APT-III

Attention Process Training

A Direct Attention Training Program for Persons with Acquired Brain Injury

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Volume 2 contains Appendix B: Task Scoresheets

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Introduction

Attention is fundamental to cognitive performance. Broadly defined, it encompasses all of the mental processes, operations, and systems requisite for acquiring and applying information. It interacts with other cognitive functions including perception, memory and learning, organization, and reasoning. Attention is core to the integration of these systems; hence, impairments in attention can impact functioning in many different domains.

Unfortunately, attention deficits are among the most prevalent symptoms reported following acquired brain injury. A wide range of patients present with attention deficits— including people with mild to severe impairments—resulting from varying etiologies in both acute and chronic stages of recovery. Management of attention deficits is thus a frequent therapy domain for professionals providing cognitive rehabilitation. The APT-3 program is a direct attention training program, consisting of a series of exercises designed to remediate deficits in attention, and to promote self-regulation and efficient allocation of attentional resources.

New Features with the APT-3

The APT-3 is an update of the previously published APT programs. The basic therapy principles and treatment approach are the same. As with the predecessor programs, the exercises aim to improve the underlying attention deficit by reducing the deficit itself. **The premise is that attentional abilities can be improved by providing structured opportunities for exercising particular domains of attention.** The primary modification with the APT-3 program is the delivery of the exercises via computer. A clinician interface allows the clinician to select exercises and associated parameters in order to create individual patient exercise profiles that are easily modifiable as the patient progresses.

There are several other notable changes with the APT-3 program. First, the attention categories—or attention framework—used to organize the tasks have been updated to reflect the expanded research elucidating the different attention processes commonly disrupted following brain injury. Second, there is an emphasis on pairing the attention training with strategy instruction, and the support of self-regulation. The Task Scoresheets shown in Appendix B facilitate observation of a client's strategy use, and the actual program encourages self-reflection by having the client rate his or her level of effort and motivation after task completion.

The computerized APT-3 assists with scoring and displaying performance data, and facilitates systematic delivery of the attention training exercises. Scoresheets can be printed from the program. However, the clinical decisions involved in selecting a patient's attention tasks, modifying the attention program over time, and measuring outcomes must be made by a professional trained in cognitive rehabilitation. The section below, *Implementation of APT-3,* reviews considerations important for rational, clinical decision-making.

Attention Training in Context

APT-3 is not designed to be a stand-alone rehabilitation program. There are a number of different options for the clinical management of attention deficits in addition to direct attention training. Some of the most common approaches include:

- *Pharmacological management*: use of medications to ameliorate attention symptoms.
- *Training the use of external aids*: selection of and training the use of aids (e.g., alarms, planners, reminder systems) to help individuals compensate for attention deficits and lessen the impact on daily functioning.
- *Environmental/Task modification*: setting up the environment to reduce demands on the attention system (e.g., posting reminders, organizing space and belongings, setting up functional systems such as bill-paying systems).
- *Behavioral modification*: altering antecedents or consequences (e.g., reinforcing facilitative attention behavior) to reduce disruptive behavior and promote desired behavior.

There is strong research evidence supporting the efficacy of each of these approaches for certain patient profiles. Rarely will direct attention training, such as the APT-3 program, be implemented in isolation. While this manual describes the procedures for using the APT-3 program with patients who have attention deficits, it will likely be implemented in conjunction with other interventions. For example, a common cognitive rehabilitation regimen might be APT-3 plus training the patient to use a Smartphone to track calendar and "things to do", and to implement a self-reinforcement regimen to encourage task completion when the patient is having difficulty maintaining attention.

This manual follows with a review of important background information including a description of the target population and types of attention deficits as well as an overview of the treatment evidence. The principles and procedures for conducting attention training using the APT-3 materials are described in the section on Implementation of APT-3. Appendix B contains the scoresheets with the task stimuli. These scoresheets can also be printed from the electronic program.

Background: Attention and the APT-3 Program

The Target Population

Attention deficits are well documented in individuals following traumatic brain injury (TBI). Attention deficits resulting from severe TBI usually co-occur with a host of other cognitive impairments, such as memory impairment, as well as concomitant sensory, psychological, and physical impairments that need to be considered in the rehabilitation process. In more recent years, there has been a focus on understanding the attention deficits that occur following mild traumatic brain injury. The attention disturbances commonly associated with mild traumatic brain injury include decrements in speed of processing (particularly in dual task conditions), sustained attention, and working memory (i.e., the active monitoring and manipulation of information) (Cicerone, 2002; Zoccolotti, Matano & Deloche, 2000). Additional somatic symptoms that often occur in mild traumatic brain injury and contribute to attention difficulties include fatigue, sleep disturbance, headache pain, and vestibular problems (Raskin & Mateer, 2000). Unfortunately, attention deficits are one of the cognitive impairments that frequently persist, and become chronic following both mild and severe brain injury.

