.

APT-II Attention Questionnaire pre-treatment results showed a little-mild disruption on ADLs. Particpant 2's APT-II Attention Questionnaire response increased at post-treament to 15 from 12 at pre-treatment, indicating a change from little-mild interuption of ADLs to a moderate disruption. At follow-up, however, her score dropped down to a 6, putting her back in the little-mild disruption category and indicating that the effects of attention deficits on daily functionig had decreased considerably from pre-treatment.

Q3. Improvement was seen on the SJS for participant 2 from pre-treatment to post-treatment and this improvement remained at follow-up. Particpant 2 scord 3.5 at pre-treatment and 4 at both post-treatment and follow-up. Refer to Appendix D for all results.

Q4. At the onset of treatment, participant 2 identified 2 functional goals that she addressed throughout the treatment. They were to consistently maintain the topic in a five minute conversation and to attend consistently to a 5-10 minute monologue such as a presentation in her bible study group. Participant 2 first focused on noticing moments where her attention would drift, and then bringing it back to the conversation or monologue. For the conversational goal she would try to repair the communication breakdown by asking for clarification. She reported steady improvement in both goals and reported being able to attend most of the time to 5-7 minute conversations and 10-15 minutes monologues by the end of treatment. Feedback from participant 2's daughter supported her progress reports. By the end of treatment, participant 2 had met both of her functional goals. See Table 4 below for participant 2's goals and outcomes.

Table 4. Participant 2 summary of functional goal progress.

Functional Goal	Pre-treatment Rating and Interpretation	Post-treatment Rating and Interpretation
1. Participant will maintain topic in a 5 minute conversation by cueing self to "tune in" and asking for clarification when needed.	-2 Able to maintain the topic in 2/5 5-minute conversations but will forget to "tune in" and ask for clarification.	+1 Able to maintain topic in 5/5 5-minute conversations by cueing self to "tune in" and asking for clarification.
2. Participant will be able to consistently attend to a 5 to 10 minute monologue (in-person, on TV, etc.) by cueing self to "tune in".	-2 Able to attend to less than a 5 minute monologue and not cueing self to "tune in".	+1 Able to attend to a 10 minute monologue by cueing self to "tune in".

3.3 Participant 3

Unlike participants 1 and 2, participant 3 was only administered the slow version of all tasks. Because she excelled on all initial trails of each task, achieving between 96-100% in the first two treatment sessions, she was not required to duplicate her performance to increase complexity. When she did score below advancement criteria in two consecutive presentations of a novel task in her third treatment session, she was required to achieve criteria on her previously mastered task before again attempting to increase complexity. Participant 3 used similar metacognitive strategies as described above, including identifying aspects of task difficulty, predicting difficulty prior to beginning a new task, and repeating instructions subvocally. She also used the breathing and postural techniques which included taking 10 deep breaths before beginning training on APT-III tasks, using "body alert" posture (an APT-III term) which involved sitting comfortably with a straight back and with the body oriented directly forward toward the computer screen.

Q1. All judges agreed that Participants 3 had stable baselines in her treated domains prior to commencing APT-III treatment. Particpant 3 began treament in the domain of selective attention. No agreement was found between judges in this domain. Working memory was judged improved by all judges between A_1-A_2 and A_1-A_3. Suppression was judged as constant in the A_2-A_2 phase, improved between A_1-A_3 by judges 1 and 2, and improved by all judges between A_2-A_3. Alternating attention was judged constant between A_1-A_2 and decreasing between A_2-A_3. Sustained attention was also judged as decreasing between A_2-A_3. Below are the graphs used during visual analysis.

Effect size calculations for working memory and suppression showed the most consistent improvement for participant 3. From post-treatment to follow-up, she maintained a positive medium effect size for working memory and moved from a medium to quite large effect size for suppression. The domain of alternating attention proved variable from one analyses to the next, but always remained negative. Selective attention displayed a slight decrease in performance from post-treatment to follow-up, going from a large effect size to a medium effect size. Sustained attention also decreased from post-treatment to follow-up, going from a small negative effect size to a large negative effect size. In summary for participant 3, improvments in performance were found for the untrained domains of working memory and suppression at both post-treatment and follow-up.

Q2. Pre-treament result of the CPT-II indicate a CI score of 83.9, meaning there was a 83.9/100 chance that a significant attention impairment was present. CPT-II CI scores showed a steady improvement from pre-treatment to post-treatment and again to follow-up, indicating that participant 3 had a decreasing attentional impairment at each phase of treatment. At post-treatment, participant 3's CI score had dropped to 70.07 and by follow-up it was 65.14. Although

partipant 3 never made it out of the range of severe attentional impairment (CI <60), she continuously brought her attention closer to the range of functional limits.

