

2011

Treatment effects of attention process training for an individual with idiopathic Parkinson's disease

Erin Renee' Guillory

Louisiana State University and Agricultural and Mechanical College

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TREATMENT EFFECTS OF ATTENTION PROCESS TRAINING FOR AN INDIVIDUAL
WITH IDIOPATHIC PARKINSON'S DISEASE

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Communication Sciences and Disorders

by
Erin Renee' Guillory
B.A., Louisiana State University, 2009
May 2011

ACKNOWLEDGEMENTS

This experience would not have been the same had it not been for a few select individuals advising and helping me along the way. To Dr. Neila Donovan, my thesis advisor, words cannot express the gratitude for the encouragement, patience, and guidance you have provided during the past year. To my other committee members, Drs. Paul Hoffman and Brittan Barker, thank you for your time, suggestions, and professional insight regarding this thesis. I would also like to thank Meghan C. Savage who, in the midst of completing her dissertation, never failed to help with charts, graphs, and wording or to give advice on all things thesis and non-thesis related. To my family, who has pushed me to go above and beyond what has been expected of me, I cannot thank you enough for your support and encouragement every step of the way. To my COMD ladies, graduate school would certainly not have been the same without each and every one of you. Thank you for always sticking around, the endless nights spent here to finish reports and projects, and always being there to celebrate another semester down. You all hold a special place in my heart. To Sadie and Caroline, even though you had absolutely no clue what I was talking about, you were always there to listen, and I can never thank you enough for that. Last, but most definitely not least, to Chris, you were always there to listen to those stories that never seemed to have a point, have picnics in the living room, and wipe the tears away when my to-do list became too long. It seemed as if this day would never get here, but, now that it has, this is what I have to show for it.

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ABSTRACT

Parkinson's disease (PD) is characterized by a degeneration of the substantia nigra, resulting in a loss of dopaminergic neurons. Cognitive impairments, evident in 72% of people with PD (PWP) are indicated by deficits in visuospatial capacity, memory, executive functioning, and attention (Cooper, Sagar, Jordan, Harvey, & Sullivan, 1991; Duffy, 2005). Unfortunately, to date, there is little research that demonstrates improvement of these cognitive processes, particularly those affecting memory recall and attentional skills.

The purpose of this study was to examine the effects of utilizing Attention Process Training (APT; Sohlberg & Mateer, 2005), a therapeutic protocol designed for individuals who have sustained a traumatic brain injury (TBI), on a person with Parkinson's disease to determine if improvement of various attentional processes and memory recall could be improved. The protocol set forth by Sohlberg & Mateer (2005) was administered to a PWP in 12 hours of treatment, targeting sustained, selective, and alternating attention.

Evidence for treatment effect could not be determined. However, the participant did reach criteria on sustained and selective attention tasks of increasing complexity. Due to the study's time constraints, the participant received only three sessions of alternating attention and no divided attention training. From visual inspection of baseline probes for alternating and divided attention, it appeared that the participant was able to stabilize performance on percent correct and decrease his response time after receiving just sustained and selective attention training. Similar findings appeared for divided attention tasks. Changes in functional attention everyday attention measured by the *Test of Everyday Attention* (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994) were minimal. The most significant improvement in attentional processes was noted on the *APT II Attention Questionnaire* (Sohlberg, Johnson, Paule, Raskin, & Mateer, 2001), a self-report measure. The literature points toward the notion that training attention is

foundational, and leads to improvement in working memory. Our results seem to bear this out, in that the participant improved on OSPAN and RSPAN automated working memory tasks (Unsworth & Spillers, 2010).

LITERATURE REVIEW

Approximately 500,000 Americans suffer from the chronic, progressive neurological condition that is Parkinson's disease (PD), with 50,000 new cases diagnosed annually (National Institute of Neurological Disorders and Stroke [NINDS], 2006). PD is characterized by a degeneration of the substantia nigra, resulting in a loss of dopaminergic neurons. Cognitive impairments, evident in 72% of people with PD (PWP), are indicated by deficits in visuospatial capacity, memory, and overall executive functioning (Cooper, Sagar, Jordan, Harvey, & Sullivan, 1991; Duffy, 2005). Such cognitive deficits, unlike the movement disorders commonly associated with PD, are not affected by dopaminergic medications (Chaudhuri, Healy, & Schapira, 2006), and, in fact, may even be antagonized by drug therapy (Cools, 2006; Park & Stacy, 2009). Unfortunately, little research exists on treatment available to remediate impaired cognitive processes (Chaudhuri et al., 2006), particularly treatments that ameliorate attentional control deficits in PWP.

Patterns of impaired cognitive function presented by PWP are consistent with the cognitive deficits resulting from frontal lobe damage (Lees & Smith, 1983), such as that of traumatic brain injuries (TBI), the result of external forces inflicted primarily on the inferior and lateral surfaces of the frontal and temporal lobes (Murray & Clark, 2006). Such an insult to the brain results in physical, cognitive, emotional, and behavioral impairments. Above all, cognitive deficits are indicated in the following areas: attention, memory, and overall executive functioning. Impairments of complex attentional skills are noted to persist long into rehabilitation and negatively contribute to other cognitive and communicative abilities, such as memory and executive function, and topic maintenance or switching, respectively (Murray & Clark, 2006).

Research is centered on a treatment program targeting the attentional deficits incurred from TBI known as Attention Process Training (APT; Sohlberg & Mateer, 2005). APT attempts to improve attentional deficits, and thus cognitive and communicative difficulties, by targeting four cardinal areas of attention commonly impaired as a result of TBI: sustained attention, selective attention, alternating attention, and divided attention (Sohlberg & Mateer, 2005). Unfortunately, the APT protocol is designed solely for attentional deficits presented in individuals with TBI. However, since PWP present with attentional deficits known to rely on frontal lobe functions, similar to attentional deficits associated with TBI comparable to the deficits associated with frontal lobe damage (Cools, 2006; Dujardin, Degreef, Rogelet, Defebvre, & Destee, 1999; Muslimovic, Post, Speelman, & Schmand, 2005; Owen, 2004; Spencer, Sanchez, McAllen, & Weir, 2010), this population may benefit from attentional control training. Due to the prevalence of cognitive impairments in PD, it must be determined whether or not the APT therapy protocol could be used with this population to improve attention deficits resulting from PD.

The current study's purpose was to determine if APT is an appropriate treatment strategy for a single PWP, a first step toward determining the efficacy of extending this treatment program to a population other than individuals with TBI, for whom treatment efficacy has already been established (Sohlberg & Mateer, 2005). This study was based on three areas of research. First, PD and the types of cognitive impairments associated with the disorder are described. Second, attention and the specific attentional deficits associated with PD are discussed. Third, APT and its relation to PWP are described.

Parkinson's Disease

Although the etiology of idiopathic PD (the majority of identified cases) is unknown, some studies have found evidence of PD related to genetic mutations, viruses, or environmental toxins, such as drugs or pesticides (NINDS, 2006; Schapira, 2009). The impairments specific to PD result from decreased dopaminergic neuron levels secondary to degeneration of the substantia nigra (NINDS, 2006). Lowered dopaminergic neuron levels have also been linked to abnormal functioning of other cortical and subcortical areas of the brain, such as the frontal lobe, and the putamen and globus pallidus, respectively (Owen, 2004; Murdoch & Whelan, 2009; Watts & Koller, 2004). Four cardinal symptoms are associated with this degenerative disease: tremor, rigidity, bradykinesia, and postural instability. Tremors are manifested as a trembling of the extremities at rest which decrease during purposeful movement. Rigidity refers to the stiff posture of the trunk and limbs musculature. Bradykinesia is evident by a reduced speed of movements. Finally, postural instability is clinically represented as imbalance and falling. Besides movement disorders per se, PWP may also demonstrate hypokinetic dysarthria, micrographia, dysphagia, and depression (Duffy, 2005).

Although depletion of dopaminergic neurons is most commonly associated with PD, the cholinergic, adrenergic, and serotonergic neurotransmitter systems may also degenerate (Schapira, 2009). Impaired functioning of the striato-prefrontal loop, resulting in frontal lobe dysfunction, is apparent in PD (Dujardin et al., 1999). Owens (2004) has hypothesized that depletion of dopaminergic cells in the prefrontal cortex combined with deterioration of the mesocortical dopaminergic system observed in PD may significantly influence executive functioning in PWP. Specifically, it appears that the cognitive declines in PD are manifested in

deficits of attention, executive functioning, memory, and visuospatial processing (Muslimovic et al., 2005).

Once thought to be simply a movement disorder, investigators are reporting a growing assortment of cognitive, neuropsychiatric, sleep, and autonomic/sensory disorders (Park & Stacy, 2009). Specific cognitive impairments found in PWP resemble deficits resulting from frontal lobe damage, such as traumatic brain injury (TBI), and include deficits in information processing (especially visuospatial), attentional control, and executive function. Decreased controlled allocation of attention resources, planning, working memory, trial-and-error learning, and response monitoring; visuospatial deficits; impaired problem-solving abilities; slowed information processing (bradyphrenia); and set-shifting deficits are particularly noticeable (Levin, Llabre, & Weiner, 1989; Owen, 2004; Park & Stacy, 2009; Spencer et al., 2010; Stuss & Knight, 2002; Watts & Koller, 2004). Moreover, Owens (2004) reported that other higher-level executive function impairments, such as manipulation of a set of stimuli (e.g. recalling letters of the alphabet and rearranging the order in which they were presented), degenerated at a faster rate than did basic executive functions, such as retrieval of a set of stimuli (e.g. simply recalling letters of the alphabet). Observed language deficits are subtle and include difficulty with implied information, inference generation, semantics, decreased language content, and reduced syntactic complexity as a result of disruption in cognitive circuits controlled by the basal ganglia, thalamus, and prefrontal cortical areas (Spencer et al., 2010). Psychosis, depression, anxiety, fatigue, apathy, sleep dysfunction, autonomic disturbances, such as nausea and excessive sweating, and sensory disturbances, such as olfaction impairment and restless leg syndrome, also accompany the motor, cognitive, and language impairments evident in PD (Park & Stacy, 2009).

Attention is conceptualized as a fundamental cognitive process. Without adequate attentional control processes, higher-level cognitive processes cannot be successfully engaged.

Attention

Attention refers to a class of mental processes that allows an individual to focus on specific stimuli; some components influence intensity, such as alertness, while others focus on selectivity, as evident by selective and divided attention (Bhatnagar, 2008; Pero, Incoccia, Caracciolo, Zoccolotti, & Formisano, 2006). Attention has been conceptualized by some as four components that build upon one another: sustained attention, selective attention, alternating attention, and divided attention. Sustained attention refers to an individual's capability to maintain focus on a stimulus set over a specific period of time. Selective attention requires the ability to selectively attend to specified stimuli while ignoring others. Alternating attention refers to the ability to alternate focus between two or more sets of stimuli presented simultaneously. Divided attention is the ability to focus on two or more concurrent events (Weber, 1990). Each component of attention requires control, the ability to direct attention to a specific set of stimuli and capacity, the extent to which an individual can attend to information in an extended period of time, and control, the ability to direct attention to a specific set of stimuli. Control and capacity are dependent on each other, in that limited control capability results in reduced capacity of attention (Weber, 1990).

Deficits incurred from impairments in attentional control greatly influences an individual's social adjustment, ability to learn new material, and ability to recall information, as attention processes form the foundation of higher mental functions (Weber, 1990). Attentional deficits, specifically those of control and capacity, have been identified as the most common behavioral impairment in individuals with TBI sustaining frontal lobe damage. Individuals often

present with a combination of impaired control deficits also found in PWP (Owen, 2004; Weber, 1990). Deficits in control are often indicated by difficulty in maintaining attentional focus and alternating such focus appropriately between stimuli sets, and inability to maintain conversational topics, thoughts, and actions. Deficits in capacity result in a reduced ability to continuously attend to information over a time period, therefore requiring additional processing time for information and has implications for both encoding and retrieval of information.

Research indicates that attentional control is the foundation of working memory capacity, defined as the mental processes that hold a limited amount of information that can be temporarily retrieved at a specific point in time (Cowan et al., 2005). Various working memory models suggest that attentional control and the size of the focus of attention are major components of working memory (Unsworth & Spillers, 2010). Unfortunately, attentional deficits may go unrecognized or misdiagnosed because they may be masked by the presence of memory impairments (Ponsford, 1988; Sohlberg & Mateer, 1987). Ponsford and Kinsella (1988) hypothesized that attention, learning, and memory were actually not discrete processes but were inter-related and dependent on one another. Their research demonstrated that memory impairments were also associated with decreased attention allocation (Ponsford & Kinsella, 1988). According to Russell and D'Hollosy (1992), both short-term and long-term memory are entirely reliant on attentional processes. Attentional processes are constrained in nature; contrarily, memory is not hypothesized to have the same constraints. However, memory capacity may be limited in situations where presented information cannot be properly stored due to a high degree of interference from extraneous stimuli (Cowan, 2005). Thus, memory and other cognitive abilities rely upon the availability of attentional resources. In order to effectively recall information, attentional processes must be focused during the initial encoding phase and

subsequent recollection of that information (Cowan, 1995). Therefore, ameliorating attentional deficits prior to rehabilitating memory deficits may be critical.

It is only within the past several decades that researchers have begun to recognize, confirm, and document the cognitive deficits associated with PD, once thought to be primarily a movement disorder (Lees & Smith, 1983). Currently, researchers recognize that PWP present with a wide range of cognitive deficits. Of those deficits, attentional impairments has gained researchers' attention. In a study conducted by Martinez-Martin et al. (2007), almost 46% of participants diagnosed with PD reported decreased attention, particularly difficulty concentrating and staying focused on a topic. Set-shifting impairments, such as difficulty suppressing automatic responses to specific stimuli, are most commonly associated with the attentional deficits in PD (Cronin-Golomb, Corkin, & Growdon, 1994). Specifically, PWP present with impairments in the following areas: alternating attention between two or more presented tasks, deficits in "shifting-aptitude" as evidenced by the inability to shift between stimuli sets and organize each set appropriately, impairment of attentional capacity, and deficits in sustained attention as evidenced by difficulty in maintaining and organizing a recently shifted topic. Such deficits are possibly due to an inability to utilize internal, or self-directed cues for attentional control (Brown & Marsden, 1988; Cools, Van den Bercken, Horstink, Van Spaendonck, & Berger, 1984; Downes et al., 1989; Dujardin et al., 1999; Owen et al., 1992; Park & Stacy, 2009; Piccirilli, D' Alessandro, Finali, Piccinin, & Agostini, 1989; Spencer et al., 2010).