Attention deficits have been identified in a number of different clinical groups with neurologic disorders. For example, several recent studies have focused on children and adults with attention deficits induced by radiation and chemotherapies for the treatment of brain cancers (Butler et al., 2008). Radiation therapy for the brain is known to cause damage to cortical white matter, and thus impair neural transmission with reduced attention processing as a result. Similarly, attention deficits have been identified as one of the most prevalent neuropsychological changes following stroke (Hochstenbach, den Otter & Mulder, 2003) with evidence indicating that attention contributes to variability in post-stroke outcomes (Robertson, Ridgeway, Greenfield & Parr, 1997). Less studied, but known to interrupt functioning, are attention deficits associated with a number of diseases and conditions such as multiple sclerosis, chronic fatigue, chemical toxicity, and immunodeficiency syndrome (Raskin & Mateer, 2000). Psychiatric conditions have also been associated with attention deficits. For example, deficits in sustained attention have been documented in people with schizophrenia and a variety of thought disorders (Mirsky, Yardley, Jones, Walsh & Kendler, 1995).

Attention deficits are also well documented for a number of developmental conditions including Attention Deficit Disorder (ADD), Attention Deficit Hyperactivity Disorder (ADHD), Fetal Alcohol Syndrome (FAS), and Learning Disability (LD). Research has attempted to identify profiles of attention deficits that are predominant in each disorder as well as to distinguish between deficits likely to occur with acquired versus developmental conditions. For example, Anderson and colleagues used a continuous performance paradigm to look at profiles of children with either developmental or acquired conditions (Anderson, Anderson & Anderson, 2006). This study found that children diagnosed with ADHD exhibited global and severe attention impairments. In contrast, children who had experienced moderate TBI displayed mild attention difficulties associated with selective and sustained attention. Predicting specific attention profiles based on diagnosis remains speculative, however, and requires clinicians to consider attention as a multidimensional domain that can be differentially impaired in patients who have the same diagnosis.

It is clear that attention is vulnerable to disruption from a wide range of acquired and developmental conditions. The APT-3, like the original APT-1 and APT-2 materials, was developed and used with adolescents and adults with acquired brain injury including TBI, anoxia, and disease processes such as brain tumor. As reviewed, there have been efficacy studies evaluating direct

attention training in other populations, but given the sparse intervention research, it is important that clinicians establish and monitor treatment outcomes for each patient recognizing the program was developed for people with acquired brain injury.

What Do We Mean By Attention?

The construct of attention has been theoretically and systematically explored since the 1800's. We have evolved from the belief that attention is a unitary concept to understanding that it is a multidimensional construct. Attention includes the ability to direct, focus, and sustain interest to stimuli under varying task and environmental conditions. It also includes the ability to control one's attention. It is widely accepted that attention is comprised of several distinct yet interrelated subcomponents. However, the precise components believed to comprise attention vary with different theoretical perspectives. Different models have evolved to account for these various groupings of attention subcomponents.

Attention Theories

Cognitive processing models are based on information collected from unimpaired individuals, and are proposed as models for understanding the manner in which information is processed. The goal of these models is to explain how human beings process incoming information by accounting for the flow of information as it is processed through the system. Early models attempted to explain attention as the ability to give priority processing to certain target information, and inhibit responding to non-target information (e.g. Schiffrin & Schneider, 1977; Treisman, 1969). Baddeley's cognitive processing model describes a system for temporarily storing and maintaining information during the performance of complex cognitive processing, i.e., working memory. This concept has been revolutionary in defining the components of attention (Baddeley, 2001). Working memory involves the short-term storage and manipulation of information relevant to ongoing mental operations and is important for both simple and complex mental activities such as problem solving, language, and learning. Baddeley goes on to describe the central executive as a component of working memory that is an attention control system responsible for strategy selection, and the control and coordination of the processes involved in short-term memory storage.

Related to cognitive processing models of attention are factor analytic models of attention that consider attention from a psychometric point of view. Using this approach, researchers have generated models of attention based upon factor analysis of multiple tests thought to evaluate attention. For example Mirsky et al. (1995) derived a model of attention with four distinct components based on a factor analysis of performance on a range of attention tests: (1) focus-execute; (2) sustain; (3) encode; and (4) shift. These four components are consistent with other information processing and clinical models of attention that minimally incorporate the functions of selectivity, vigilance, and shifting sets.

Another approach to categorizing attention components is to correlate various attentional abilities with the different brain regions that subserve those functions. Research by Posner and colleagues supports a neuroanatomic model of attention. They argue that attention is an anatomically separate system from our human data processing systems, and is comprised of three distinct anatomical networks that correspond to attentional subsystems: alerting (vigilance); orienting (selecting information); and executive control (detecting signals from conscious processing and resolving conflict) (Posner & Rothbart, 2006).