More specifically, CPT-II results showed improvement for hit reaction time block change from poor vigilance at pre-treatment and post-treatemnt to within normal limits at follow-up, and for hit standard error block change from poor vigilance at pre-treatment to within normal limits at post-treatment and follow-up. Variability t-scores also improved from inattention at pre-treatment to within normal limits at post-treatment and at follow-up. Hit reaction time, hit reaction time standard error, response style and perserverations were all variable from A_1 to A_2 to A_3. Perseverations t-scores dropped to the level of impulsive at post-treatment from within normal limits at pre-treatment, but returned to within normal limits at follow-up. Hit reaction time, hit reaction time standard error, and response style all showed the opposite pattern, improving at post-treatment only to return to their pre-treatment levels at post-treatment. Refer to Appendix D for all secondary outcome results.

Pre-treatment TEA scores indicated that participant 3 scored 1 or more SDs below the mean for selective attention only. TEA results were the same across phases for Elevator Counting and remained within 1 SD above or below the mean for the Lottery subtest. These combined results indicate that sustained attention abilities remained about the same throughout treatment. The Telephone Search subtest showed a steady decline in scores from A_1 to A_2 to A_3. The Map Search subtest score remained extremely low from pre-treatment to post-treatment and could not be tested at follow-up due to participant health. The Telephone Search Couting subtest scores remained fairly steady from phase to phase, indicating no real change in alternating attention. The Elevator Couting with Distractions subtest decreased steadily from A_1-A_2-A_3, suggesting a progressively decreased performance in working memory.

Results of the APT-II Attention Questionnaire indicate that particpant 3's attentional deficits caused a severe disruption to her ADLs throughout treatment. Her scores varied little at each phase, going from 29 at pre-treatment to 26 at post-treatment and back to 29 at follow-up.

Q3. Compared to participants 1 and 2, results of the SJS were more variable for participant 3 who scored 3.5 at pre-treatment, 3 at post-treatment, and 3.5 again at follow-up. Refer to Appendix D for all results.

Q4. The two goals that participant 3 decided upon were to maintain the topic in a 7 minute conversation and to summarize the most important details of the latest chapter she'd read in a novel. The first goal was reported on regularly with participant 3 indicating steady improvement over the course of treatment. The second goal identified by participant 3 was not addressed until mid-treatment due to participant illness, family emergency, and other complications. However, by the time it was addressed, participant 3 made notable progress in succinctly summarizing what she had read with details sufficient to elucidate the plot to the research assistant who was otherwise unfamiliar with the novel. Participant 3 clearly felt that she had made progress on her conversational goal and was able to meet her second goal of summarizing a novel chapter, but only with considerable cueing in the form of questions from the research assistant. Refer to Table 5 below for participant 3's goals and outcomes.

Table 5. Participant 3 summary of functional goal progress.

Functional Goal	Pre-treatment Rating and Interpretation	Post-treatment Rating and Interpretation
1. Participant will maintain topic in a 7 minute conversation by cueing self to "tune in" and asking for clarification when needed.	-2 Able to maintain the topic in 3 a minute conversation but forgets to "tune in" and ask for clarification when needed.	+1 Able to maintain the topic in a 10 minute conversation by cueing self to "tune in" and asking for clarification when needed.

Table 5. continued

Functional Goal	Pre-treatment Rating and Interpretation	Post-treatment Rating and Interpretation
2. Participant will be accurately summarize the main plot points of the most recent chapter of a novel she has read by reminding herself to pay attention while reading.	-2 Able to summarize each chapter read with 50% accuracy.	+2 Able to summarize each chapter read with 100% accuracy. *moderate cueing was required on the part of the research assistant to achieve this level of accuracy

CHAPTER 4. DISCUSSION

Overall, the APT-III treatment resulted in improvement in both treated and untreated attentional domains. Results of secondary outcome measures designed to identify changes in impairment, activity, and participation levels were variable across participants. Working memory as measured by the SJS task showed that all participants began and remained within normal limits for healthy controls their age (i.e. could manipulate 3-4 items). Participants all made progress on functional goals addressed through goal attainment scaling. The theoretical, clinical and research implications of these findings will be presented in the following sections, as will limitations and future research. However, since each participant serves as his or her own control in SCED, the discussion begins with how individual participants with PD responded to the treatment.

4.1 Participant 1

Participant 1 was a 72 year-old former professional, 6 years post PD diagnosis with a Hoehn & Yahr severity score of 2. In regards to our first experimental question, improvements were noted in the untrained domains of working memory, suppression, and alternating attention but not the trained domain (sustained attention). For working memory, this included a very large effect size at post-treatment and an even larger effect size at follow-up. Suppression showed yet larger effect sizes at post-treatment and follow-up. Alternating attention showed more modest but nonetheless significant improvement with a medium post-treatment effect size and a small to medium effect size at follow-up. Inspection of the sustained attention probe data suggest that possible improvements noted in participant 1's successful mastery of the computerized sustained attention tasks may have been lost because the probe did not measure what was being trained, as it was intended to do.