The decreased attentional resources found in PWP resemble the attentional deficits incurred from frontal lobe damage in individuals who have sustained diffuse brain pathology and focal cerebral lesions as determined by examinations and tasks sensitive to frontal lobe injury (Dujardin et al., 1999; Owen, et al., 1992; Piccirilli et al., 1989). Like PWP, individuals with

TBI often exhibit impairments in sustained, selective, and alternating attention such as a decreased ability to maintain topic selection, ignore extraneous stimuli, and to alternate focus between two or more stimuli as a result of diffuse frontal lobe injury (Mathias, Beall, & Bigler, 2004; Murray & Clark, 2006).

Attention Process Training

Specific attentional deficits require specific training, especially when basic attention functions are involved (Sturm, Willmes, Orgass, & Hartje, 1997). Therefore, in an attempt to reduce the attentional deficits associated with TBI, Sohlberg and Mateer (1987) developed a treatment plan that systematically orders attentional training as determined by a pre-established intervention model, targeting four components of attention: sustained attention, selective attention, alternating attention, and divided attention. Sustained attention is the ability to consistently maintain specific behavioral responses during repetitive or continuous activities. Sustained attention tasks include cancellation tasks (e.g. crossing out a specific letter/number from a group of letters/numbers) and selection of a target stimulus from a group of stimuli through the use of auditory cues. Selective attention involves the cognitive processes necessary to exclude extraneous information when discrimination of stimulus items is required. Selective attention tasks include utilizing cancellation tasks, such as selecting a specific shape from a group of shapes, with the addition of masking sheets to distract the participant. Alternating attention entails the mental capabilities essential to switching between different cognitive tasks. Appropriate tasks call for the participant to alternatively select two target stimulus items from cancellation tasks. Divided attention tasks require the individual to attend simultaneously to multiple presented tasks. Divided attention tasks require the individual to select specific stimuli as acoustic cues are presented simultaneously (Pero et al., 2006). Typically, specific attentional

deficits are identified, and tasks are selected in which at least 50% accuracy is obtained. Selected tasks are continued until an accuracy rate of at least 85% is achieved, upon which a higher level task is introduced. Each level is targeted hierarchically (i.e., the treatment progresses from easy tasks to difficult tasks).

Researchers demonstrated that individuals with TBI who received APT improved significantly in facilitation of coping strategies for cognitive deficits (Pero et al, 2006). In a study conducted by Sohlberg and Mateer (1987), the standard APT protocol was utilized with four participants with TBI and varying degrees of attentional deficits. The two participants with mild to moderate attentional deficits demonstrated attentional skills within normal limits upon completion of APT as measured by scores obtained from the *Paced Auditory Serial Addition Task* (PASAT; Gronwell, 1977). The remaining two subjects with severe attentional deficits demonstrated mild attentional deficits following completion of APT. Another study conducted by Sohlberg, McLaughlin, Pavese, Heidrich, and Posner (2000) compared the standard APT protocol with an educational and support methodology used to ameliorate attentional deficits associated with TBI. Fourteen participants were divided into two groups, one group received ten weeks of APT and the other group received ten weeks of brain injury education. Results indicated improvement for both groups; however, the group receiving brain injury education demonstrated greater psychosocial functioning, while the group receiving APT demonstrated greater cognitive function in memory and attention. Pero, Incocchia, and colleagues (2006) examined the effects of APT in two participants with TBI. Both participants demonstrated significant changes in attentional behaviors in their study. Conversely, a study conducted by Park, Proulx, and Towers (1999) did not find similar results. While improvements were noted for each of the 23 participants, increased performance levels were not significantly different from

the control group receiving no treatment. The researchers suggested improvement was due to the participants' learning new skills necessary for attentional control. However, it should be noted that baseline measures obtained from the PASAT were taken often, and sensitivity to repeated presentations of the test may have occurred, thus skewing results (Pero et al., 2006). With the exception of the study conducted by Park et al. (1999), these studies demonstrate significant efficacy for APT. Although APT has been widely used in cognitive rehabilitation of individuals with TBI for at the least the past twenty years, the results presented here comprise the sole evidence for the treatment's efficacy.

The current study represents the first attempt to determine the treatment effect of APT for a PWP presenting with decreased attentional control. Although the type of injury and resulting neuroanatomical injury differ between TBI (improving trajectory) and PD (degenerative trajectory), both result in attention disorders which have been associated with frontal lobe dysfunction. While still using the principles described by Sohlberg and Mateer (2005), the current study aimed to follow the standard APT protocol but manipulate the population to which it is administered in order to determine if treatment is effective using an established attention training model. Improvements in working memory (as a secondary effect) were also examined in this study. The research questions to be answered upon completion of this study were:

1. Is there a treatment effect for sustained, selective, alternating and divided attention following 16 sessions of APT?

We hypothesized that improvement would be demonstrated based on the literature that shows improvement in other populations with frontal lobe disorders like TBI.

2. Is there a change in secondary outcome measures of attention following 16 sessions of APT as follows:

- a. *Test of Everyday Attention (TEA)* (sustained, selective, alternating, and divided attention)

We hypothesized that improvement would be demonstrated based on the literature that showed improvement with other populations with frontal lobe disorders like TBI.

- b. *APT II Attention Questionnaire* (a self-report for attentional control)

We hypothesized that ratings of attentional control would improve based on that literature that shows improvement with other populations with frontal lobe disorders like TBI.

3. Is there a change in outcome measures of working memory following 16 sessions of APT per OSPAN and RSPAN automated working memory tasks?

We hypothesized that an improvement of working memory would be observed upon the completion of the APT protocol due reports from the literature suggesting that improvement of attentional deficits may result in improvement of memory recall.

4. Is there a change in secondary outcome measures of attention one month post-treatment as follows:

- a. *TEA*

We hypothesized that improvement would be demonstrated based on the literature that showed improvement with other populations with frontal lobe disorders like TBI.

b. *APT II Attention Questionnaire*

We hypothesized that ratings of attentional control would improve based on that literature that shows improvement with other populations with frontal lobe disorders like TBI.

5. Is there a change in outcome measures of working memory one month post-treatment per OSPAN and RSPAN automated working memory tasks?

We hypothesized that an improvement of working memory would be observed one month upon the completion of the APT protocol due reports from the literature suggesting that improvement of attentional deficits may result in improvement of memory recall.

METHODS

Robey (2004) describes a systematic means by which clinical outcome research can be classified utilizing a five-phase model. A phase I (pre-efficacy) study is used to determine the therapeutic effect of a treatment and, if present, explore the extent of effect. Case studies, exploratory single-subject design studies, small group studies, and retrospective studies are appropriate for this phase. This was a prospective, Phase I, multiple baseline, single-subject study to determine if a treatment effect exists for APT when it is administered to a participant with PD and attention deficits. The Louisiana State University (LSU) Institutional Review Board for the protection of human subjects approved this study's proposal prior to the enrollment of the participant and data collection. Informed consent was obtained from the participant preceding commencement of data collection.

Participant

One male participant presenting with idiopathic PD and self-reported attentional deficits was recruited for this study from the Baton Rouge Parkinson's Disease Support Group based on the following inclusion criteria: (1) diagnosis of PD as determined by a neurologist, (2) no history or evidence of neurologic or neurodegenerative disease other than PD, (3) a Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975) score >24, (4) an Apathy Scale (Starkstein et al., 1992) rating <14, (5) a Hoehn & Yahr Rating of Parkinson's disease (Hoehn & Yahr, 1967) 1-3, (6) a Geriatric Depression Scale (GDS) Short Form (Sheikh & Yesavage, 1986) score of <10, (7) corrected or uncorrected visual acuity of 20/100 in the better eye as determined by the Rosenbaum pocket vision screener (Rosenbaum, 1982), (8) adequate hearing as determined by patient report and conversational analysis, and (9) a self-reported concern about

attention skills. Subjects were excluded from the current study based on the following criteria: (1) dementia, (2) apathy, or (3) depression.

Based on the inclusion criteria, one participant with PD, a 68-year-old Caucasian male (P01), was recruited for this study. He received a diagnosis of PD in 2006. Participant characteristics are summarized in Table 1.

Table 1. Participant characteristics.

Characteristics	P01
Age in years	68
Years post-diagnosis	5
MMSE Score*	27
Apathy Scale Rating (Starkstein et al., 1992)	3
Geriatric Depression Scale Score (Sheikh & Yesavage, 1986)	2
Hoehn & Yahr Rating (Hoehn & Yahr, 1967)	1
Rosenbaum Vision Screening (Rosenbaum, 1982)	20/100
Hearing Screening	Passed

*MMSE = Mini Mental State Examination (Folstein et al., 1975)

Design

A multiple baseline A-B-A-A design was utilized in the current study to examine the effects of APT in PWP. In an attempt to answer the experimental questions, the present study investigated the effect of an attention training model on attentional deficits resulting from a diagnosis of PD during APT tasks specifically targeting area(s) of deficits as well as the effect on memory recall. The dependent variable will measure number of errors on each stimulus sheet, number of seconds needed to complete each stimulus sheet, and number of false positive

responses (if necessary) by recording percent correct obtained on each task as well time needed to complete each task.

Pre-test, post-test, and follow-up testing used three secondary outcome measures to examine the impact of APT on the level of attentional control in PWP: the *Test of Everyday Attention (TEA)* (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994), the *APT-II attention questionnaire* (Sohlberg, Johnson, Paule, Raskin, & Mateer, 2001), and automated working memory tasks (Unsworth & Spillers, 2010). The *TEA* is a diagnostic battery with established validity and reliability (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1996). It was developed to assess attentional control deficits in adults aged eighteen to eighty years and recognize patterns of attentional deficits with various populations, primarily TBI. It utilizes eight subtests to measure four areas of attentional abilities: sustained attention, selective attention, attentional switching and auditory-verbal working memory. The *TEA* was used to identify specific areas of attentional deficits. A summary of the *TEA* is provided in Appendix A.

The *APT-II Attention Questionnaire* is a self-report survey used to determine an individual's self-perception of attention deficits (Sohlberg et al., 2001). In this self-report, the participant selects the statement that best describes attentional deficits in twelve various activities of daily living (ADLs). It also contains a section for the participant to specifically list the five most problematic events in which attentional deficits occur and describe reactions to such breakdowns. Appendix B includes the questionnaire and scoring conventions.

Complex span tasks include operation and reading span tasks and are designed to assess working memory capacity (Unsworth & Spillers, 2010). Operation span (OSPAN) tasks require an individual to solve a series of mathematical calculations while simultaneously being visually presented with a set of unrelated letters. Upon completion of these calculations, the individual

must recall each letter in the order in which they were presented. Reading span (RSPAN) tasks require an individual to determine whether a sentence is logical while concomitantly attempting to remember a set of unrelated letters. Upon completion of the exercise, the set of unrelated letters must be recalled in the order presented. These tasks consist of three sets of each set-size, ranging from three to seven, for a total of 75 letters and 75 sentence problems. Participants are instructed to maintain an accuracy level of 85% consistently. These tasks are designed to examine an individual's ability to store information while simultaneously being required to perform additional tasks.

The primary and secondary outcome measures provided a comprehensive examination of treatment effects and behavioral change for the participant, analyzing the specific types of attentional deficits present and the effect such deficits have on the subject's participation in daily life.

Procedures

Both the assessment and treatment phases of this study took place in the LSU Speech, Language, and Hearing Clinic. Treatment was administered by a second-year SLP graduate clinician trained by a certified SLP with expertise in the assessment and treatment of adults with cognitive and communicative disorders. All assessment and treatment procedures were completed in a quiet room with minimal distractions. The treatment protocol was conducted in the following manner.

During the pre-treatment phase (A1), the primary and secondary outcome measures described above was administered to the participant. Attentional deficits were identified based on test results. Baseline data was established over two sessions for percentage of accuracy on attention task(s). The participant completed 45 minutes of therapy, twice a week, for a total of

16 treatment sessions and 12 hours of treatment. This 16 session treatment phase (B) was immediately followed by one post-testing session (A2) in which the participant received readministration of administration of the secondary outcome measures. The participant did not receive therapy during the one month post-testing phase (A3) but was encouraged to continue utilizing the skills learned during APT. After completion of the one month post-treatment phase, follow-up testing, identical to post-testing, occurred. Refer to Figure 1.

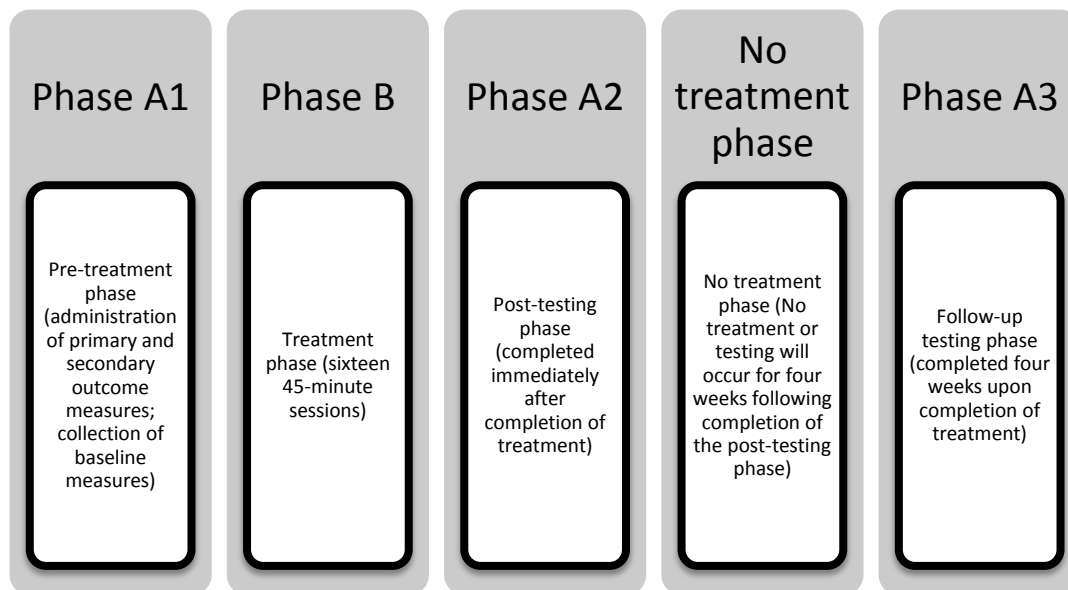


Figure 1. Represents the ABAA single subject design used in this study.