While theoretical differences exist between the various attention models, most include the following subcomponents: maintenance/sustaining attention; selectivity; capacity; and control or shifting attention. These subcomponents reveal the range of processes involved from lower level, more basic attention functions that allow individuals to orient to a particular environmental stimulus to higher-level attention processes that allow individuals to control their attention or manipulate information. There is thus an overlap between attention and executive function abilities.

Rehabilitation researchers have studied atypical populations, and attempted to derive clinical models of attention to link the above theories with observations and analysis of behavior, and performance in patients with neurological impairments. For example, Sbordone (1991) described a clinical model of attention that includes: alertness, stimulus selectivity; concentration and freedom from distraction; vigilance; flexibility; capacity; and speed of processing. Included in his model is the notion of resistance to fatigue and to emotional factors.

Sohlberg and Mateer (2001) described a clinical model of attention that was derived by examining cognitive theories of attention in concert with clinical observations from the assessment and rehabilitation of individuals with traumatic brain injuries. These authors divided attention into five components: focused attention, sustained attention, selective attention, alternating attention, and divided attention. This model served as the framework for organizing the materials in the previous APT programs.

The framework has been modified with current APT-3 materials to reflect the functional importance of executive control and working memory, and the lack of clarity around the concept of divided attention. Consistent with all types of attention theories is the notion that sustained attention and working memory processes are distinct. In the previous model these two attention components were considered in one category along a continuum. The APT-3 materials categorize them separately.

A discussion of the validity of divided attention as a distinct attention component (i.e. the validity of dual-task or multitasking theory) is beyond the scope of this manual, but there is a notable lack of clarity around the conditions or processes necessary for a person to engage in simultaneous processing. Much of what we formerly defined as multitasking may be rapid alternating attention or shifting. As such, we recognize that dividing one's attention necessarily requires attentional control, and we hold the position that the ability to multitask would be addressed by the executive control exercises. Thus, the APT-3 framework does not have a separate divided attention category.

The APT-3 clinical attention model described below allows clinicians to identify discrete attention components that may be differentially impaired, and to then intervene on select areas of concern. The attention framework used to categorize the APT-3 exercises assumes that a clinician can differentially assess and identify attention impairment profiles. The attention components comprising the APT-3 framework are defined below.

APT-3 Clinical Attention Framework

Basic Sustained Attention

Sustained attention refers to the ability to maintain attention during continuous and repetitive activities. It incorporates the concepts of vigilance, persistence, and task consistency. Sustained attention APT-3 tasks would be useful for clients who have short attention spans or lose their concentration over time.

Executive Control: Working Memory

Working memory refers to the processes required for holding on to and manipulating information in one's head such as is required when doing mental calculations. It is the system that allows a person to hold on to information temporarily in order to be able to integrate it with existing information, and then store it in memory. It is also the system that allows a person to retrieve information from a long-term memory and use it, such as remembering a password to access a website. Working memory APT-3 tasks would be useful for clients who demonstrate difficulties holding on to information (e.g., remembering the topic of conversation) during a task.

Executive Control: Selective Attention

Selective attention refers to the ability to selectively process target information while inhibiting responses to non-target information. It is the ability to maintain a behavioral set in the presence of distracters or other competing stimuli, and thus incorporates the notion of "freedom from distractibility". Impairments in selective attention may be seen in individuals who are easily disrupted by external distracters, such as surrounding noise or movement and/or internal distracters, such emotional states (e.g., anxiety, worry). Selective attention APT-3 tasks may be useful for clients who are easily distracted by external or internal stimuli.

Executive Control: Suppression

Suppression is the ability to control impulsive responding. It is related to selective attention and working memory as it requires processing incoming information and inhibiting automatic responses. We have designated suppression a separate category as this area is often difficult for people following brain injury. Suppression APT-3 tasks may be useful for clients who tend to be disinhibited or impulsive.

Executive Control: Alternating Attention

Alternating attention is the ability to shift one's focus of attention. It is the capacity for mental flexibility that allows an individual to switch attention between tasks or activities that demand different behavioral responses or cognitive sets. Impairments in alternating attention may be seen in patients who have difficulty initiating a task after they have been engaged in an alternate activity, or who continue performing according to the parameters of the previous task after they are supposed to shift to a new task. Alternating attention APT-3 tasks are designed to help a person shift their attentional set between tasks, and may be useful for clients who tend to perseverate, lack mental flexibility, demonstrate slowed processing, or have difficulty with working memory.

What Does the Research Say About Attention Training?