On the CPT-II, participant 1 maintained a clinical impairment score of 50 at all phases. While this score did not indicate a significant attentional impairment, individual subscores for response style, a correalte to suppression in the APT-III hierarchy, indicated that participant 1 consistently improved from A_1-A_2 and A_2-A_3. This improvement supports the increasingly large effect sizes in the suppression domain from A_2 to A_3.

On the TEA, participant 1's results also showed consistent performance on sustained attention activities (Elevator Counting and Lottery) and improved performance on selective attention (Telephone Search) at A_3.

The APT-II Attention Questionnaire, indicated that participant 1 continuously decreased the level of impairment on his ADLs from severe at pre-treatment to moderate at post-treatment and little-mild at follow-up. Likewise, participant 1 reported consistent improvement on his functional goals, suggesting that direct attention training may have generalized and made an impact on his everyday life.

The SJS task results showed that participant 1 was within funcional limits for adults his age, remaining 1 SD above or below the mean at each phase. While always within 1 SD of the mean, participant 1 improved his SJS performance from pre-treatment to post-treatment and this improvement remained at follow-up. This upward trend supports the very large effect sizes seen for working memory at A_2 and A_3.

4.2 Participant 2

Participant 2 was a 70 year-old former professional, 10 years post PD diagnosis with a Hoehn & Yahr severity score of 3. For participant 2, treatment effects were found at follow-up

for sustained attention (trained) and working memory (untrained). Also at follow-up, sustained attention and working memory both showed small effect sizes.

On the CPT-II, particpant 2 showed a consistent decline on CI score. However, TEA results showed functional gains in sustained attention (Lottery subtest). Results of the APT-II Attention Questionnaire showed fairly consistent results at A_1 and A_2, staying near the cusp of little-mild to moderate impairment. At follow-up, however, her score dropped well within the category of little-mild impairment.

SJS results showed that participant 2 was within functional limits for adults her age, remaining within 1 SD above or below the mean at each phase, but improving her performance at both A_2 and A_3. This improvement pattern aligns with the effect size in working memory at the A_3 phase. Participant 2 met both her functional goals addressed through GAS, indicating successful generalization of attentional gains to ADLs.

4.3 Participant 3

Participant 3 was a 69 year-old former professional, 11 years post PD diagnosis with a Hoehn & Yahr severity score of 3. Over the course of treatment, participant 3 experienced several personal setbacks that likely influenced her performance both in treatment and on secondary outcomes measures. Foremost was a change in PD medication halfway through treatment that made her elligible for disqualification from the study. Because of her high level of motivation to complete the treatment, she was allowed to remain in the study. Treatment effects were found at both post-treatment and follow-up for working memory and sustained attention. Working memory showed the medium effect size at post-treatement and a small-medium effect

size at follow-up. Suppression showed a small to medium effect size at post-treatment and a very large effect size at follow-up.

On the CPT-II, particpant 3 consistently reduced her CI score. While it never dropped below the cutoff for severe attentional impairment, her level of impairment clearly dropped. On the TEA, participant 3 showed consistent performance on all sustained attention tasks (Lottery, Elevator, and Telephone Search). Her participation impairment as measured by the APT-II Attention Questionnaire remained roughly the same through all phases, never dropping below the severe category.

SJS results showed that participant 3 was within functional limits for adults her age, remaining less than 1 SD below the mean at each phase. For working memory, participant 3 also showed medium and small effect sizes at post-treatment and follow-up respectively, supporting the high level of performance seen on the SJS. Like participants 1 and 2, participant 3 met her functional goals, indicating successful generalization of trained attentional skills.

In summary, effect sizes were found for each participant in at least two attentional domains, although not always the trained domains. All participants showed improvments in multiple subcategories of the CPT-II and at least 1 attentional domain measured on the TEA. For participants 1 and 2, the APT-II Attention Questionnaire indicated significant decreases in the effect of attentional deficits on ADLs by follow-up. All particpants remained within 1 SD of the mean for healthy controls their age on the SJS, and participants 1 and 2 improved their scores from pre-treatment. These results across participants suggest that these participants with PD were able to improve their attentional performance in the impairment, activity, and participation domains of the ICF model, and maintain gains one-month post-treatment. These results add an important piece of information to the APT literature, where no investigators have demonstrated

improvement in attentional processes in a group with degenerative neurological disease previously.