Treatment Protocol

The study adhered to the APT hierarchical treatment protocol established by Sohlberg and Mateer (2005). Tasks were selected from areas that indicated attentional deficits per the *TEA* protocol, and level of task difficulty was assigned on a criterion of minimally 50% accuracy on the presented task. The participant received training for each task using samples of questions and directions to ensure comprehension of tasks. Tasks were repeatedly administered until an accuracy level of 85% was achieved over two consecutive presentations **and** a minimum 35% decrease in time was obtained over three consecutive presentations. When criterion was reached,

task difficulty increased. However, if the participant did not reach criteria after 15 consecutive presentations, the task was abandoned, but task difficulty increased. The participant completed each task according to the instructions received from the primary investigator (PI). Responses obtained from the participant were collected and scored upon completion of each session according to the protocol set forth by the APT manual. For a complete listing of targeted tasks, see Appendix C.

Depending on the task presented, data was collected on number of errors and time in seconds needed to complete each stimulus sheet obtained on each stimulus sheet.

Data Analysis

Intra-rater reliability was established by the PI reanalyzing data collected from three randomly selected treatment activities through video and audio recordings, which reflected 23% of data collected from primary outcome measures. Inter-rater reliability was established through the use of a research assistant simultaneously collecting data with the PI during three randomly selected treatment sessions, which reflected 19% of data collected from primary outcome measures.

To answer questions about treatment efficacy (1), visual inspection of data collected during pre-treatment assessment and throughout the treatment protocol was used to compare baseline measures with treatment measures. All changes in primary and secondary outcome measures were descriptively reported.

RESULTS

The participant attended all 16 therapy sessions, resulting in the maximum total of 12 hours of therapy.

Reliability

Intra-rater reliability was established by the PI reanalyzing data collected from three randomly selected treatment activities within three treatment sessions for average percent correct responses through video and audio recordings (see Table 2).

Table 2. Intra-rater reliability.

	Tasks	Actual Score	Reviewed Score	Percent Agreement
	Number			
Session 1	cancellation (sustained attention)	99%	95%	95.96%
	Attention CDs			
Session 2	(selective attention)	63%	63%	100%
	Flexible shape			
Session 3	cancellation (alternating attention)	97%	97%	100%

Inter-rater reliability was established through the use of a research assistant simultaneously collecting data for average percent correct with the PI during three randomly

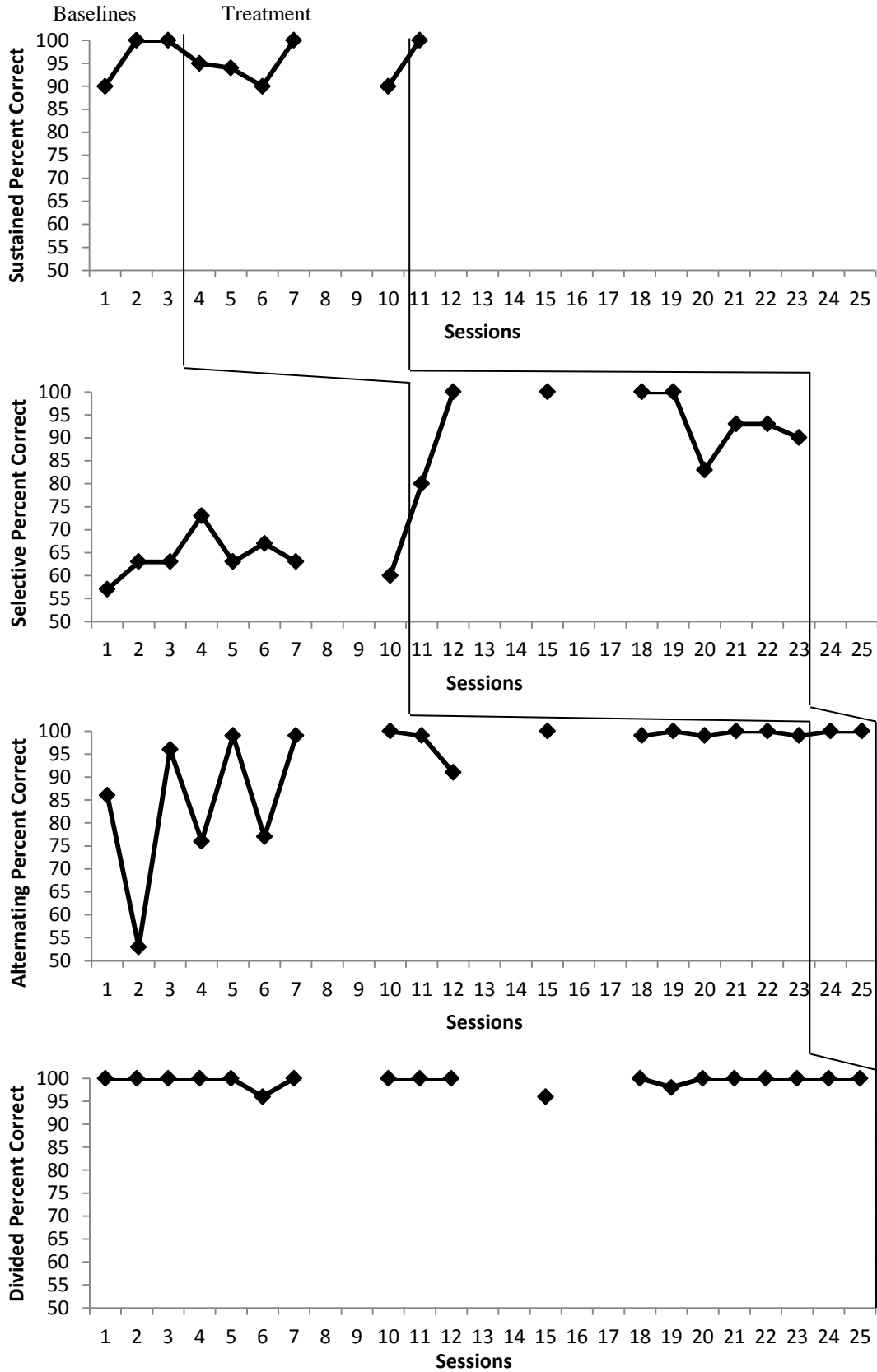
selected tasks within 3 treatment sessions. (See Table 3) Point-to point comparisons of responses were compared to derive percent agreement.

Table 3. Inter-rater reliability.

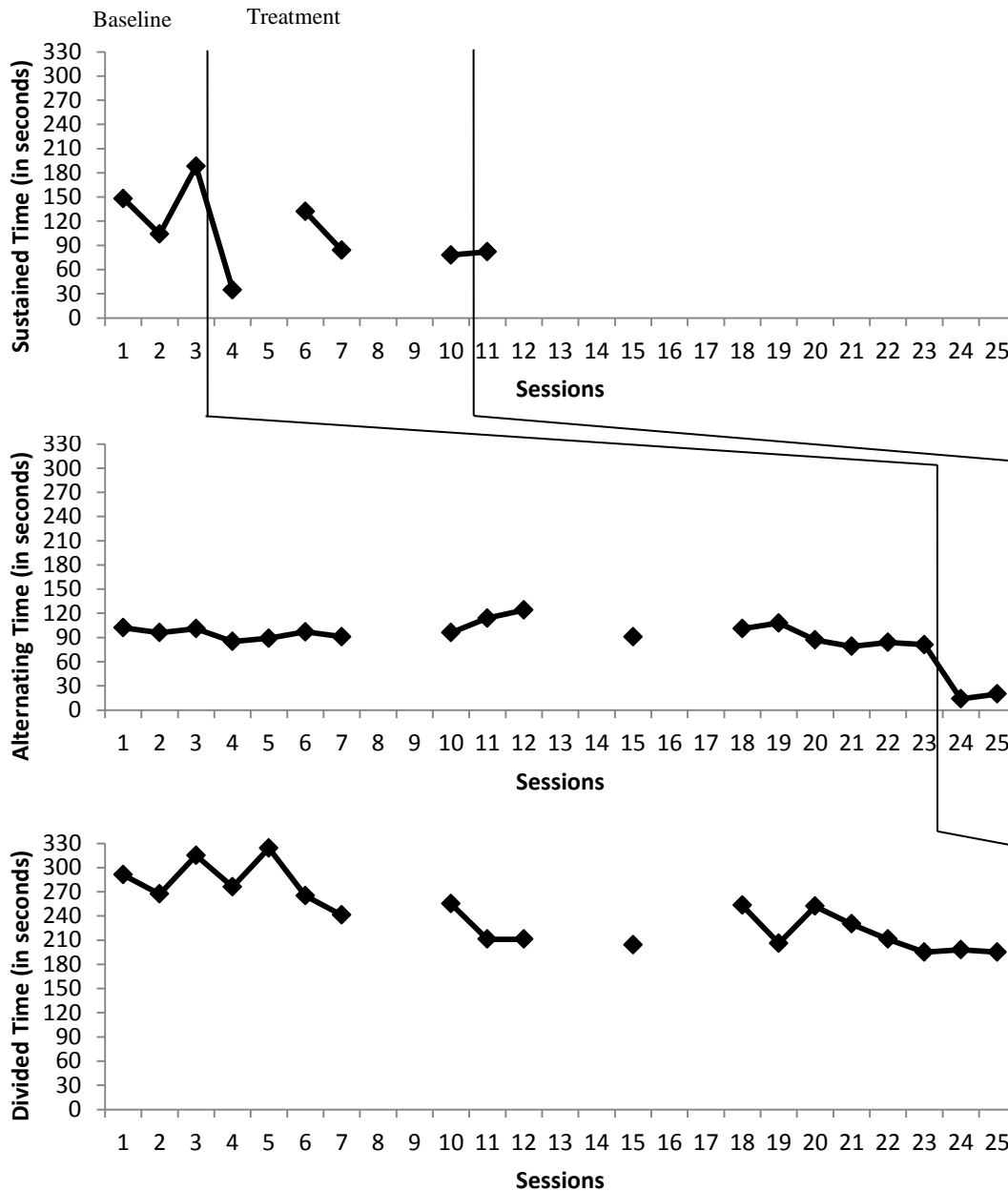
	Tasks	Actual Score	Reviewed Score	Percent Agreement
Session 1	Serial Numbers (sustained attention)	95%	95%	100%
Session 2	Number cancellation with distractor overlay (selective attention)	98%	98%	100%
Session 3	Flexible number cancellation (alternating attention)	98%	98%	100%

Experimental Questions

1. Is there a treatment effect for sustained, selective, alternating, and divided attention following 16 sessions of APT? See Graph 1 for percent accuracy on tasks across the attentional components. See Graph 2 for comparable timed data. For a more thorough analysis of data by percent and time, please refer to Appendix D where the raw data for all treatment tasks are graphed and criteria are noted.



Graph 1. Percent of accuracy on APT tasks.



Graph 2. Time (in seconds) of APT tasks. Sustained Attention task 5 and the Selective Attention tasks did not include a timed component.

For percent of accuracy on APT tasks, empty data points signify treatment sessions that were missed due to holidays or illness. Baseline measures and treatment tasks in sustained attention remained stable over the course of treatment and maintain an accuracy of 90% or greater. Selective attention baseline measures maintained a percent of accuracy between 55%

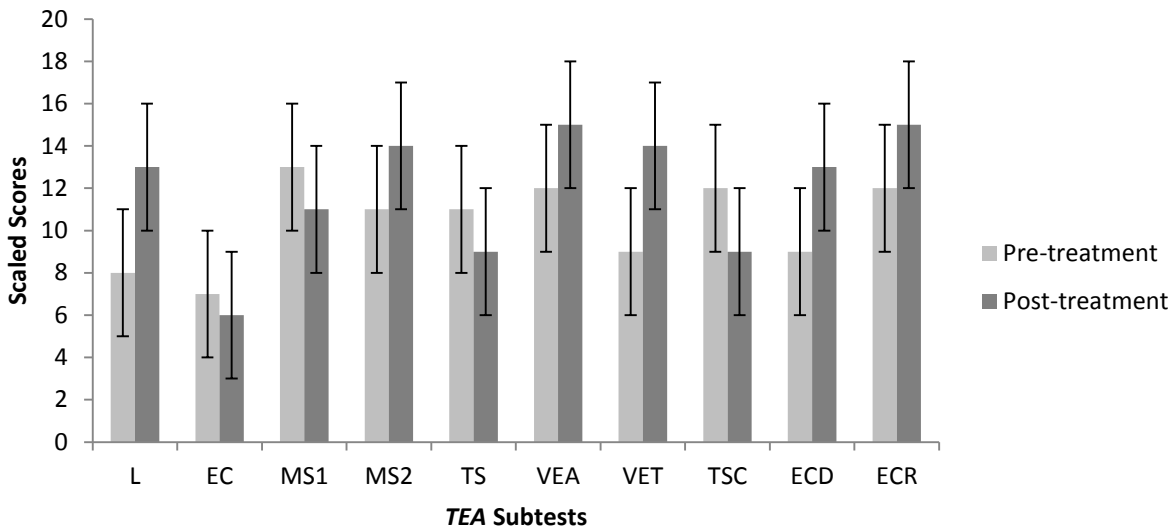
and 80%. However, treatment tasks increased level of percent of accuracy and maintained a high level of accuracy over the course of treatment. Alternating attention baseline measures fluctuated in the early stages of treatment. However, as lower levels of attention were targeted in treatment, alternating attention baseline measures increased and maintained a high percent of accuracy. Alternating attention treatment tasks also maintained a high percent of accuracy. Baseline measures of divided remained higher than 95% accuracy throughout treatment, though this area of attention was never targeted.