The field of cognitive rehabilitation has embraced the Evidence-Based Practice (EBP) movement that tries to ensure that clinical decisions are guided by empirical evidence and, ideally, evidence from well-controlled studies that systematically evaluate outcome, efficacy, and effectiveness of different interventions (Golper et al., 2001). The Academy of Neurological Communication Disorders and Sciences supported research to establish practice guidelines for the rehabilitation of cognitive-communication deficits following brain injury (Kennedy et al., 2002). Part of this work resulted in the development of treatment guidelines and options for the use of direct attention training (Sohlberg et al., 2003). This work reviewed nine experimental studies, and compared participant parameters, attention training components, methodology, and outcomes. Based on the research evidence available at that time, the article made the following practice recommendations.

Candidacy

Evidence was stronger for the efficacy of direct attention training with clients in the postacute rehabilitation phase who had mild to moderate attention impairments and intact basic vigilance. There was not enough evidence to make recommendations about severely impaired clients, and those in the acute phase of rehabilitation.

Critical Components of Attention Training

Evidence was generally supportive of direct attention training when performed in conjunction with metacognitive activities (e.g., feedback, self-monitoring, strategy training), and when training was matched to the individual's attention profile. Sufficient dosage or intensity of treatment (more than one time per week) was also a practice recommendation based on the literature.

Outcomes

The literature suggests that attention training resulted in improvements on standardized attention tests and on activities closely related to the type trained tasks. Generalization of training effects to different daily activities was inconsistently reported. The treatment guidelines emphasized the importance of identifying desired outcomes prior to implementing treatment and making sure that training is closely matched to the attention goal areas.

A Review of Selected Studies Published after the Practice Guidelines

The newer literature continues to support the above conclusions as well as expand the clinical populations with whom attention training has been evaluated. The potential effects of attention training were evaluated in 65 children and adolescents with cognitive impairments following traumatic brain injury (Galbiati et al., 2009). Participants in the experimental attention training group received drill-oriented attention exercises that targeted different aspects of attention such as sustained, selective and divided attention as well as strategy and self awareness training 4 times a week for 6 months. The results were compared to a control group, and showed that participants who received the attention training demonstrated significant gains on tests of attention and on a test of adaptive functioning. The intervention program described in this study contained the essential components of: (1) sufficient intensity; and (2) pairing attention exercises with strategy instruction as recommended in the practice guidelines described above.

A study with similar conclusions compared attention training to nonspecific stimulation in 9 adult patients with traumatic brain injury, and found that attention training had a beneficial effect on improving a number of attention and executive function subsystems, and that improvements generalized to patients' everyday lives (Serino et al., 2006). The attention training in this study utilized a repetitively administered working memory task that required the participants to hold on to number sequences and add pairs of digits. The training was administered 4 times a week supporting the notion

of intensity. Another study that also showed improved attention using graduated attention exercises and strategy training relied on a different rationale for selecting attention exercises (Duval, Coyette & Seron, 2008). Instead of trying to re-establish working memory ability through systematic, restorative training exercises, the authors delivered attention drills designed to encourage a reorganization of how information is encoded by specifically targeting separate components of the central executive or working memory system: storage capacity; updating/revising; and dual-task completion. The authors then used scenario analysis and simulations of real life situations to encourage generalization. Similar to the practice guidelines, Duval and colleagues recommended carefully selected attention exercises that matched the needs of the client (i.e., clients with impaired working memory), and pairing attention training with strategy training and practice during real-life scenarios.

The most rigorous evaluation of attention training in general, and the APT program in particular, was conducted by Butler and colleagues (Butler et al., 2008). This group conducted a randomized controlled trial of a cognitive remediation program for 161 children and adolescents who were at least 1 year post-treatment for cancer, and who manifested acquired attention deficits. They were enrolled in studies at 7 sites nationwide. The cognitive remediation program consisted of APT exercises and explicit strategy training. The results showed significant improvements on parent report of attention changes and increases in academic achievement. The authors suggest that APT in conjunction with strategy instruction is a potentially beneficial treatment for survivors of pediatric cancer with acquired attention deficits.

The APT program has also been evaluated as a possible treatment for reading deficits in patients with mild aphasia. The notion is that attention deficits play an important role in acquired language impairments, and if attention can be improved, it may result in improved language skills. Positive gains in reading skills including reading rate, comprehension, and the ability to read increasingly complex passages were documented in two single-subject experiments following an 8-week course of APT training (Coelho, 2005; Sinott & Coelho, 2007). The research identifying attention deficits as a predominant cognitive impairment in individuals following stroke has encouraged further exploration of APT with this population. A prospective, randomized controlled clinical trial was conducted to examine the impact of APT on attention and functional outcomes in survivors of first-time stroke. The results of this trial were positive with those receiving APT (treatment group) improving significantly when compared to those receiving standard care (control group) on the primary attention outcome measures (Barker-Collo, Feigin, Lawes et al., 2009).