The results of this study suggest that direct attention training using APT-III can improve attention in PPD, and that these improvements appear to generalize to increased performance on ADLs and other functional activities. Further, it suggests that PPD may benefit from future research investigating the use of APT-III. In doing so, attention should be paid to using primary outcome measures that are adequately sensitive to small increments of improvement and secondary outcome measures that equate closely with the attentional domains measured on the APT-III for participants in the age group studied.

4.4 Theoretical Implications

The results of our study suggest that training attentional deficits in PPD using APT-III is effective in reducing impairment, improving activity, and increasing participation in the realms of attention and working memory. As described in the literature review, the depletion of dopamine in the basal ganglia contributes to the cognitive deficits in PD by preventing effective communication between this deep brain structure and cortical structures via frontostriatal loops (Nieoullon, 2002; Owen, 2004; Zgaljardic et al., 2006). Our results now suggest that attention can be improved in a small group of participants with PD who are stable on their PD medications. The best way to test whether dopamine plays a role in attention training would be to train participants on and off of their PD medications. However, it seems unlikely many PPD would participate in such a study. Another possibility could be to use neuroimaging to support changes after treatment in the frontalstriatal loops discussed earlier.

4.5 Clinical Implications

Like Molhman & Chazin's 2011 findings for APT-II, we found that APT-III is a feasible treatment for PPD. Participants were able to complete all APT-III activities with the use of metacognitive strategies. While the APT-III protocol was challenging for particpants, the treatment dose of two 1 hour sessions per week did not produce excessive fatigue and participants reported enjoying the training and feeling a sense of accomplishment after completing more difficult tasks.

Metacognitve strategies were used in APT-III training but their use did not appear to generalize well, even in the somewhat similar post-treatment and follow-up assessment tasks. These strategies were included in training not only to help participants compensate for their attentional deficts and on APT-III tasks, but also to help them compensate in everyday settings outside of treatment. However, based on lack of generalization, clinicians may have to train the use of metacognitive strategies more explicitely.

Metacognitive strategy use extended attention training from treating only the impairment level to treating the activity and participation levels as well. Future studies would benefit from more actively training participants to use these strategies in a variety of settings. For example, one strategy all particpants utilized was summarizing the directions of each new APT-III task before beginning that task. This strategy was chosen because it gave particpants a way to monitor their understanding of the task and ask for repetition of the directions if necessary. This metacgonitve strategy could have easily been used prior to post-treatment and follow-up assessment measures for the same purpose. Likewise, this strategy could be used at any time the participant was faced with novel directions. However, it appeared that by the end of the study, participants almost exclusively associated their metacognitive strategies with APT-III training

exercises. While metacognitive strategy use may not have generalized as well as hoped, participants did appear to generalize trained attentional skills as evidenced by the progress they made toward functional goals. All three participants reported steady, satisfactory progress on their goals over the course of treatment.

4.6 Research Implications

One specific area that deserves to be addressed is the adequacy of the probes used in this study. As stated above, all participants were able to move through the hierarchy of APT-III tasks for the attentional domain in which they were trained. When more difficult tasks were encountered, metacognitive strategies were employed to help participants perservere and participants always managed to do so. This continuous progress was not reflected in the results of treatment probes. Rather, performance on probes proved for the most part highly variable. Despite reviewing the data for any pattern that may have contributed to these ups and downs, such as cognitive fatigue caused by more difficult training sessions, no convincing causal pattern was found. As a result, we propose that the probes, which were based on the most difficult task in each attentional domain, did not adequately reflect the smaller increments of learning that participants achieved over the course of training and maintained into post-treatment and follow-up. Future experiments would benefit from probes designed to reflect attentional demands commensurate with lower difficulty levels for the trained domain to more accurately capture progress. This might take the form of probes that increase in difficulty as participants move up the APT-III hierarchy.

As part of pre-treatment screening, all participants were administered the Mental Fatigue Scale (MFS), a valid and reliable measure used to quantify the energy output required in daily tasks among those with traumatic brian injury or other neurological disease such as PD

(Johansson & Ronnback, 2014). The MFS has a cutoff score of 10.5, meaning that above this score, mental faituge is present and affecting performance of ADLs. All participants were well above this cutoff with participant 1 scoring 18.5, participant 2 scoring 14.5, and participant 3 scoring 22. Factoring in mental fatigue may provide an explanation for the variable performance on treatment probes collected at the conclusion of each session. If training tasks were more difficult for participants on a given day, this was likely reflected in poor perfomance on probes. One way to avoid the affects of mental fatigue on probe results in the future might be to administer probes prior to treatment in each session.

4.7 Limitations

The results of this study cannot be generalized to the broader PD population due to its small sample size. Additionally, the participants were recruited from a PD support group where members are actively encouraged to participate in research toward improving the quality of life for those with PD. Therefore the motivation to persevere and dedicate the time necessary to complete the study demonstrated by these three participants may not be typical in a broader PD sample.