Graph 2 represents the timed component for task performance. As in Graph 1, empty data points in Graph 2 indicate missed treatment sessions. Selective attention is not represented on this graph because tasks did not include a timed component. To meet criteria the participant had to reduce his timed performance on tasks by 35% over three consecutive presentations. On the sustained attention baseline measures, timed performance fluctuated. When treatment began, and hierarchical training began with easier tasks administered first, timed performance improved immediately (see sustained attention session 4). Time increased as more difficult tasks were administered but decreased to meet criteria on sustained attention tasks. Alternating attention baseline measures remained stable throughout treatment suggesting that sustained and selective attention training had little effect on alternating attention. The decreased time to complete alternating attention tasks decreased when treatment began because simple tasks were initiated first. Divided attention baseline time measures fluctuated at the start of APT. However, visual inspection indicated that over the course of the treatment of the other attention processes, the participant's ability to perform divided attention tasks more quickly increased. The implications of this finding will be discussed further.

3. Is there a change in secondary outcome measures following 16 sessions of APT?

TEA

The *Lottery* and *Elevator Counting* subtests analyzed changes in sustained attention. These subtests measure an individual’s ability to focus attention on a relatively unchanging task. Scaled scores from the *Lottery* (L) subtest at pre-treatment and post-treatment were 8 and 13, respectively. Raw scores of the *Elevator Counting* (EC) subtest obtained at pre-treatment revealed 7 of 7 correctly counted strings of beeps, resulting in a rating of “normal.” Scores of the *Elevator Counting* subtest obtained at post-treatment revealed 6 of 7 correctly counted strings of beeps, resulting in a rating of “possibly abnormal.” However, it should be noted that the normative sample occasionally obtained one error on this subtest, and therefore, scores falling in this range do not necessarily denote abnormality. Results of the *TEA* indicated improvement in scaled scores on subtests targeting sustained attention. See Graph 3 for a comparison of pre-treatment and post-treatment scaled scores. Scaled scores have a mean of 10 and a standard deviation of ± 3 .



Graph 3. *TEA* pre-treatment and post-treatment scaled scores.

Scaled scores from the *Map Search* (MS) and *Telephone Search* (TS) subtests of the *TEA* were used to analyze changes in selective attention skills. These subtests measure an individual's ability to select pertinent information while ignoring irrelevant stimuli. Scaled scores from the *Map Search* subtest at one minute (MS1) at pre-treatment and post-treatment were 13 and 11, respectively. Measures obtained from the two-minute interval (MS2) revealed a scaled score of 11 at pre-treatment and a score of 14 at post-treatment. Scaled scores and percentile rankings from the *Telephone Search* (TS) at pre-treatment and post-treatment revealed a scaled score of 11 and 9, respectively. Unfortunately, none of these comparisons resulted in change in targeted attention skills when the standard deviations are taken into consideration.

Scaled scores from the *Visual Elevator* subtest of the *TEA* analyzed changes in alternating attention. This subtest has two components, accuracy and timing, that measure an individual's ability to quickly alternate between two topics. The participant obtained a scaled score of 12 on the *Visual Elevator* accuracy (VEA) subtest at pre-treatment and 15 at post-treatment testing. On the *Visual Elevator* timing (VET) subtest, the participant obtained scaled scores of 9 and 14 at pre-treatment and post-treatment, respectively. See Graph 3. Again, no change was indicated when scores were compared.

Scaled scores obtained from the *Telephone Search While Counting* subtest of the *TEA* were used to analyze changes in divided attention. The *Telephone Search While Counting* (TSC) subtest measure an individual's ability to complete two tasks simultaneously. Scaled scores obtained at pre-treatment and post-treatment were 12 and 9, respectively. Results from the *TEA* did not indicate improvement on scaled scores on the subtest targeting divided attention. Scaled scores obtained from the *Elevator Counting with Distraction* and *Elevator Counting with Reversal* subtests analyzed changes in auditory-verbal working memory. These subtests measure

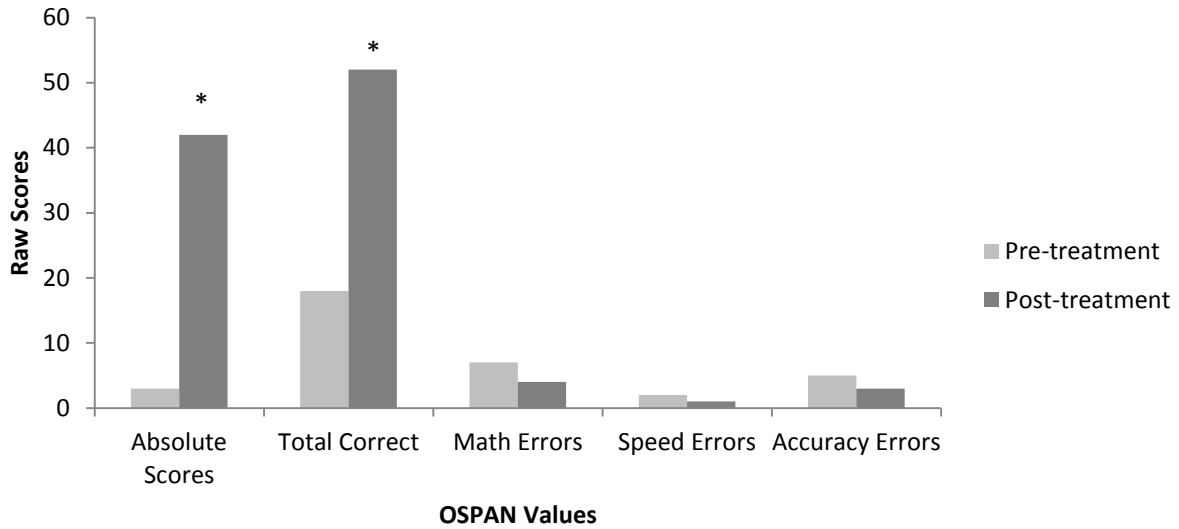
an individual's ability to manipulate information in auditory-verbal working memory. Scaled scores on the *Elevator Counting with Distraction* (ECD) subtest obtained pre-treatment and post-treatment were 9 and 13, respectively. Pre-treatment measures from the *Elevator Counting with Reversal* (ECR) subtest indicated a scaled score of 12, while post-treatment measures revealed a scaled score of 15. See Graph 3. Results indicated that no change occurred.

APT II Attention Questionnaire

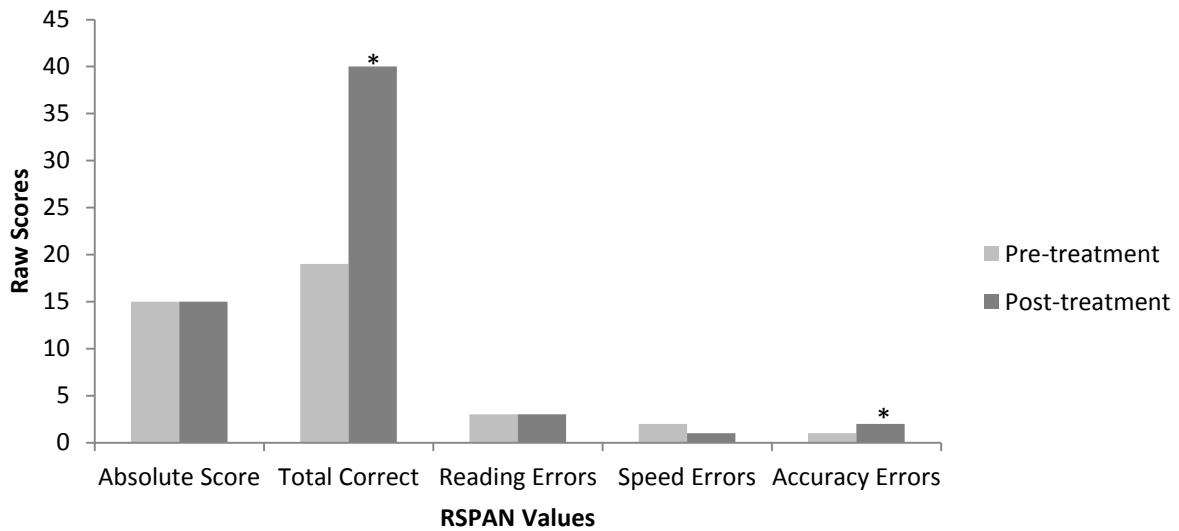
At pre-treatment, the participant scored a 15 on the subjective attention control ratings, indicating decreased attention span which may have a moderate disruptive effect on the individual's life. At post-treatment, the participant scored a 12, indicating a decreased attention span which may have a mild disruption on the individual's life. At one month follow-up the participant scored a 1 on the questionnaire. Although these results would indicate normal attentional control, the wording on the questionnaire may have led to this score, in that the person is asked to rate "change" since last rating. Therefore the follow-up score could indicate that the participant perceived no change (i.e., continued mildly disruptive attention control).

OSPAN and RSPAN automated working memory tasks

Absolute scores obtained from the operation (OSPAN) and reading (RSPAN) span tasks were used to analyze changes in working memory. Five values are reported upon completion of each task: OSPAN or RSPAN absolute score (sum of all perfectly recalled sets), total correct (total number of letters recalled accurately), math or reading errors (total number of errors made), speed errors (errors due to the participant running out of time), and accuracy errors (errors in which the participant inaccurately solved the math problem or verified the sentence). A summary of scores obtained are in Graphs 4 and 5.



Graph 4. Summary of OSPAN scores.



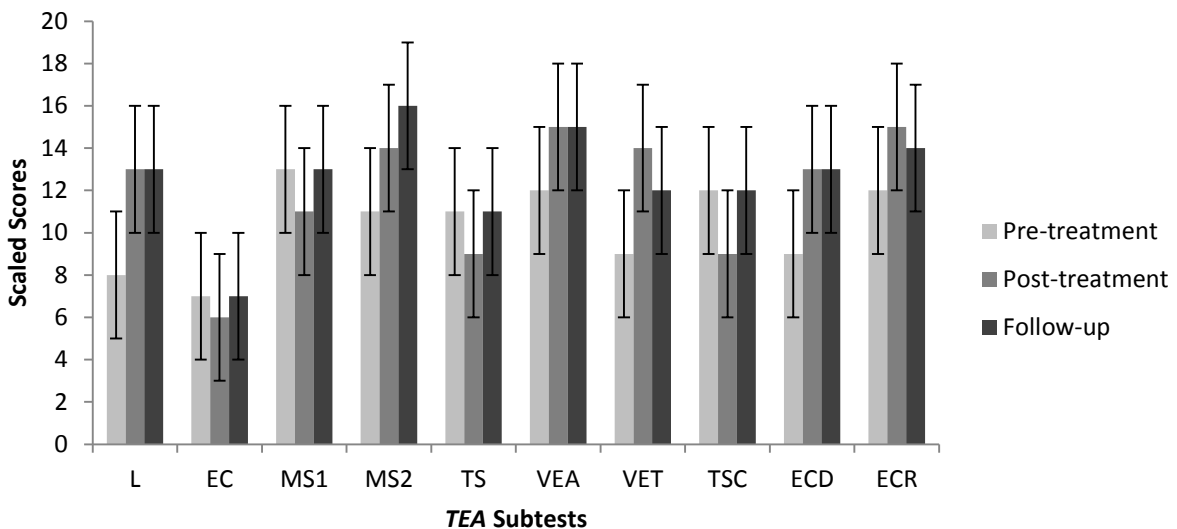
Graph 5. Summary of RSPAN scores.

Scores on the OSPAN and RSPAN tasks indicate increase or maintenance in performance levels in all areas, with the exception of the RSPAN accuracy error score, in which more errors were observed during post-testing. The RSPAN absolute score and reading error score did not change.

4. Is there a change in secondary outcome measures one-month post-treatment?

TEA

TEA scaled scores have a mean of 10 and a standard deviation of ± 3 . Results of follow-up testing indicated that certain attentional skills were maintained: *Map Search (one minute)*, *Map Search (two minutes)*, *Elevator Counting*, *Elevator Counting with Distraction*, *Visual Elevator (accuracy)*, *Telephone Search*, *Telephone Search While Counting*, and *Lottery*. These subtests targeted the following areas of attention: sustained, selective, alternating, and divided, as well as auditory-verbal working memory. However, the scores were not maintained on the *Visual Elevator (timing)* and *Elevator Counting with Reversal*, which targeted alternating attention and auditory-verbal working memory, respectively. Results indicated overall improvement or maintenance in scaled scores. See Graph 6.



Graph 6. Summary of scores obtained from the TEA.