Results of an evaluation of the potential impact of APT on cognitive functions in patients with schizophrenia revealed the complexity in trying to predict training outcomes on different attention profiles (Lopez-Luengo & Vazquez, 2003). Twenty-four patients with schizophrenia were randomly assigned to either APT or no training. Those in the APT group received twice weekly training. Both groups were tested on a number of different cognitive measures. Contrary to expectations, the APT group did not improve on attention tests, but did show significant improvement on a test of executive function in comparison to the control group. The authors concluded that it is feasible to use attention training exercises to remediate executive function deficits in patients with schizophrenia.

But Does It Generalize?

The number of studies supporting the efficacy of direct attention training in general, and APT in particular, is growing. There is research evidence showing that different clinical populations with different cognitive profiles improve following attention training. What is not clear is how much the training is task- or domain-specific. There is a complexity introduced by the range of treatment and population variables that have been studied in the literature—at this stage in our knowledge, it is not possible to prescribe a set treatment protocol for a specific patient profile to achieve an expected

outcome. The impact of factors such as the frequency of attention training, inclusion of supplemental intervention components such as strategy training, and patient-specific characteristics is far from clear. We can say that, by and large, intensively presented attention drills that stimulate impaired subcomponents of attention can enhance the corresponding processing abilities. In some patients, training has been shown to generalize to functional activities that specifically require these abilities and/or to related cognitive processes that are dependent upon the trained attention areas. The combination of available research and our clinical experience suggests that the likelihood of generalization and transfer is enhanced when attention training occurs twice weekly or more and is accompanied by strategy training that encourages self-regulation and deliberate allocation of attentional resources as described in the implementation section.

What Types of Metacognitive Strategies Have Been Paired with APT?

Because the research is increasingly showing the enhanced efficacy of metacognitive strategy instruction, we describe several of the strategies that have been evaluated in the literature in conjunction with APT training. The field of cognitive rehabilitation provides strong support for the efficacy of training an individual to self-regulate or to "think about his or her own thinking", and to self-monitor while performing an activity (Kennedy et al., 2008). The goal is for the learner to use methods to affect his or her own learning and behavior. When paired with attention training, strategy instruction usually focuses on helping the patient efficiently allocate his or her cognitive resources. It often includes provision of feedback, goal setting and self-awareness enhancement.

Cicerone and colleagues (2002) paired attention exercises designed to tax working memory with strategy instruction in patients with mild TBI. The strategies were designed to help patients allocate attentional resources, and manage the rate of information during task performance. Examples of strategies included verbal mediation, verbal rehearsal, anticipation of task demands, and self-pacing. The authors also encouraged the patients to self-monitor their effort during performance. Specific to the use of APT, one large randomized controlled trial (Butler et al., 2008) divided the cognitive strategies used in conjunction with APT into temporally organized strategies to be used at different points in time during a task. They taught patients the following types of strategies: *Task Preparation Strategies* (e.g., goal setting, relaxation, establishing a ready-set); *During-Task Strategies* (e.g., visualization, re-auditorization, marking your place, taking a break); and *Post-Task Strategies* (e.g., rewarding self, double checking). Other metacognitive strategies include the provision of feedback and having clients reflect on their performance in order to enhance engagement and motivation (Galbiati et al., 2009).

Why Would APT Work?

Biological mechanisms have been identified that could account for the changes observed following attention training. We know that the brain is a dynamic organ capable of reorganization following neurological impairment. When we provide attention training, our goal is to positively influence that neural reorganization and encourage connections that will boost attention. Although attention is extremely vulnerable to disruption, as demonstrated by the range of acquired and developmental conditions that have attention impairment as a core symptom, it also appears to be amenable to improvement.

APT is based on the premise that neuroplasticity can be encouraged. The research evaluating neuroplasticity is growing with the advent of different technologies that allow us to measure activity in different neural networks. One study is relevant in particular to identifying possible mechanisms responsible for benefits with APT: Kim and colleagues (2009) explored the cerebral attention

network in patients with TBI using functional magnetic imaging (fMRI). Specifically, the authors assessed possible changes in the attention network following direct attention training. Ten patients completed attention training 3 times per week for 4 consecutive weeks using tasks designed to train sustained and divided attention in both visual and auditory modes. Participants then received follow-up fMRI studies using a visuospatial attention task and were compared to healthy individuals. Following the cognitive training, the patients with TBI demonstrated improved performance on attention tasks accompanied by changes in attention network activation including a decrease in frontal lobe activity and an increase in the anterior cingulated cortex activity. The authors suggested that the results demonstrate the plasticity of the neural networks, and the ability for attention training to induce redistribution of the visuospatial attention network in patients with TBI.