Participants 1 and 2 maintained pre-treatment inclusion criteria status throughout the study, including stable medication cycles and no significant changes to their pre-treatment status. On the other hand, participant 3 changed medications halfway through treatment and also experienced a constellation of personal setbacks that likely constributed to the high degree of variability in both her primary and secondary outcome measures. Nonetheless, we elected to keep participant 3 in the study because of her enthusiasm to finish the treatment.

As discussed under research implications, the probes used in this study were not reflective of the day to day progress participants made in APT-III treatment. While effect sizes were found for some attentional domains for each participants, it is likely that more sensitive probes would have generated a greater number and/or higher degree of treatment effects.

4.8 Future Research

To test the theory that lack of dopamine in the frontostriatal loops leads to the cognitive deficits in PD would require training individuals on and off their medications, which was discussed above. It is possible that in the future, neuroimaging will be refined to the point that a a neurotransmitter's effect on a specific pathway could be identified, but that type of imaging is not available to us at this time. Until then, using designs such as the one presented here will have to suffice. However this study's results are based on a very small, select group of participants. Therefore replicating this study with a larger group of participants must be done.

Second, cognitive decline is present in about one third of newly diagnosed PD patients and this number increases to more than half of patients within the first five years following diagnosis (Toma & Mihancea, 2014). Providing direct attention training early after PD onset, while participants still have relatively low impairment due to PD (i.e. Hoehn and Yahr scores of 1 or 2) may increase the duration of their independence and participation in ADLs, consequently decreasing the mental, emotional, and financial toll on PPD, their caregivers, and society.

Third, visual analysis for this study was carried out by having untrained judges determine the stability of baselines and the trend from phase to phase. According to Fisher, Kelley, and Lomas in 2003, using judges trained in visual analysis tends to yield more accurate results. They also advocate the use of trend lines in visual analysis graphs to assist judges in determining trend

when it is unclear (Fisher, Kelley & Lomas, 2003). The use of trained judges and trend lines in future studies would likely decrease the instances of disagreement found between visual analysis results and effect size calculations, of which there were a handful.

Fourth, concerning secondary outcome measures, it became clear that CPT-II results were not clinically sensitive to self-report attentional problems provided by participants, calling into question the ecological validity of this measure for the purposes of this study. Future studies would benefit from finding or developing a more sensitve measure of attention impairment in PPD rather than relying on existing neuropsychological assessments that have not included this population. For the TEA, several subtests required faster processing times than these three participants had. Therefore, several tasks could not be completed by participants (as denoted in Appendix D). Slowed processing times were reflected in treatement by the increased difficulty participants had moving from the slow version of a task to the fast version, typically requiring multiple trials on the fast version to meet criteria. Future studies might benefit from finding an activity level measure that allows for processing time requirements of individuals with PD.

4.9 Conclusion

This study sought to determine the presence and degree of change direct attention training using the APT-III could make in PPD. Effect sizes were found for all participants and the largest effect sizes were reinforced by results of visual analysis. Secondary outcome measures also indicated improvement within the ICF domains of impairment, activity, and participation for all participants. From a clinical standpoint, this study supported the literature indicating the feasibility of using APT-III on people with PD. These findings are very preliminary and must be studied systematically to establish the evidence for direct attention training in PPD.

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APPENDIX A: ATTENTIONAL PROBES

All probes were modeled after the most difficult task for each attention domain in APT-III (Sohlberg & Mateer, 2010; Ourso, 2015).

I. Sustained Attention:
- Directions: The participant will see a series of slides, each with either a face or an emotion word. The participant will press a button each time he sees a word that matches the emotion of the face from the previous slide.
- Description: Five faces with corresponding emotion words are possible – happy, sad, angry, tired, or surprised. During the instructions, all five faces are presented. A slide with one face will be presented, followed by another slide with one emotion word. If the word matches the face, the participant responds by clicking a button. If the word does not match the face, no action is taken.

II. Selective Attention:
- Directions: The participant will see a series of slides, each showing a face or an emotion word. The participant will press a button each time he sees a word that matches the emotion of the face from the previous slide.
- Description: This task is presented similarly to the Matching Faces and Emotion Words task for sustained attention (a face is presented followed by a word; if the emotion word matches the face, the participant responds). However, a distracter is also presented with the task. An additional face is presented to the side of a box which contains the target information.

III. Working Memory:
- Directions: The participant will see a clinician reading a series of 6-word sentences, one at a time. The participant will manipulate each sentence and say the answer out loud. The participant's answer will be scored by the investigator.
  - Progressive word order – the participant will say the words of the sentence in ascending order, by the number of letters in each word. Words that have the same number of letters will be ordered alphabetically (e.g., The black dog is very big. -> is big dog the very black)
- Description: For this task, a speaker appears on-screen and reads the sentence aloud. The participant is to order the words appropriately (as described above) and state the answer out loud. The investigator clicks a button to move on to the next sentence.