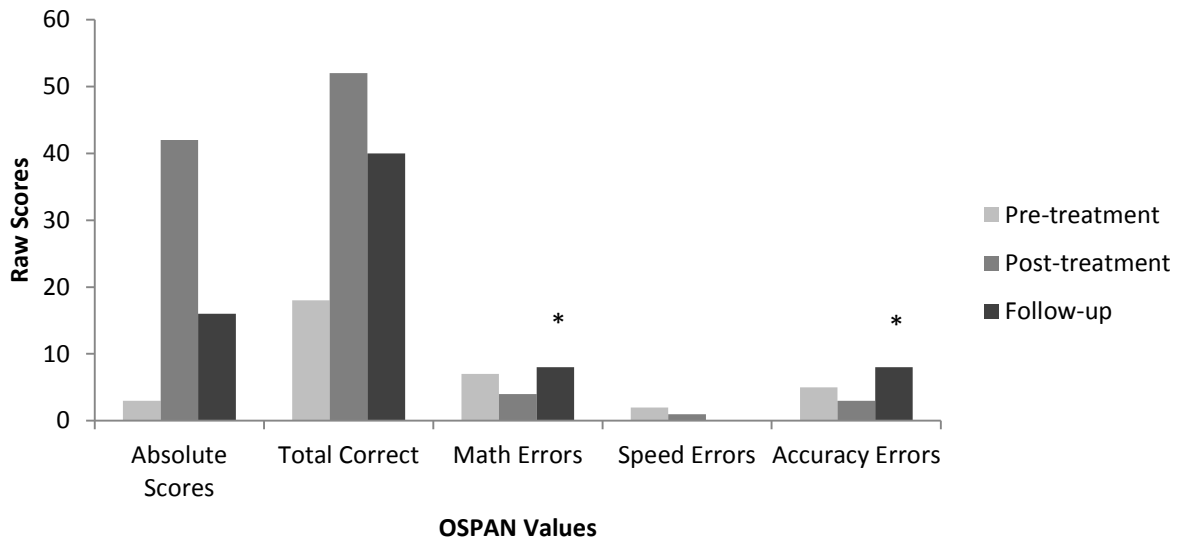
APT II Attention Questionnaire

At one month following the completion of the APT protocol, the participant scored a 1 on subjective attentional control ratings, indicating the decreased attention span may have little to

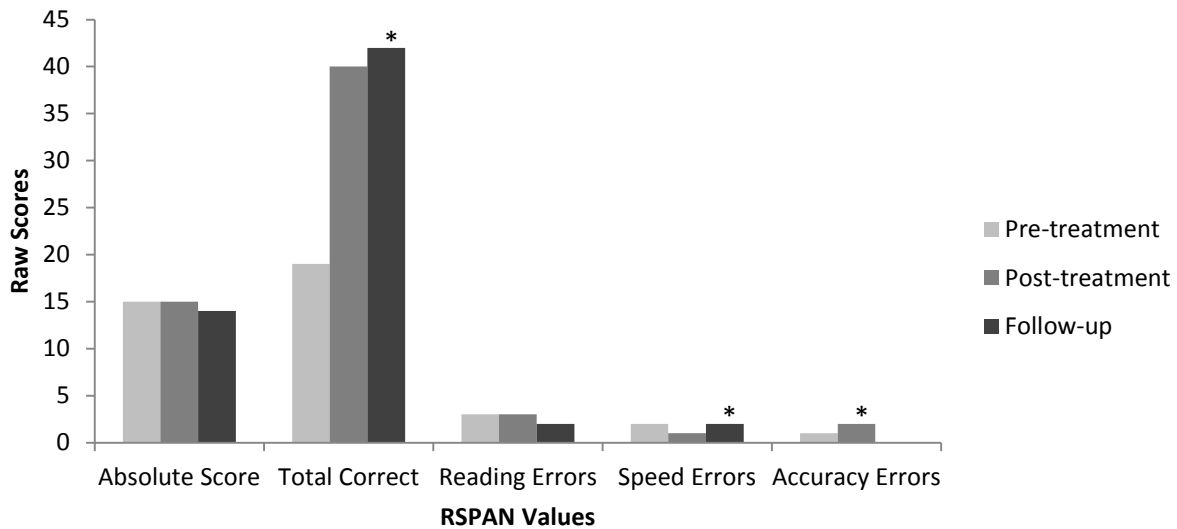
no effect on the quality of life. The participant reported attentional deficits to be not a problem or no change from before treatment began with the exception of one area assessed. Results indicated maintenance of treatment effects on subjective ratings.

OSPAN and RSPAN automated working memory tasks

Raw scores obtained from the operation (OSPAN) and reading (RSPAN) span tasks were used to analyze maintenance of the treatment effect one month following completion of the APT protocol. A summary of OSPAN and RSPAN raw scores are in Graphs 7 and 8, respectively.



Graph 7. Summary of OSPAN raw scores.



Graph 8. Summary of RSPAN raw scores.

Maintenance of the treatment effects was observed in the following scores: OSPAN speed errors, RSPAN total correct, RSPAN reading errors, and RSPAN accuracy errors. The following scores were observed to be less than or equal to scores obtained immediately upon completion of the APT protocol: OSPAN absolute score, OSPAN total correct, OSPAN accuracy errors, RSPAN absolute score, and RSPAN speed errors. However, it should be noted that the OSPAN absolute score, OSPAN total correct, and RSPAN speed error pre-treatment scores were maintained at post-treatment.

In summary, the study’s aim to demonstrate a treatment effect for APT in an individual with PD was not met because baseline probes were not conducted at post-testing and follow-up testing due to an oversight on the part of the investigator. Therefore treatment effects could not be determined. The participant demonstrated no or little improvement on the *TEA*. However, he self-reported improved attentional control on the *APT II Attention Questionnaire*. Finally, the participant did demonstrated improvement on working memory tasks after undergoing 12 hours of APT training. These implications will be discussed in the next section.

DISCUSSION

Although Sohlberg and Mateer (1987) designed the APT protocol for individuals with TBI, the investigator wondered if improvement might be demonstrated in PWP due to similar patterns of frontal lobe impairment associated with attention processes between TBI and PD, although the mechanisms that caused the damage are different. The following discussion will address the implications of the study's results, the study's limitations, and finally the need for further research.

In the methods section I discussed the difference between primary and secondary outcomes in a treatment efficacy study. The primary outcome measures address treatment efficacy based on performance during treatment. The secondary outcome measures provide evidence of the participant's behavioral change (associated with attention processes) pre-, post-treatment and at follow-up. To examine a participant's behavioral changes comprehensively (i.e. not only in the clinic, but also in day-to-day life) no single secondary outcome measure is adequate. For this study, I selected secondary outcome measures designed to assess the participant's behavioral changes in sustained, selective, alternating, and divided attention (*TEA*), self-reported attentional deficits, and working memory skills.

The study's results are mixed. However, according to Robey's five-phase model of research, the purpose of a Phase I study is not only to seek evidence of treatment efficacy, but also to determine the viability of the treatment protocol. First, no treatment effect could be determined due to failure to collect post-treatment and follow-up probes to compare with baseline probes. However observation of the multiple-baseline training graphs indicated that the APT protocol in its current form may not be viable for demonstrating improvement since this participant frequently had high percent correct on even the most difficult tasks, leaving little

room for improvement. The same may be said for timed performance, although substantial normative data would have to be obtained to determine how the motor deficits of PWP interfere with increasing rapid processing. Furthermore, the APT protocol requires a rigid order of task completion, which may prolong training unnecessarily. This is an important consideration in this time of decreasing healthcare service delivery and reimbursement. However, it appears that this participant benefitted from more basic sustained and selective attention on alternating and divided attention, which makes me wonder whether all levels need to be trained.

With regard to secondary outcome measures the participant demonstrated mixed changes in attentional behaviors, depending on the type of test given. For example, although changes in *TEA* standard scores were noted for many of the subtests, when standard deviations were factored in, I observed no significant difference between pre-treatment, post-treatment, and follow-up data. However, the participant self-reported improved attention control in the *APT II Attention Questionnaire*. Perhaps the most important finding, if the theory that attention forms the foundation upon which working memory relies, the participant demonstrated improvement or maintenance on working memory tasks.

Tasks used to target sustained attention deficits included shape cancellation, number cancellation, attention CDs, and serial numbers. The participant required some modifications to the APT primarily because of his inability to complete tasks requiring complex visuospatial processing. For example, he required more expansive training than suggested by the APT to perform a cancellation task properly. In another case the participant reached criteria on all but one selective attention task. I discarded a number cancellation with visual distractor overlay because the participant was unable to reach criteria after repeated trials and reinstruction. We suggest this difficulty with these tasks may have been due to decreased visual processing ability

for complex stimuli that has been cited in the PD literature (Muslimovic et al., 2005; Park & Stacy, 2009; Spencer et al., 2010), although we cannot generalize based on the performance of one individual.

Of interest, visual inspection of probes administered at the beginning of each treatment session demonstrated improvement in percent accuracy in alternating attention over the course of treatment. Visual inspection of divided attention probes indicated that the participant was improving in the timing component of the task. Neither task was being trained in treatment. We suggest that targeting and improving lower levels of attention (e.g. sustained, selective) may have led to improved higher levels of attention (e.g. alternating, divided). Of interest, although divided attention was not trained, inspection of divided attention probes indicated that the participant was improving in both quicker response time and accuracy of response. The participant's scores decreased at post-treatment but maintained pre-treatment scores at follow-up testing. This indicates the participant was able to simultaneously focus attentional processes on two stimuli sets. Since divided attention was not trained, we suggest that targeting and improving lower levels of attention (e.g. sustained, selective) may have led to improved higher levels of attention (e.g. alternating, divided).

Secondarily we hypothesized that improved attention would lead to improved working memory performance as well. OSPAN and RSPAN scores indicated overall improvement at post-treatment and follow-up testing. Although some error scores increased at post-treatment and follow-up testing, OSPAN and RSPAN absolute scores and total correct increased or maintained pre-treatment data. While error scores are reported by the OSPAN and RSPAN software, only absolute and total correct scores report information on memory recall. Improvement indicated a relationship between attention and working memory in this PWP.

Moreover, it appears that improved attentional skills generalized to improved working memory skills in this PWP as well.

The participant self-reported an increase in attentional skills at post-treatment and follow-up testing. This indicates that although objective measures obtained from the *TEA* were inconsistent in demonstrating improvement in each subtest(s)'s attentional domain, the participant recognized improvement in attentional span in his day-to-day life. It seems reasonable to suggest that some of these improvements may have resulted from the participant using strategies he was taught during treatment.

The participant utilized a combination of strategies (presented by trainer or self-determined) to progress through the treatment program. On timed cancellation tasks, he made short marks rather than big lines, snaked through each line (e.g. moving from left to right, then right to left), and counted each number of symbol that appeared. On alternating attention tasks that required the participant to quickly switch between two stimuli sets, he used one hand to denote stimulus one and the other to denote stimulus two. On tasks requiring him to select specific stimuli while ignoring others, he used patterns in the numbers to increase his ability to ignore specific numbers. For example, after repeated exposure to certain selective attention tasks (e.g. math problems requiring the participant to multiply by three and subtract by one), he realized any number following the number four was not to be selected.

These results indicate that it may be possible for individuals with PD and attentional deficits to benefit from APT. Although we cannot generalize our findings from one individual's performance, it appears to be an area that would benefit from further research, particularly in light of the evidence of improved working memory skills.

The findings garnered from this study are important for two reasons. First, it is the first study to see if a PWP with identified attention deficits that interfered with daily functioning could benefit from attention training. While the study could not determine a treatment effect, evidence was found for improved functional attention and increased working memory skills. As the population ages, experts expect a significant increase in the number of people diagnosed with PD. Furthermore, because many of those individuals demonstrate speech and cognitive deficits, speech-language pathologists may expect to see them with increasing frequency. It is critical that we begin to understand how the cognitive deficits now being evidenced affect established and new speech treatments, and find effective cognitive-communicative treatments for those with PD.

Limitations

There were several limitations to the study, that now identified will improve the next phase of research in this area. Some of these are particular to conducting a single-subject study, where the participant's behavior can influence the outcomes. First, the participant missed 6 sessions, resulting in the 16 treatment protocol running over a two-month time period. The absences were due to school closing for the holidays and participant illness. Therefore, it is hard to say that the improvement in behaviors were due to the treatment or perhaps to the additional time the participant had to incorporate training and compensatory strategies into his daily life. During the study the participant self-reported that he was altering his medication cycle on occasion although the study protocol stated that the participant was to take medications 30 minutes prior to or after treatment. This may have attributed to some of the performance fluctuations noted in the data. I discussed the importance of adhering as closely as possible to the medication regime with the participant on various occasions.

In addition to the participant's contribution to study limitations, a serious limitation in the study was absence of the post-treatment and follow-up treatment probes necessary for treatment effect calculations. This limitation is attributed to the investigator's limited research experience. A final limitation of the study was the participant's relatively high level of performance on the APT tasks, which did not allow for improvement. Rather, the participant made improvement in time to complete task.

Future Studies

Results from this multiple baseline study resulted in mixed results that suggest many opportunities for further research in finding effective treatments for PWP. This study could be broadened to include more PWP and a wider range of attention deficits to determine whether treatment effects can be discovered using the APT. Another study might compare APT training to a computer attention training that has established evidence behind it. If attention is the foundation for memory, and memory is necessary for learning, yet another study might make a comparison between using APT prior to traditional speech therapy with using traditional speech therapy alone to determine if a greater benefit can be demonstrated when attentional deficits are targeted first.

SUMMARY

As the population ages, the number of individuals diagnosed and living with PD will increase as well. We now know that these individuals will experience cognitive and communicative deficits as well as movement disorders. A chief complaint of individuals with PD is that they have difficulty concentrating, staying focused on a topic, and alternating attention between two things. Therefore it may be important to address attentional deficits prior to conducting other kinds of cognitive-communicate treatment to ensure that a person receives maximum benefit from treatment. In any case, addressing attentional deficits are a critical first step in memory and learning, which may be important for maintaining independence and managing the disease. This is work that has never been done with a PWP presenting with attentional deficits. Our results demonstrated a positive impact in secondary outcome measures comparable to research conducted with whom APT was designed. It is imperative to continue this research to improve the quality of life in PWP. While these results from one individual cannot be generalized to others with PD, it would appear that APT might be useful in assisting PWP to improve their attentional skills.

REFERENCES

- Bhatnagar, S. C. (2008). *Neuroscience for the study of communicative disorders* (3rd ed). Baltimore, MD: Lippincott Williams & Wilkins.
- Brown, R.G. & Marsden, C.D. (1988). Internal versus external cues and the control of attention in parkinson's disease. *Brain*, *111*, 323-345.
- Chaudhuri, K., Healy, D., Schapira, A. (2006). Non-motor symptoms of parkinson's disease: Diagnosis and management. *Lancet Neurology*, *5*, 235-245.
- Cools, A., Van den Bercken, J., Horstink, M., Van Spaendonck, K., & Berger, H. (1984). Cognitive and motor shifting aptitude disorder in parkinson's disease. *Journal of Neurology, Neurosurgery, and Psychiatry*, *47*, 443-453.
- Cools, R. (2006). Dopaminergic modulation of cognitive function: Implications for l-dopa treatment in parkinson's disease. *Neuroscience and Biobehavioral Reviews*, *30*, 1-23. doi: 10.1016/j.neubiorev.2005.03.024
- Cooper, J., Sagar, H., Jordan, N., Harvey, N., & Sullivan, E. (1991). Cognitive impairment in early, untreated parkinson's disease and its relationship to motor disability. *Brain*, *114*, 2095-2122.
- Cowan, N. (1995). *Attention and Memory: An Integrated Framework*. New York: Oxford University Press, Inc.
- Cowan, N. (2005). *Working Memory Capacity*. New York: Psychology Press.
- Cowan, N., Elliott, E., Saults, J., Morey, C., Mattox, S., Hismjatullina, A., & Conway, A. (2005). On the capacity of attention: Its estimation and its role in working memory and cognitive aptitudes. *Cognitive Psychology*, *51*, 42-100. doi: 10.1016/j.cogpsych.2004.12.001
- Cronon-Golomb, A., Corkin, A., & Growdon, J. (1994). Impaired problem solving in parkinson's disease: Impact of a set-shifting deficit. *Neuropsychologia*, *32*, 579-593.
- Downes, J. J., Roberts, A. C., Sahakian, B. J., Evenden, J. L., Morris, R. G., & Robbins, T. W. (1989). Impaired extra-dimensional shift performance in medicated and unmedicated parkinson's disease: Evidence for a specific attentional dysfunction. *Neuropsychologia*, *27*, 1329-1343.
- Duffy, J. R. (2005). *Motor speech disorders: Substrates, differential diagnosis, and management* (2nd ed). St. Louis, MO: Elsevier Mosby.
- Dujardin, K., Degreef, J.F., Rogelet, P., Defebvre, L., & Destee, A. (1999). Impairment of the supervisory attentional system in early untreated patients with parkinson's disease. *Journal of Neurology*, *246*, 783-788.

- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*, 189-198.
- Hoehn, M. M., & Yahr, M. D. (1967). Parkinsonism: Onset, progression, and mortality. *Neurology, 17*, 427-442.
- Lees, A. J. & Smith, E. (1983). Cognitive deficits in the early stages of parkinson's disease. *Brain, 106*, 257-270.
- Levin, B., Llabre, M., & Weiner, W. (1989). Cognitive impairments associated with early parkinson's disease. *Neurology, 39*, 557-561.
- Mathias, J., Beall, J., & Bigler, E. (2004). Neuropsychological & information processing deficits following mild traumatic brain injury. *Journal of the International Neuropsychological Society, 10*, 286-297. doi: 10.1017/S1355617704102117
- Martinez-Martin, P., Schapira, A., Stocchi, F., Sethi, K., Odin, P., MacPhee, G., ... Chaudhuri, K. (2007). Prevalence of nonmotor symptoms in parkinson's disease in an international setting; Study using nonmotor symptoms questionnaire in 545 patients. *Movement Disorders, 22*, 1623-1629. doi: 10.1002/mds.21586
- Murdoch, B. & Whelan, B. (2009). Pallidal and thalamic involvement in language: evidence from stereotactic surgical studies. In *Speech and Language Disorders Associated with Subcortical Pathology* (pp. 112-136). Chichester, West Sussex: Wiley-Blackwell.
- Murray, L. L. & Clark, H. M. (2006). *Neurogenic disorders of language: Theory driven clinical practice*. Clifton Park, NY: Thomson Delmar Learning.
- Muslimovic, D., Post, B., Speelman, J., & Schmand, B. (2005). Cognitive profile of patients with newly diagnosed parkinson disease. *Neurology, 65*, 1239-1245.
- National Institute of Neurological Disorders and Stroke. (2006). Parkinson's Disease: Hope Through Research. Retrieved from http://www.ninds.nih.gov/disorders/parkinsons_disease/parkinsons_disease_background_r.htm
- Owen, A. (2004). Cognitive dysfunction in parkinson's disease: The role of frontostriatal circuitry. *The Neuroscientist, 10*, 525-537.
- Owen, A., James, M., Leigh, P., Summers, B., Marsden, C., Quinn, P., Lange, K., & Robbins, T. (1992). Fronto-striatal cognitive deficits at different stages of parkinson's disease. *Brain, 115*, 1727-1751.

- Park, A., & Stacy, M. (2009). Non-motor symptoms in parkinson's disease. *Journal of Neurology*, 256, S293-S298. doi: 10.1007.s00415-009-5240-1
- Park, N., Proulx, G., & Towers, W. (1999). Evaluation of the attention process training programme. *Neuropsychological Rehabilitation*, 9, 135-154.
- Pero, S., Incoccia, C., Caracciolo, B., Zoccolotti, P., & Formisano, R. (2006). Rehabilitation of attention in two patients with traumatic brain injury by means of 'attention process training'. *Brain Injury*, 20, 1207-1219. doi: 10.1080/02699050600983271
- Piccirilli, M., D'Alessandro, P., Finali, G., Piccinin, G., & Agostini, L. (1989). Frontal lobe dysfunction in parkinson's disease: Prognostic value for dementia? *European Neurology*, 29, 71-76.
- Ponsford, J. & Kinsella, G. (1988). Evaluation of a remedial programme for attentional deficits following closed head injury. *Journal of Clinical and Experimental Neuropsychology*, 10, 693-708.
- Robertson, I., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1994). *The Test of Everyday Attention*. Bury St Edmund, England: Thames Valley Test Company.
- Robertson, I., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1996). The structure of normal human attention: The test of everyday attention. *Journal of the International Neuropsychological Society*, 2, 525-534.
- Robey, R. R. (2004). A five-phase model for clinical-outcome research. *Journal of Communication Disorders*, 37, 401-411. doi: 10.1016/j.jcomdis.2004.04.003
- Rosenbaum, J. (1982). *Rosenbaum Vision Pocket Screener*. Quincy, MA: Grass Instruments Company.
- Russell, E. W. & D'Hollosy, M. E. (1992). Memory and attention. *Journal of Clinical Psychology*, 48, 530-538.
- Schapira, A. (2009). Neurobiology and treatment of parkinson's disease. *Trends in Pharmacological Sciences*, 30, 41-47. doi: 10.1016/j.tips.2008.10.005
- Sheikh, J. I., & Yesavage, J. A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. In *Clinical Gerontology: A Guide to Assessment and Intervention* (pp. 165-173). New York: Haworth Press.
- Sohlberg, M., Johnson, L., Paule, L., Raskin, S., & Mateer, C. (2001). *Attention Process Training: A program to address attentional deficits for persons with mild cognitive dysfunction (an upper extension of the APT-I)* (2nded). Wake Forest, NC: Lash & Associates Publishing/Training Inc.

- Sohlberg, M. & Mateer, C. (1987). Effectiveness of an attention-training program. *Journal of Clinical and Experimental Neuropsychology*, 9, 117-130.
- Sohlberg, M., & Mateer, C. (2005). *Attention Process Training: A program for cognitive rehabilitation to address persons with attentional deficits ranging from mild to severe* (3rd ed). Wake Forest, NC: Lash & Associates Publishing/Training, Inc.
- Sohlberg, M., McLaughlin, K., Pavese, A., Heidrich, A., & Posner, M. (2000). Evaluation of attention process training and brain injury education in persons with acquired brain injury. *Journal of Clinical and Experimental Neuropsychology*, 22, 656-676.
- Spencer, K., Sanchez, J., McAllen, A., & Weir, P. (2010). Speech and cognitive-linguistic function in parkinson's disease. *Perspectives in Neurophysiology and Neurogenic Speech and Language Disorders*, 20, 31-38.
- Starkstein, S.E., Mayberg, H.S., Preziosi, T.J., Andrezejewski, P., Leiguarda, R., & Robinson, R. G. (1992). Reliability, validity, and clinical correlates of apathy in parkinson's disease. *Journal of Neuropsychiatry and Clinical Neurosciences*, 4, 134-139.
- Sturm, W., Willmes, K., Orgass, & Hartje, W. (1997). Do specific attention deficits need specific training? *Neuropsychological Rehabilitation*, 7, 81-103.
- Stuss, D. & Knight, R. (2002). Neurochemical modulation of prefrontal cortical function in humans and animals. In Arnsten, A. & Robbins, T. (Eds), *Principles of Frontal Lobe Function* (pp. 51-84). New York: Oxford University Press, Inc.
- Unsworth, N. & Spillers, G. (2010). Working memory capacity: Attention control, secondary memory, or both? A direct test of the dual-component model. *Journal of Memory and Language*, 62, 392-406. doi: 10.1016/j.jml.2010.02.001
- Watts, R. & Koller, W. (2004). *Movement disorders: Neurologic principles and practice*, 2nd edition. New York: McGraw-Hill.
- Weber, A. M. (1990). A practical clinical approach to understanding and treating attentional problems. *The Journal of Head Trauma Rehabilitation*, 5, 73-85.

APPENDIX A

Summary of *TEA* (Robertson et al., 1994)

<i>TEA</i> subtest	Description	Area of attention targeted
<i>Elevator Counting</i>	An auditory task that requires the subject to complete simple counting procedures (counting seven strings of tones).	Sustained attention
<i>Lottery</i>	An auditory task requiring the subject to listen to a string of letters and numbers (e.g. BC143) and specify the two letters preceding all numbers ending in “55”.	
<i>Map Search</i>	A visual search task that involving searching a map for two minutes and circling a specified symbol when located.	Selective attention
<i>Telephone Search</i>	A visual task in which the subject is required to search a telephone directory for a specified group of symbols.	
<i>Visual Elevator</i>	A visual task requiring the subject to count elevator doors imagining it as a representation of a floor, following the arrows signifying the elevator is moving up or down.	Alternating attention
<i>Telephone Search While Counting</i>	A visual task in which the subject is required to search a telephone directory for a specified group of symbols while simultaneously counting the number of tones presented auditorily.	Divided attention
<i>Elevator Counting with Distraction</i>	An auditory task that requires the subject to complete simple counting procedures while not counting a distracting tone.	Auditory-verbal working memory
<i>Elevator Counting with Reversal</i>	An auditory task requiring the subject to count floors as signified by a higher-pitched tone to designate going up and a lower-pitched tone to designate going down.	

APPENDIX B

APT-II

Attention Questionnaire (Sohlberg, Johnson, Paule, Raskin, & Mateer, 2001)
 (Authors permitted reproduction.)

Client Name: _____

Rater's Name and Relationship to Client (if applicable): _____

Therapist: _____ Date: _____

I. RATING SCALE: Please answer the following questions about your attention as it applies to daily functioning by ticking the box which offers the best description.

DESCRIPTION	Not a problem or no change from before	Only gets in the way on occasion (less than once a week)	Sometimes gets in the way (about 1-3 times per week)	Frequently gets in the way (is a problem most days)	Is a problem all the time (affects most activities)
1. Seem to lack mental energy to do activities					
2. Am slow to respond when asked a question or when participating in conversations					
3. Can't keep mind on activity or thought because mind keeps wandering					
4. Can't keep mind on activity or thought because mind feels "spacy" or "blank"					
5. Can only concentrate for very short periods of time					
6. Miss details or make mistakes because level of concentration					

decreased					
7. Easily get off track if other people milling about nearby					
8. Easily distracted by surrounding noise					
9. Trouble paying attention to conversation, if more than one other person					
10. Easily lose place if task or thinking interrupted					
11. Easily overwhelmed if task has several components					
12. Difficult to pay attention to more than one thing at a time					

II. INDIVIDUALIZED ATTENTIONAL PROBLEM LIST: In the space provided below describe the five most frequent and frustrating breakdowns in your attention ability. The first line has been filled out with an example description.

Describe Attention Breakdown (include setting and approx. frequency.)	What do you do when it occurs?
Example: I cannot concentrate when I am preparing dinner because the noise from the children playing around my feet and even in the next room distracts me. I forget ingredients or parts of the meal and usually feel totally frustrated during this time. This happens for every dinner.	I often yell or blow up at the children or cry while I am cooking. Sometimes I just give up and make something simple like sandwiches.
1.	

2.	
3.	
4.	
5.	

APT-II
Attention Questionnaire Scoring

Scoring:

- a) Total number of items ticked in second column multiplied by (1) _____
- b) Total number of items ticked in third column multiplied by (2) _____
- c) Total number of items ticked in fourth column multiplied by (3) _____
- d) Total number of items ticked in fifth column multiplied by (4) _____

Total Score: Add a) through d) _____

Analysis of Scores

Score Obtained	Level of Disruption on ADLs
0-12	Little – mild disruption
13-24	Moderate disruption
25-36	Severe disruption
37-48	Profound disruption