The next section reviews principles and procedures for implementing APT-3. While many of the procedures are evidence-based, and have support in the research literature, other practices represent clinical heuristics, and have yet to be validated. As with all rehabilitation, it is critical to establish baseline functioning and outcome measures, and to treat each patient as a single case, continually evaluating treatment effects. The best clinical evidence is patient-specific treatment response. Clinicians ultimately need to make clinical decisions based on patient response measures. The details of the therapy program should be rationally derived from research findings, the patient's values, and the documentation of change—or lack of change—over time. These are the ingredients for a scientific practitioner.

Implementation of APT-3

The APT-3 program is a direct attention training approach aimed at improving underlying attention deficits secondary to acquired brain injury. As noted, restorative approaches such as direct attention training are based on principles of neuroplasticity. The different attention components described under the APT-3 framework are trained using structured drills or tasks targeting the specific attention areas. The premise is that repeated activation and stimulation of a particular attention subcomponent will strengthen connections in the underlying neural circuitry, and lead to a corresponding increase in that processing ability.

As described in this section, patients complete a series of repetitive exercises with increasingly greater attention demands. The exercises resemble laboratory tasks, which, in and of themselves, are not functional; hence, generalization issues are critical. The reason for using discrete attention tasks rather than multidimensional functional activities is that most functional activities, for example, cooking or money management, do not allow targeted practice of select attention processes because they require activating a range of cognitive processes (e.g., visuoperceptual abilities, organization, reasoning, etc.). The procedures described in this section allow targeted stimulation of discrete attention subcomponents while encouraging transfer of improved processing to everyday functioning. The APT-3 software facilitates standardized, efficient delivery of the discrete attention tasks and provides self reflection opportunities. Clinicians deliver this therapy in conjunction with strategy training and generalization activities.

Adhering to a set of overarching therapy principles helps to ensure delivery of an effective, efficient therapy program. The following APT-3 principles pertain to any "process-oriented" or "impairment-based" cognitive rehabilitation approach that relies on high rates of specific practice or drill to encourage neurological recovery. They have been described and validated for a variety of cognitive rehabilitation domains including attention, language, and prospective memory functioning (e.g., Raskin & Sohlberg, 2009; Sohlberg & Mateer, 2001). As noted, the clinician's challenge is to design therapy so that cognitive improvements generalize to the performance of relevant everyday activities. The therapy principles described below should be followed when implementing the APT-3 to promote maximum impact and generalization.