IV. Suppression:
- Directions: The participant will see a series of slides with two words on each slide. The words "up" "down" "forward" "backward" or "diagonal" will appear on the left side of each screen. On the right side of each screen will be a second word written in one of the five named directions. The participant will press a button when the direction of the writing of the word on the right side matches the actual word on the left side of the screen.
- Description: Both words that appear on the screen are one of the five direction words. The word on the left is printed normally, and states the direction the participant is looking for. The word on the right is written to demonstrate one of the different directions. The

participant is to press the response button when the written direction demonstrated by the word on the right matches the direction word on the left.

V. Alternating Attention:
   - Directions: The participant will see a series of slides with two words on each slide. The words “up” “down” “forward” “backward” or “diagonal” will appear on the left side of each screen. On the right side of each screen will be a second word written in one of the five named directions. The participant will press a button when the actual word on the left matches or does not match the direction of the word on the right.
   - Description: Both words that appear on the screen are one of the five direction words. The word of the left is printed normally, and states the direction the participant is looking for, while the word on the right is written to demonstrate one of the different directions. The participant begins the task by pressing the button when the written direction demonstrated by the word on the right matches the direction word on the left. After five sets, the investigator will say the word “switch”. The client is then to click the button when the written direction demonstrated by the word on the right DOES NOT match the direction word on the left.

APPENDIX B: METACOGNITIVE STRATEGIES

Metacognitive strategies assist with the need to self-regulate and think about one's own thinking. They enhance self-awareness (Ourso, 2015).

According to Sohlberg & Mateer (2010) strategy instruction may include:

- Education regarding attention strengths and weaknesses
- Better self-awareness of attention deficits to facilitate improved self-monitoring and regulation
- Selection and use of strategies designed to facilitate task completion and increase motivation

Strategies suggested in the APT-III Manual and used in this study include:

- Pacing, taking breaks
- Body alert (sitting up straight, facing the computer screen)
- Working toward a goal (e.g. setting a task objective; trying to beat a score)
- Breathing, relaxation techniques
- Reviewing previous performance
- Predict easy/hard task components
- Repeat instructions (Sohlberg & Mateer, 2010, pp. 23)

APPENDIX C: GOAL ATTAINMENT SCALING

Goal Attainment Scaling (GAS) Examples (Sohlberg & Mateer, 2010; Ourso, 2015)

Participant: _____

Date: _____Session #: _____

Participant will be able to maintain attention long enough to complete a five minute conversation without forgetting the topic of the conversation. The participant will:	
+2	Use strategies to complete conversation and *rarely* need to self-cue to maintain attention. (not everyday, on some days)
+1	Use strategies to complete conversation and *occasionally* need to self-cue to maintain attention. (>3 times, every day)
0	Use strategies to complete conversation and *sometimes* need to self-cue to maintain attention. (1-3 times, every day)
-1	*Frequently* forget topic and *frequently* need to self-cue to maintain attention. (Multiple times, every day)
-2	A*lways* forget topic and *always* need to self-cue to maintain attention. (Every time, every day)

Participant will use a key hook and attend to placing his keys on the hook each time he enters his home, reducing the number of times he cannot locate his keys. The participant will:	
+2	Use the key hook *most of the time* and *rarely* misplace his keys.
+1	Use the key hook *sometimes* and *sometimes* misplace his keys.
0	Use the key hook *5-6 times per week* and *occasionally* misplace his keys.
-1	Use the key hook *3-4 times per week* and *often* misplace his keys.
-2	Not use the key hook *multiple times* per week and *frequently* misplace his keys.

APPENDIX D: SECONDARY OUTCOME MEASURES

Secondary Outcome Measures for all Participants at 3 time points

Participant 1								
Connors' Continuous Performance Test II (CPT II v.5)								
Pre-treatment			**Post-treatment**			**Follow-up**		
Measures	**T-Score**	**Interpretation**	**Measures**	**T-Score***	**Interpretation**	**Measures**	**T-Score**	**Interpretation**
Clinical Profile CI **= 50			Clinical Profile CI **= 50			Clinical Profile CI **= 50		
Omissions	46.05	OK	Omissions	61.43	Inattention	Omissions	42.97	OK
Hit RT	57.68	OK	Hit RT	58.48	Inattention	Hit RT	58.34	Inattention
Hit RT se	51.39	OK	Hit RT se	55.13	OK	Hit RT se	49.07	Inattention
Variability	38.19	OK	Variability	54.82	OK	Variability	35.65	OK
Response Style	30.13	Markedly atypical	Response Style	62.11	Mildly atypical	Response Style	47.53	Average range
Perseverations	53	OK	Perseverations	53	OK	Perseverations	42.49	OK
Hit RT Block Chg	48.87	OK	Hit RT Block Chg	43.81	OK	Hit RT Block Chg	39.05	OK
Hit se Block Chg	55.8	OK	Hit se Block Chg	48.12	OK	Hit se Block Chg	48.33	OK