APPENDIX C

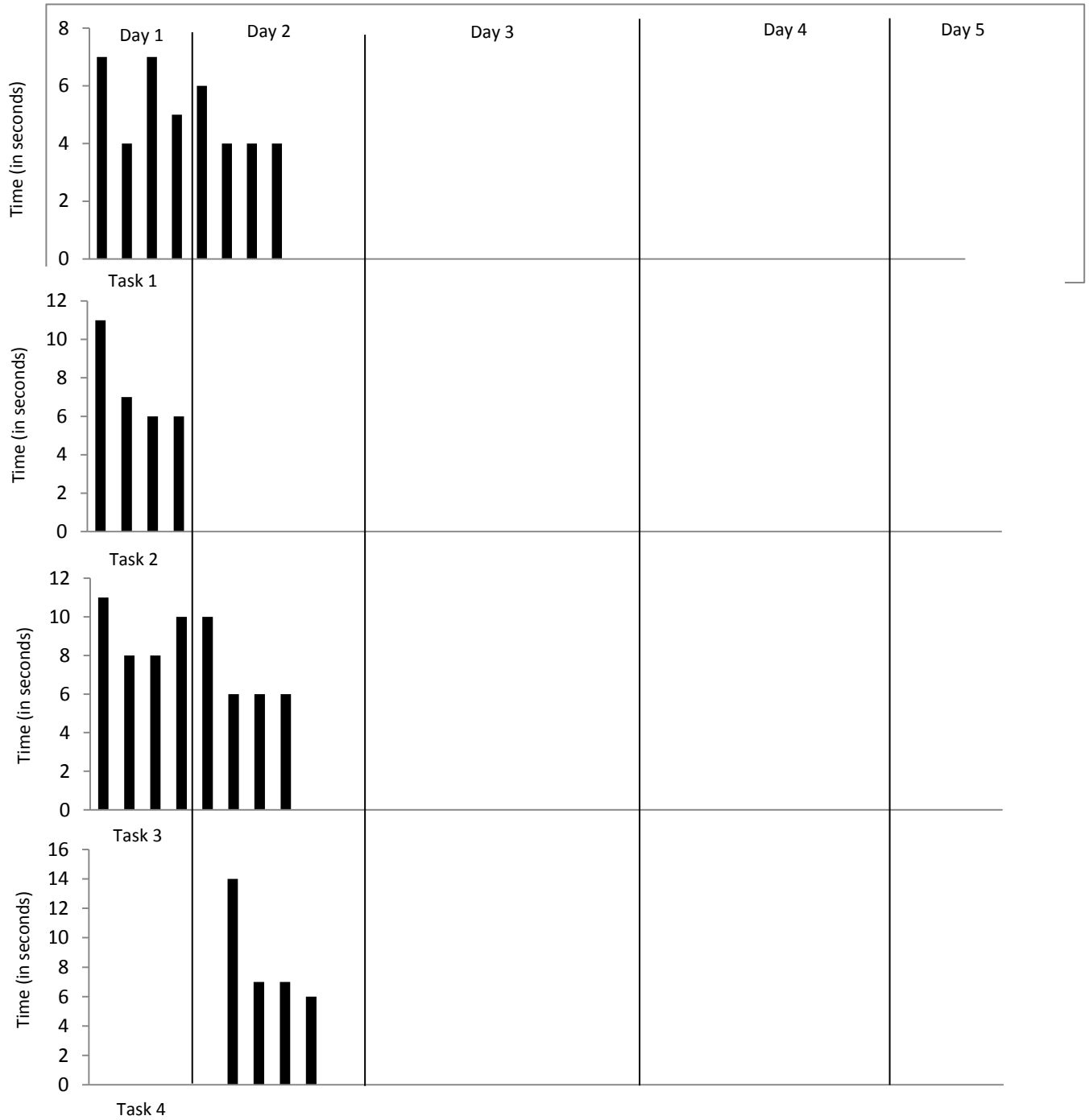
Targeted APT Tasks

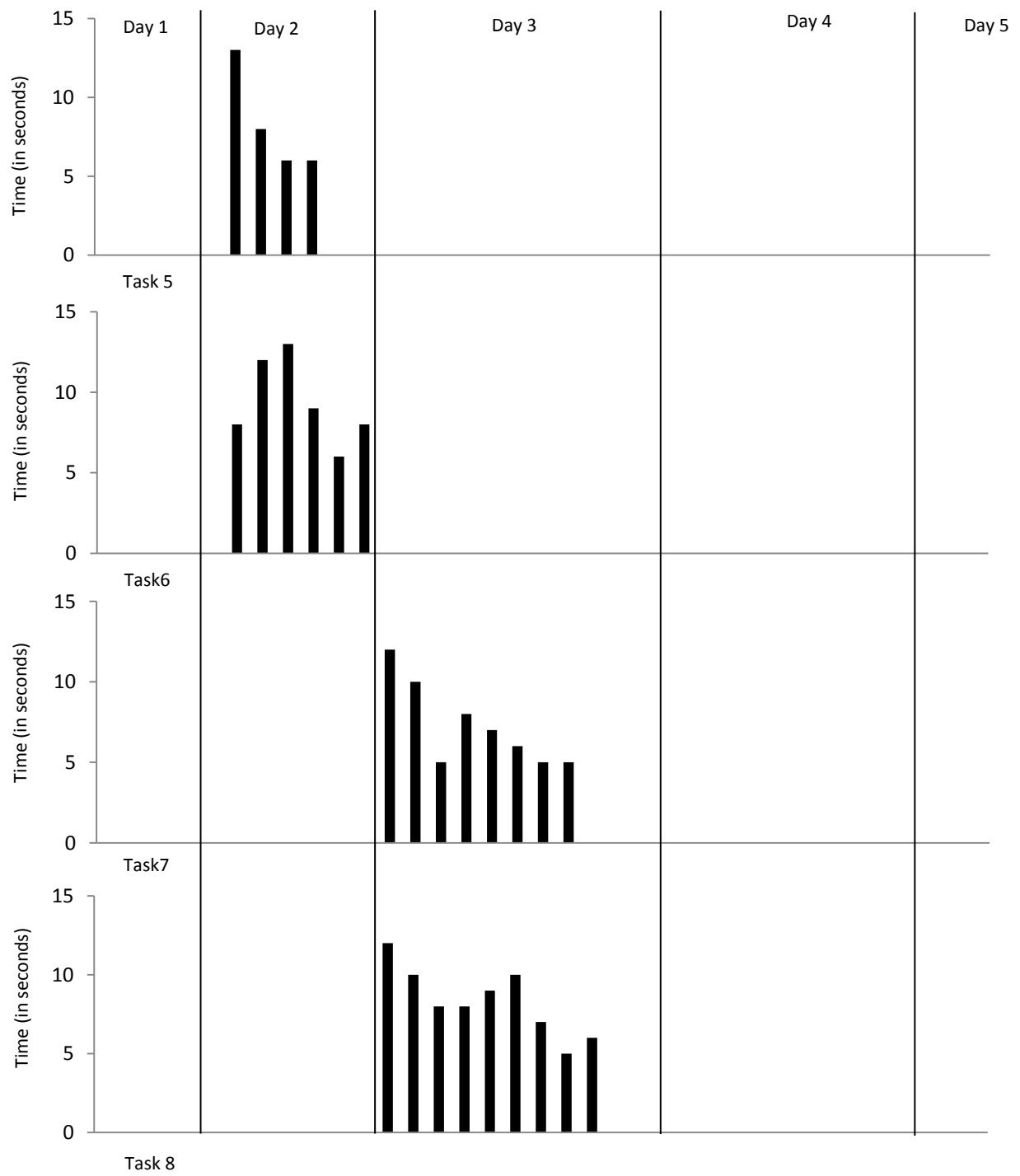
Attention Component	Treatment Activity	Activity description	Data Collected
Sustained	Shape Cancellation	Select target shape(s) on cancellation tasks	Number of errors Time (in seconds)
	Number Cancellation	Select target number(s) on cancellation tasks	Number of error Time (in seconds)
	Attention CDs	Press buzzer each time target response is heard via auditor cue	Number of errors Number of false positives
	Serial Numbers	Count backwards from designated number	Number of errors Time
Selective	Shape Cancellation with Distractor Overlay	Select target shape(s) on cancellation tasks with the presence of a distractor overlay	Number of errors Time
	Attention CDs	Press buzzer each time target response(s) is heard via auditory cue in the presence of background noise.	Number of errors Number of false positives
Alternating	Flexible Shape Cancellation	Alternative between target shapes when PI says “change”	Number of errors Time