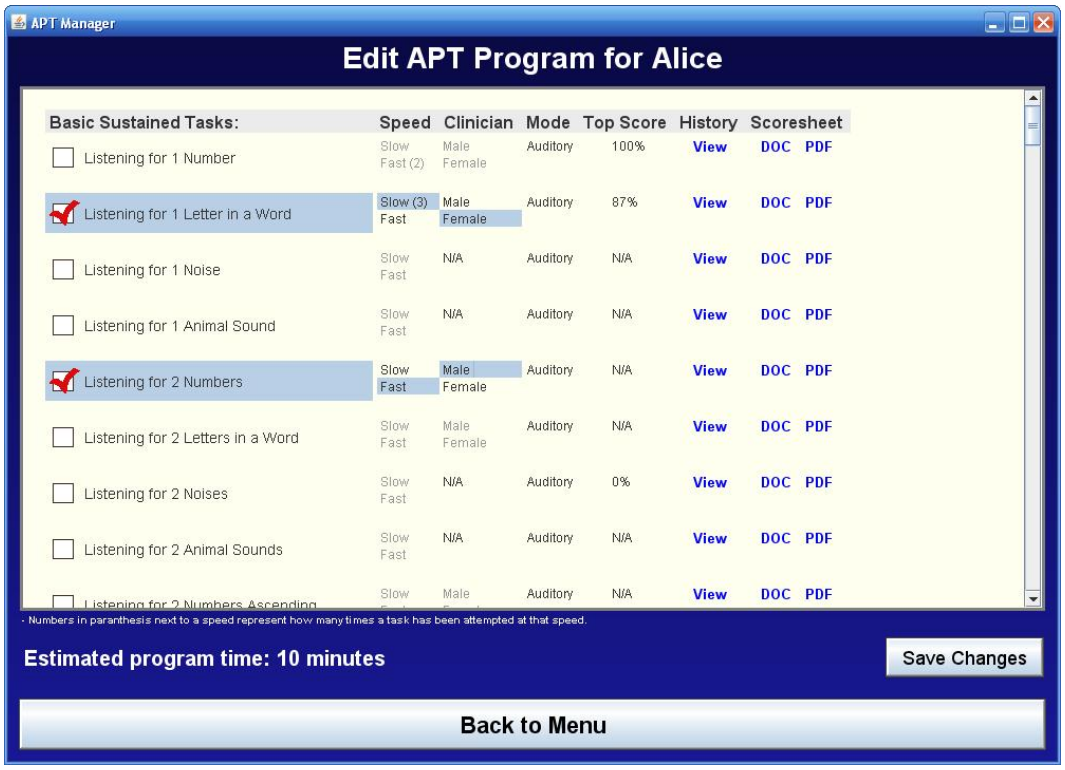
APT-3 Therapy Principles

Principle One: Organize Therapy Activities Using a Theoretically Grounded Model

Working from a model ensures a scientific basis for the treatment hierarchies being utilized. It also promotes the systematic delivery of a therapy regime as it organizes assessment and treatment activities. **The APT-3 program is based on a rational, theoretically derived clinical model of attention including: basic sustained attention; working memory; selective attention; suppression; and alternating attention.** These categories enable the clinician to group exercises that target similar attention networks and arrange tasks hierarchically in order to provide repetitive activation of that particular system.

The Create and Edit APT Program screens contained in the APT Manager software list all of the APT-3 tasks within each type of attention component. The clinician can easily see the available options for working on particular types of attention. As can be seen in Figure 1, the clinician has chosen 2 tasks under the attention component Basic Sustained Tasks. Speed and voice have also been chosen for each task.

Figure 1. Task Selection Screen



Principle Two: Provide Sufficient Repetition

Sufficient intensity of training is critical for facilitating reorganization of brain networks and/or establishing an attention skill so that it becomes automatic. If therapeutic constraints do not permit repetition, establishing a home therapy program or enlisting caregivers in a practice regimen outside of established clinical hours might be an important adjunct to therapy. A general recommendation based on review of the literature suggests a minimum of twice weekly APT-3 sessions for six weeks. Some clients may need to have more frequent sessions for less time. In our own clinic, we try to have clients complete three 45-minute APT-3 sessions per week for a 6-8 week duration. At least 30 minutes in a session are devoted to completing the APT-3 tasks and the remaining time is used for metacognitive strategy training.

Home practice for the verbal self-paced working memory tasks may be encouraged by printing stimuli for the tasks and having a care provider deliver the stimuli orally. Alternatively, a clinic may decide to purchase two APT drives and use one as homework drive or as a practice drive for an extra computer station where clients can come do independent supplementary practice.

Product Note: Because the intensity of practice is critical, a dedicated "homework" drive is under development that will allow clinicians to upload a client's specific APT-3 home exercises.

All purchasers of APT-3 will receive notice when it becomes available as a supplement to the APT-3 program. If a clinic already purchased a second APT-3, they can trade in their second drive for a set of homework versions.

Each APT-3 task is 3 minutes. When the clinician selects the tasks for a client's program, it automatically totals the program time to help the clinician plan for sufficient repetition. In Figure 1, the clinician is told that the current program totals 10 minutes. The clinician can also see that the client performed the first selected task with a top score of 87% on past trials. The clinician can see the entire record of past trials by clicking the View button in the History column.

Principle Three: Use Patient Performance Data to Direct Therapy

Ongoing evaluation of the utility and efficacy of a clinical treatment tool is only possible when the clinician gathers data. Indeed, data-based treatment allows the clinician to make informed decisions about when to start, stop, or modify a therapy program. For example, if a client's performance on a particular attention task appears to plateau, and no further progress is demonstrated, a clinician might develop a branch step to simplify the task in order to facilitate improvement at that difficult juncture. Data can also be a motivating factor for many patients: showing a patient his or her performance on a graph can be an objective, powerful illustrator of progress. The APT-3 attention tasks lend themselves well to being data-based: performance on most tasks can be empirically described using measurements of accuracy and speed in addition to documentation of qualitative information such as error profiles and strategy use.

The APT-3 software shows patient performance data in several ways. Scoresheets are available in Appendix B and can be printed out to document observations of strategy use and error patterns. The program will provide performance feedback following completion of each task and display error patterns. On the Performance Data screen, a clinician can click the "Task Data Over Time" button to see patient data on a particular task over time. Additionally, the clinician can click the "Detailed Task Data" button to look at specific performance on the five most recent attempts of a specific task. Figures 2 and 3 give an example of each.