Participant 2								
Connors' Continuous Performance Test II (CPT II v.5)								
Pre-treatment			**Post-treatment**			**Follow-up**		
Measures	**T-Score**	**Interpretation**	**Measures**	**T-Score***	**Interpretation**	**Measures**	**T-Score**	**Interpretation**
Clinical Profile CI **= 55.54			Clinical Profile CI **= 57.13			Clinical Profile CI **= 73.39		
Omissions	85.11	Inattention	Omissions	52.9	OK	Omissions	47.93	OK
Hit RT	81.49	Inattention	Hit RT	84.54	Inattention	Hit RT	87.9	Inattention
Hit RT se	64.3	Inattention	Hit RT se	58.69	Inattention	Hit RT se	64.14	Inattention
Variability	63.03	Inattention	Variability	36.93	OK	Variability	46.6	OK
Response Style	73.1	Markedly atypical	Response Style	61.5	Mildly atypical	Response Style	39.39	Mildly atypical
Perseverations	80.62	Impulsive	Perseverations	45.52	OK	Perseverations	45.52	OK
Hit RT Block Chg	54.29	OK	Hit RT Block Chg	50.58	OK	Hit RT Block Chg	60.1	poor vigilance
Hit se Block Chg	45.26	OK	Hit se Block Chg	46.45	OK	Hit se Block Chg	58.1	poor vigilance

Participant 3								
Connors' Continuous Performance Test II (CPT II v.5)								
Pre-treatment			**Post-treatment**			**Follow-up**		
Measures	**T-Score**	**Interpretation**	**Measures**	**T-Score***	**Interpretation**	**Measures**	**T-Score**	**Interpretation**
Clinical Profile CI **= 83.9			Clinical Profile CI **= 70.07			Clinical Profile CI **= 65.14		
Omissions	55.53	OK	Omissions	47.93	OK	Omissions	47.93	OK
Hit RT	69.88	Inattention	Hit RT	56.88	OK	Hit RT	63.62	Inattention
Hit RT se	68.64	Inattention	Hit RT se	57.18	OK	Hit RT se	63.66	Inattention
Variability	59.73	Inattention	Variability	48.12	OK	Variability	55.43	OK
Response Style	39.39	mildly atypical	Response Style	45.87	average range	Response Style	43.53	mildly atypical
Perseverations	45.52	OK	Perseverations	63.07	Impulsive	Perseverations	45.52	OK
Hit RT Block Chg	58.47	poor vigilance	Hit RT Block Chg	62.57	poor vigilance	Hit RT Block Chg	47.54	OK
Hit se Block Chg	69.36	poor vigilance	Hit se Block Chg	55.96	OK	Hit se Block Chg	51.78	OK

Secondary Outcome Measures for all Participants at 3 time points (continued)

Participant 1					
Test of Everyday Attention					
Pre-treatment		**Post-treatment**		**Follow-up**	
Factor/Subtest	**Scaled Scores (M=10 SD±3)**	**Factor/Subtest**	**Scaled Scores (M=10 SD±3)**	**Factor/Subtest**	**Scaled Scores (M=10 SD±3)**
Visual Selective attention/speed		**Visual Selective attention/speed**		**Visual Selective attention/speed**	
Map Search	6	Map Search	4	Map Search	3
Telephone Search	5	Telephone Search	4	Telephone Search	9
Attentional Switching		**Attentional Switching**		**Attentional Switching**	
Visual Elevator (# correct)	CNC***	Visual Elevator	CNC***	Visual Elevator	CNC***
Sustained Attention		**Sustained Attention**		**Sustained Attention**	
Lottery	13	Lottery	8	Lottery	13
Elevator Counting	10	Elevator Counting	10	Elevator Counting	10
Telephone Search Count.	2	Telephone Search Count.	6	Telephone Search Count.	2
Auditory/Visual Working Memory		**Auditory/Visual Working Memory**		**Auditory/Visual Working Memory**	
Elevator Counting Rev.	CNC***	Elevator Counting Rev.	CNC***	Elevator Counting Rev.	CNC***
Elevator Counting Dist.	13	Elevator Counting Dist.	5	Elevator Counting Dist.	10
Participant 2					
Test of Everyday Attention					
Pre-treatment		**Post-treatment**		**Follow-up**	
Factor/Subtest	**Scaled Scores (M=10 SD±3)**	**Factor/Subtest**	**Scaled Scores (M=10 SD±3)**	**Factor/Subtest**	**Scaled Scores (M=10 SD±3)**
Visual Selective attention/speed		**Visual Selective attention/speed**		**Visual Selective attention/speed**	
Map Search	7	Map Search	7	Map Search	5
Telephone Search	7	Telephone Search	4	Telephone Search	4
Attentional Switching		**Attentional Switching**		**Attentional Switching**	
Visual Elevator (# correct)	11	Visual Elevator	7	Visual Elevator	11
Sustained Attention		**Sustained Attention**		**Sustained Attention**	
Lottery	6	Lottery	8	Lottery	13
Elevator Counting	10	Elevator Counting	4	Elevator Counting	10
Telephone Search Count.	15	Telephone Search Count.	11	Telephone Search Count.	8
Auditory/Visual Working Memory		**Auditory/Visual Working Memory**		**Auditory/Visual Working Memory**	
Elevator Counting Rev.	CNC***	Elevator Counting Rev.	CNC**	Elevator Counting Rev.	CNC***
Elevator Counting Dist.	6	Elevator Counting Dist.	CNC**	Elevator Counting Dist.	CNC***