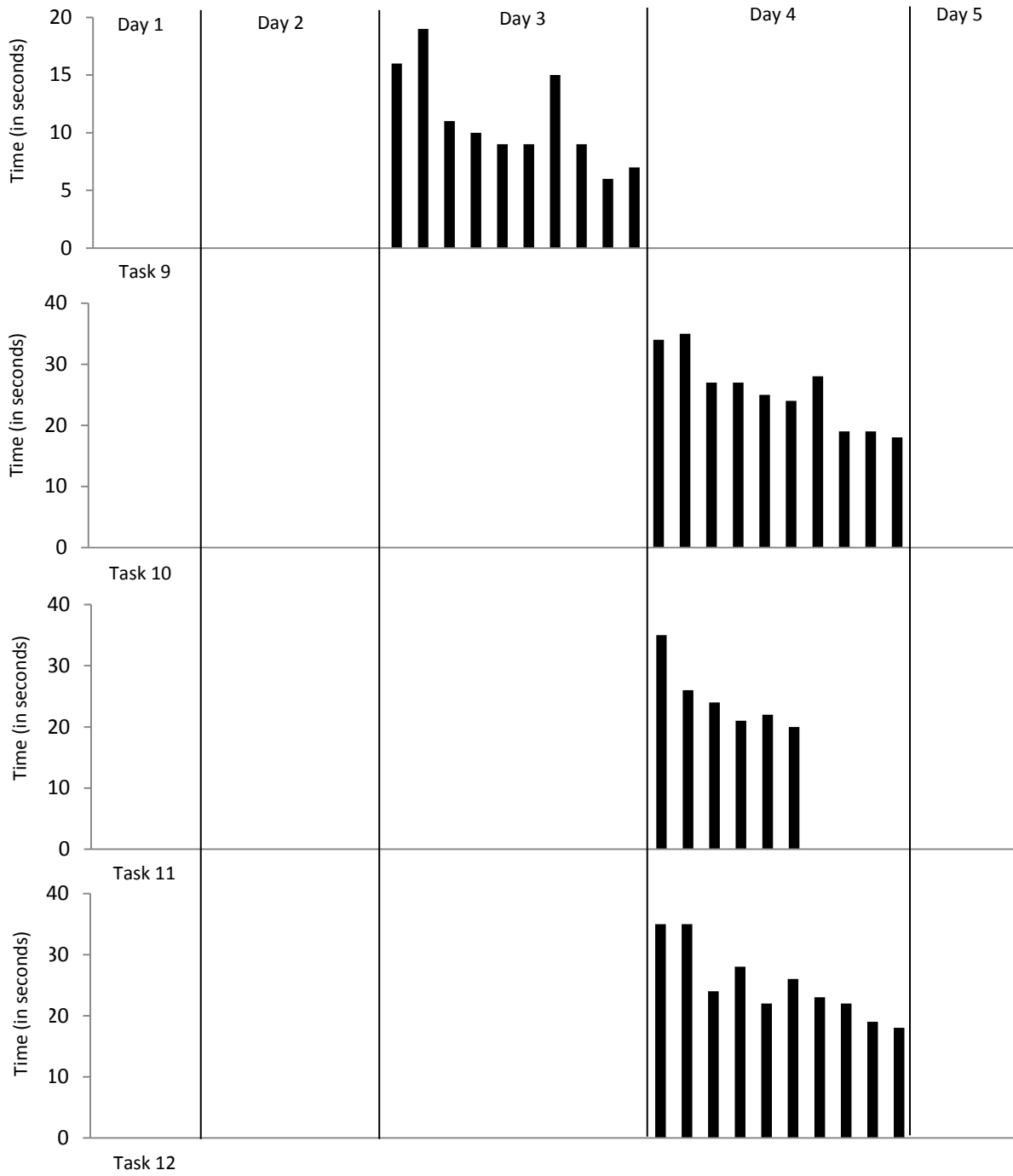
APPENDIX D

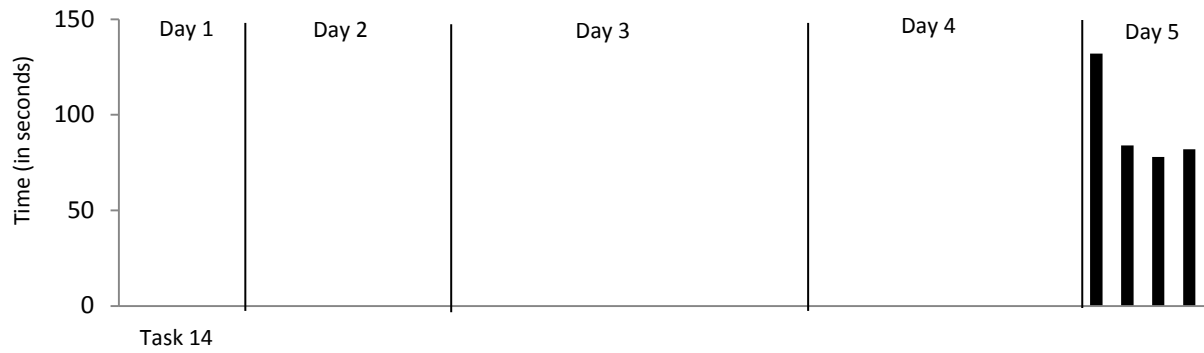
Graphs of Raw Data for Attention Tasks

Sustained Attention

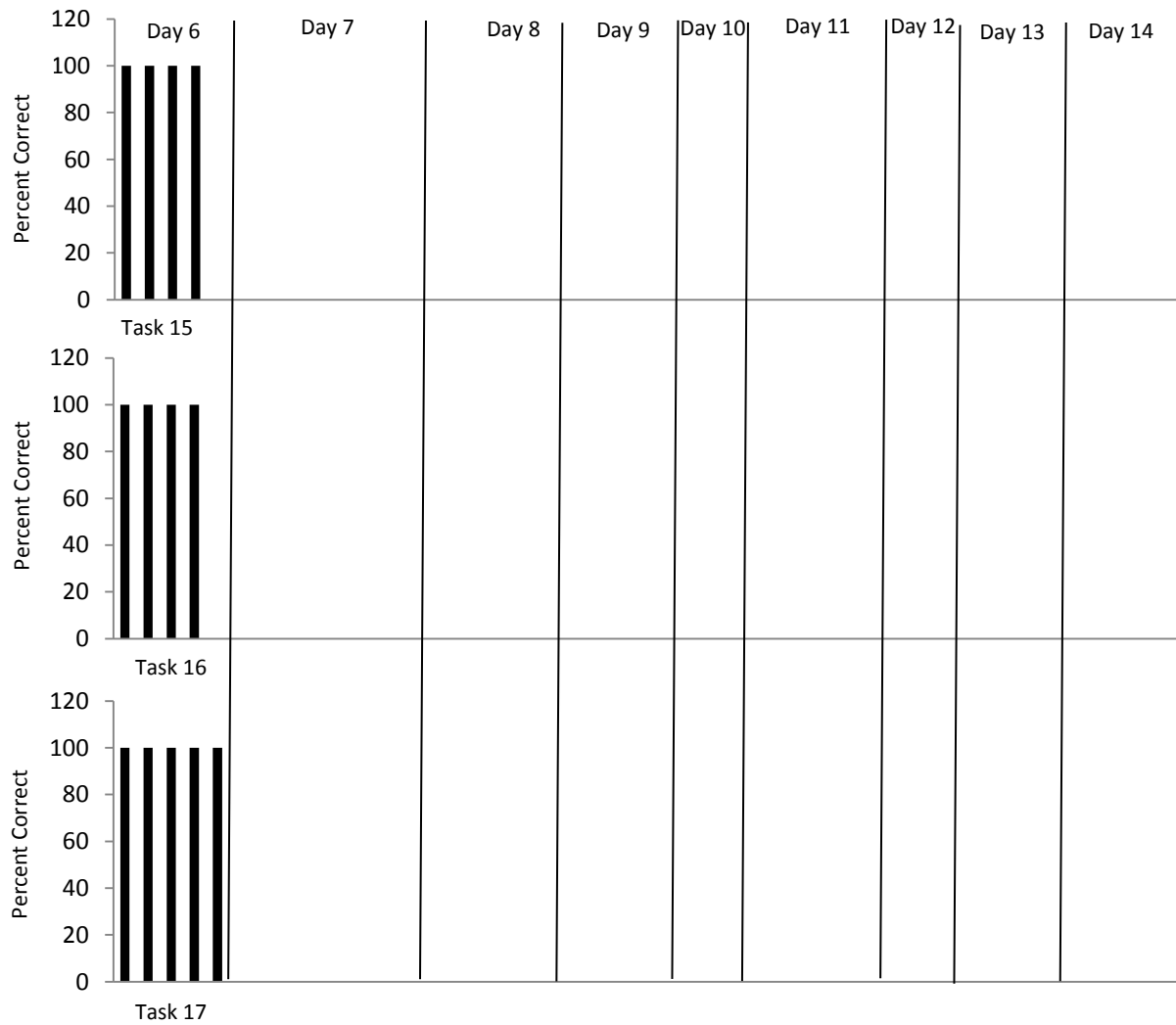


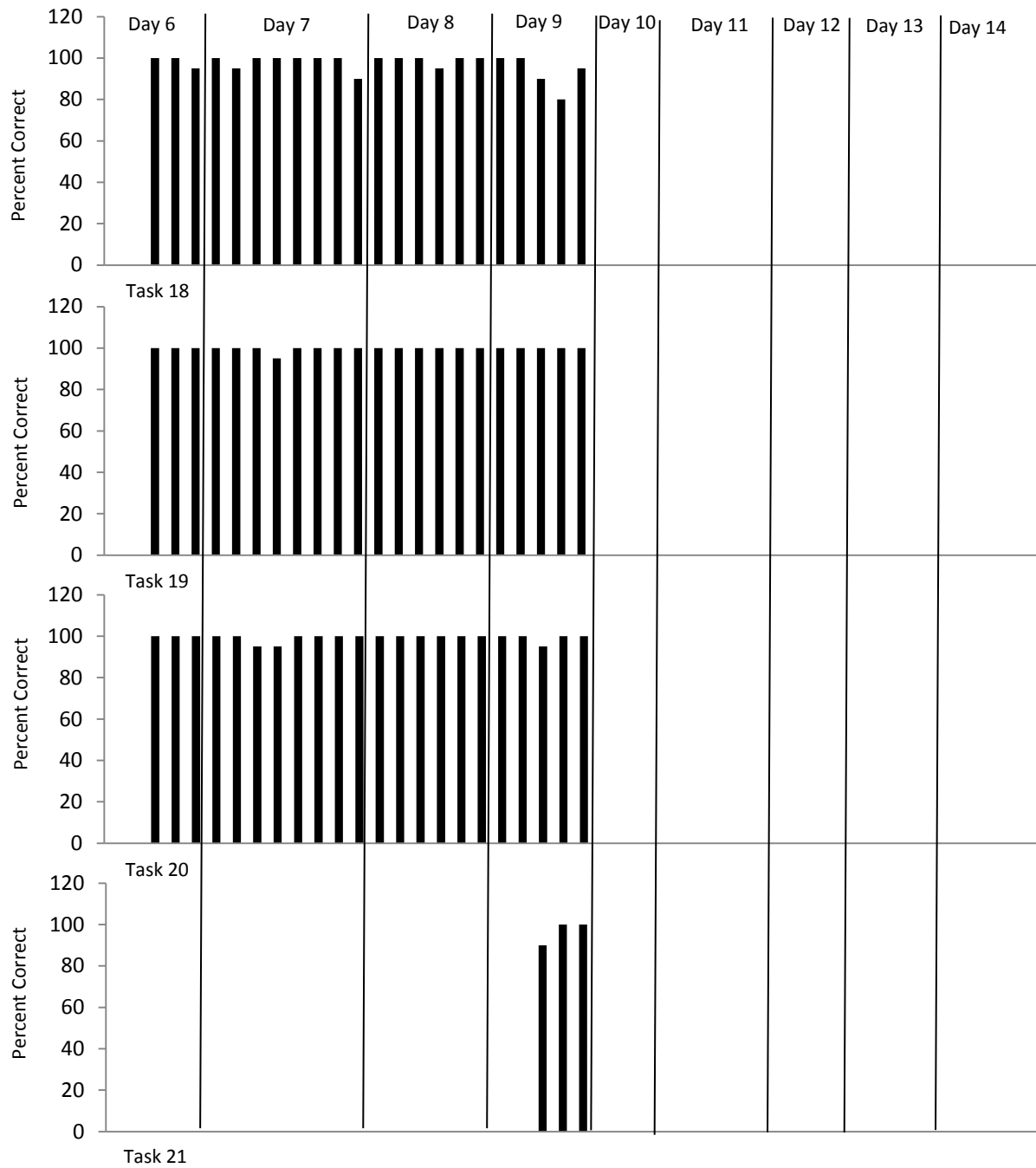


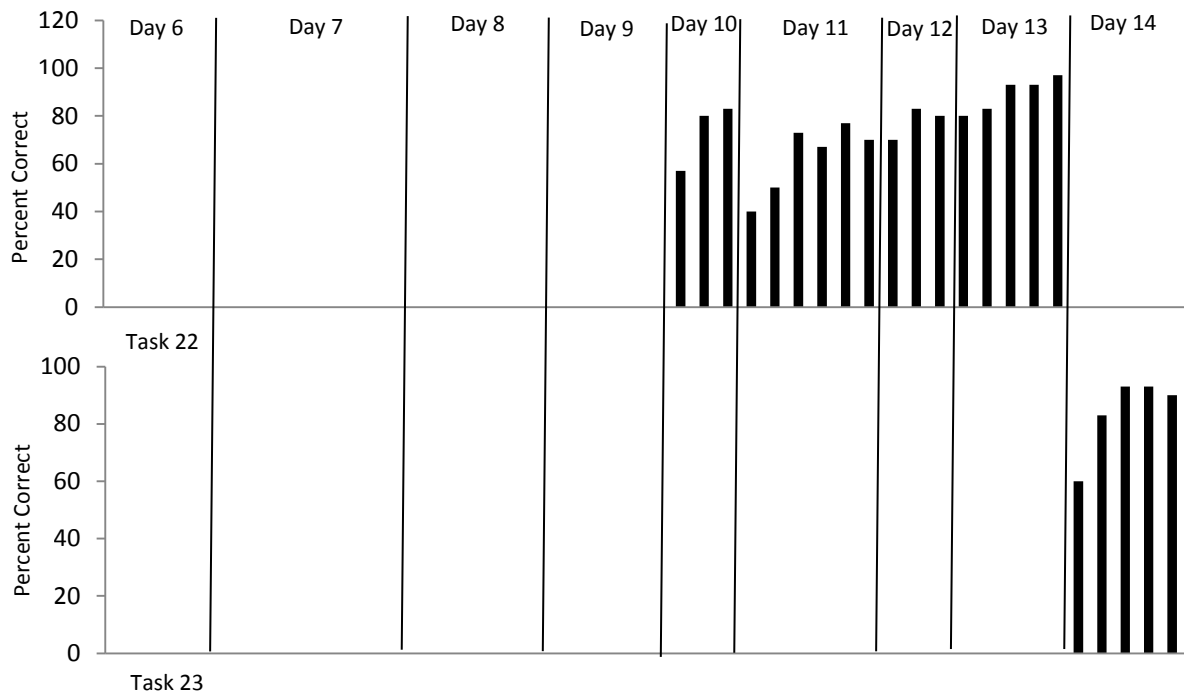




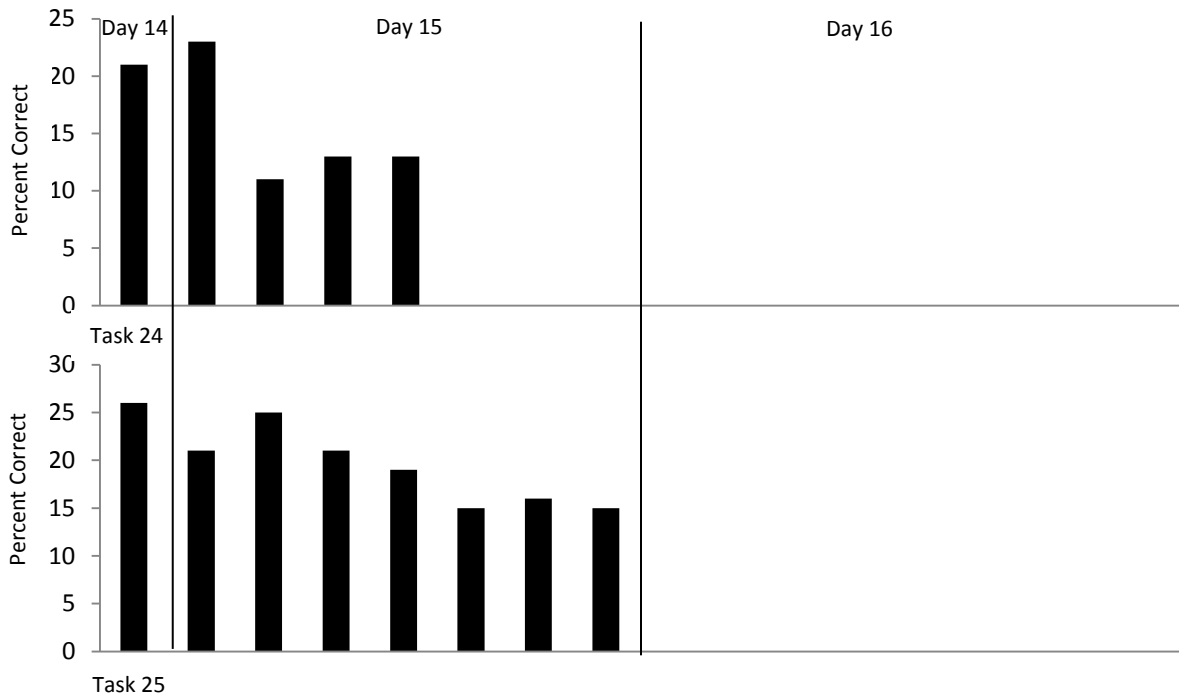
Selective Attention

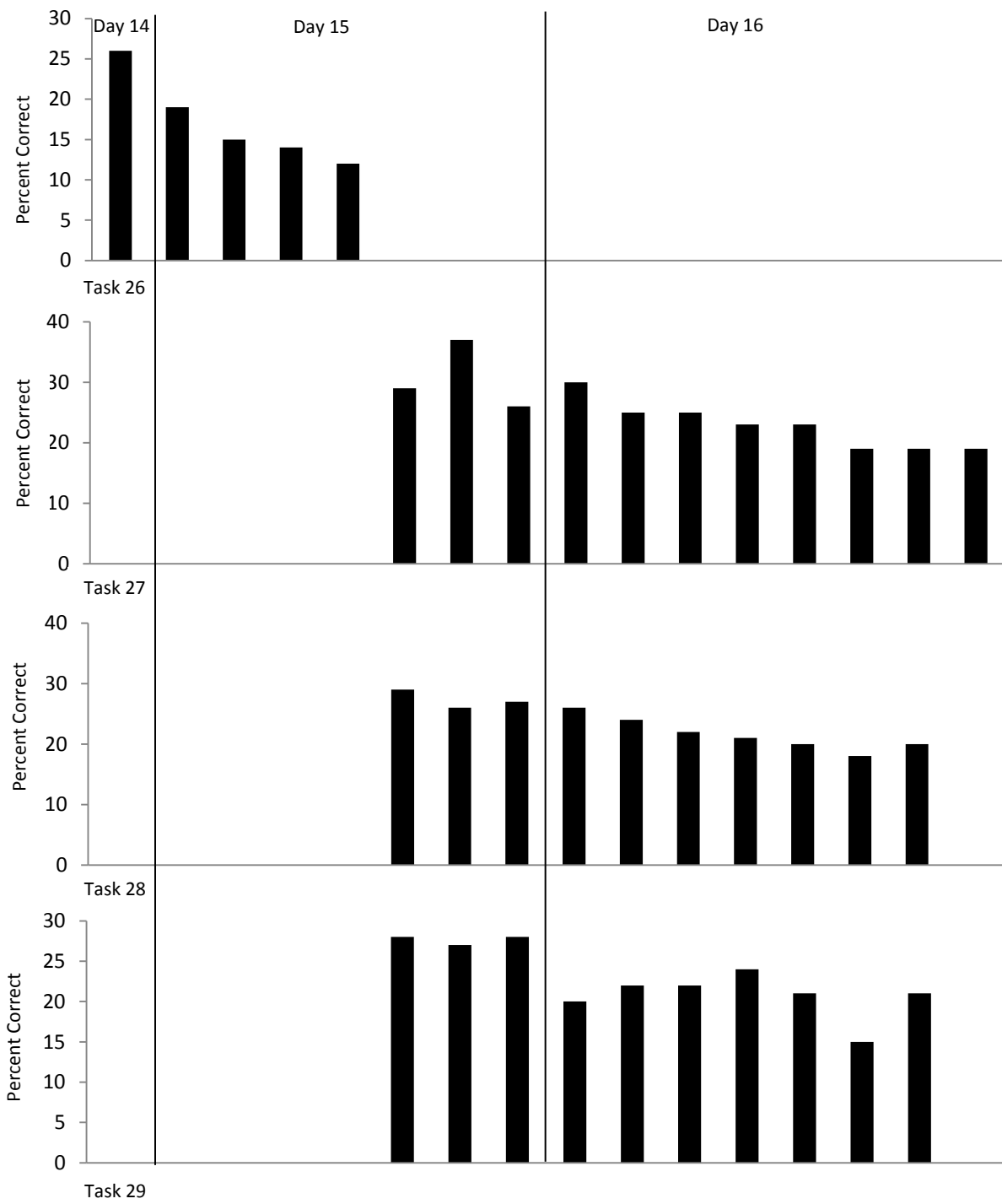






Alternating Attention





VITA

Erin Renee' Guillory was born and raised in Ville Platte, Louisiana. Upon graduating Sacred Heart High School in 2005, she enrolled in Louisiana State University and Agricultural and Mechanical College of Baton Rouge in August 2005. In May 2009, Miss Guillory received a Bachelor of Arts in communication sciences and disorders with a minor in linguistics. Upon completion of her first year of graduate school in communication sciences and disorders, Miss Guillory became intrigued by the research opportunities related to individuals with Parkinson's disease. She then began work on a master's thesis under the direction of Dr. Neila Donovan in partial fulfillment of the requirements for a Master of Arts degree, to be awarded in May of 2011. Upon graduation, Miss Guillory plans to reside in Baton Rouge, Louisiana, where she hopes to complete the necessary clinical fellowship requirements to become a licensed speech-language pathologist.