Secondary Outcome Measures for all Participants at 3 time points (continued)

Participant 3					
Test of Everyday Attention					
Pre-treatment		**Post-treatment**		**Follow-up**	
Factor/Subtest	**Scaled Scores (M=10 SD±3)**	**Factor/Subtest**	**Scaled Scores (M=10 SD±3)**	**Factor/Subtest**	**Scaled Scores (M=10 SD±3)**
Visual Selective attention/speed		**Visual Selective attention/speed**		**Visual Selective attention/speed**	
Map Search	<3	Map Search	<3	Map Search	CNC***
Telephone Search	7	Telephone Search	2	Telephone Search	<1
Attentional Switching		**Attentional Switching**		**Attentional Switching**	
Visual Elevator	CNC***	Visual Elevator	CNC***	Visual Elevator	CNC***
Sustained Attention		**Sustained Attention**		**Sustained Attention**	
Lottery	13	Lottery	13	Lottery	8
Elevator Counting	10	Elevator Counting	10	Elevator Counting	10
Telephone Search Count.	8	Telephone Search Count.	6	Telephone Search Count.	7
Auditory/Visual Working Memory		**Auditory/Visual Working Memory**		**Auditory/Visual Working Memory**	
Elevator Counting Rev.	CNC***	Elevator Counting Rev.	CNC***	Elevator Counting Rev.	CNC***
Elevator Counting Dist.	7	Elevator Counting Dist.	5	Elevator Counting Dist.	2

APT-II Attention Questionnaire			
	Pre-test	**Post-test**	**Follow up**
Participant 1	32	17	12
Participant 2	12	15	6
Participant 3	29	26	29
Size Judgment Span Task			
	Pre-test	**Post-test**	**Follow-up**
	Global Index (M=3.53 SD ±.72)	**Global Index (M=3.53 SD ±.72)**	**Global Index (M=3.53 SD ±.72)**
Participant 1	3.00	4.00	4.00
Participant 2	3.50	4.00	4.00
Participant 3	3.50	3.00	3.50

Note: CPT-II, (Conners, 2004); TEA, (Robertson et al., 1994); APT-II Attention Questionnaire, (Sohlberg et al., 2001); SJS, (Cherry et al., 2007)

APPENDIX E: INSTITUTIONAL REVIEW BOARD APPROVAL

ACTION ON PROTOCOL CONTINUATION REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu | lsu.edu/irb

TO: Neila Donovan
COMD

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: February 1, 2016

RE: **IRB#** 3471

TITLE: Treating attention in and individuals with Parkinson's disease using Attention Process Training-III

New Protocol/Modification/Continuation: Continuation

Review type: Full ___ Expedited _X_ **Review date:** 1/29/2016

Risk Factor: Minimal ___X___ Uncertain _____ Greater Than Minimal_____

Approved_____X_____ **Disapproved**_____

Approval Date: 1/29/2016 **Approval Expiration Date:** 1/28/2017

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 25

LSU Proposal Number (if applicable):

Protocol Matches Scope of Work in Grant proposal: (if applicable) ___

By: Dennis Landin, Chairman _____

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE:**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

VITA

Mora Johanna Mahoney is a native of coastal California. She received her first bachelor's degree in Social Science in 2010 from California State University, San Marcos. After graduation she worked teaching English as a second language. In 2012 she made the decision to pursue a career in speech-language pathology. She earned a second bachelor's degree in Communication Disorders and Deaf Education from Utah State University in 2013. Mora plans to graduate from Louisiana State University with her MA in Communication Sciences and Disorder in May of 2016.