Figure 2. Performance Data Over Time

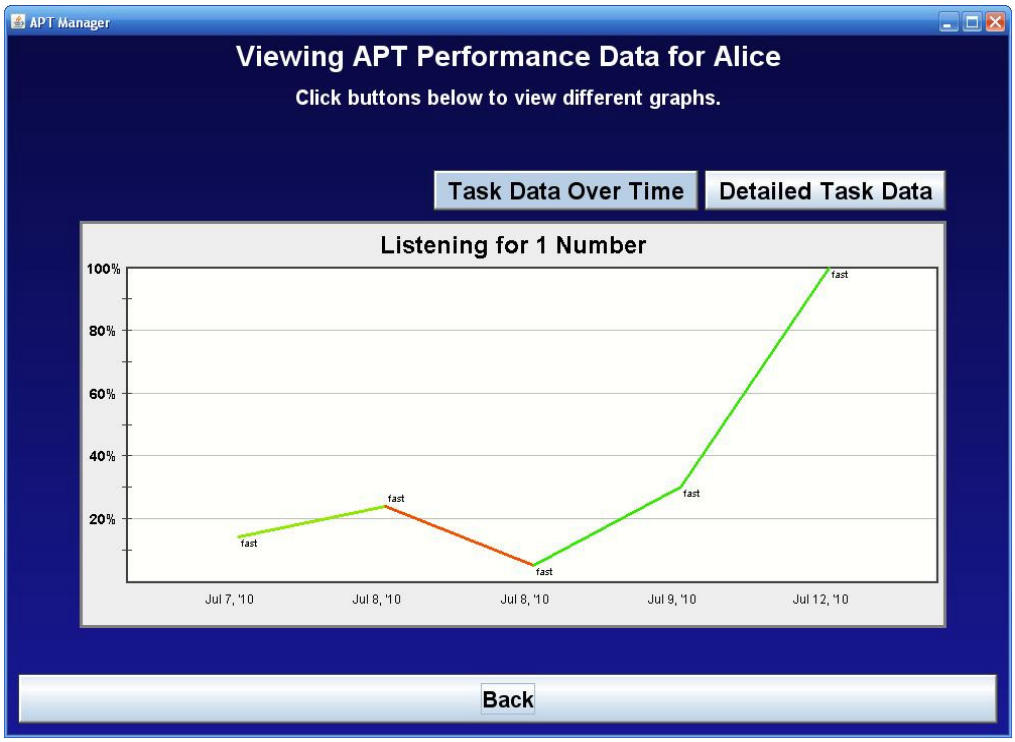
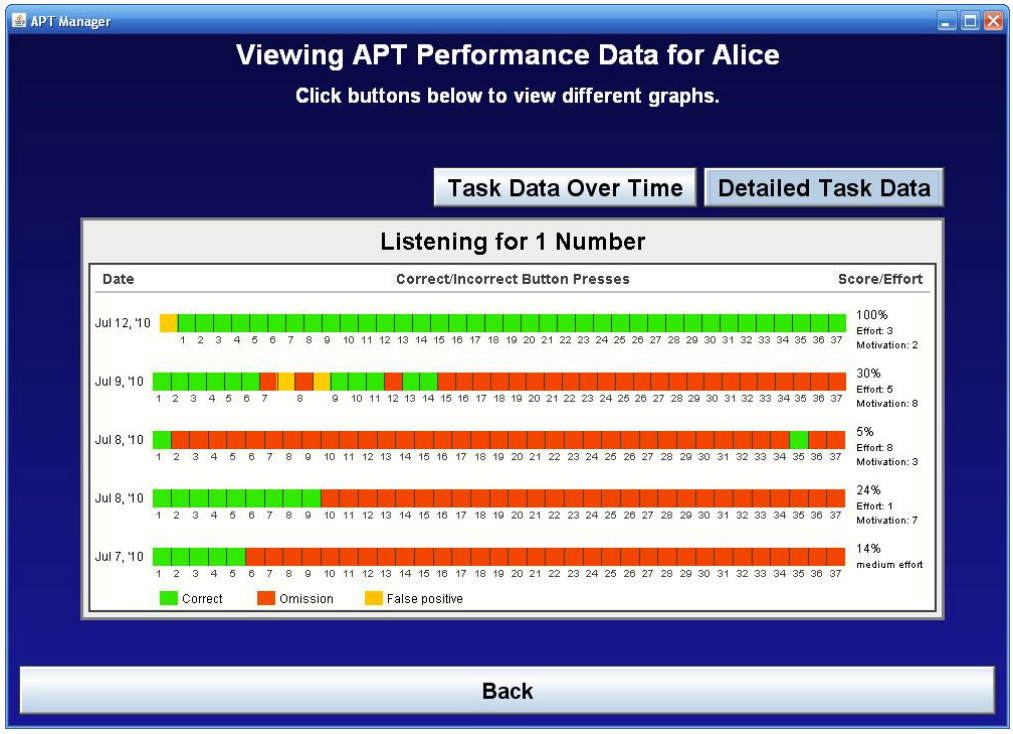


Figure 3. Detailed Performance Data



Principle Four: Include Metacognitive Strategy Training

Strategy instruction encourages patients to mobilize their attention, and deliberately allocate their cognitive resources to maximize processing and task performance.

Strategy instruction may be aimed at:

(1) Educating patients about their strengths and vulnerabilities,

(2) Increasing their awareness of their own attention issues so that they can be more deliberate in their processing,

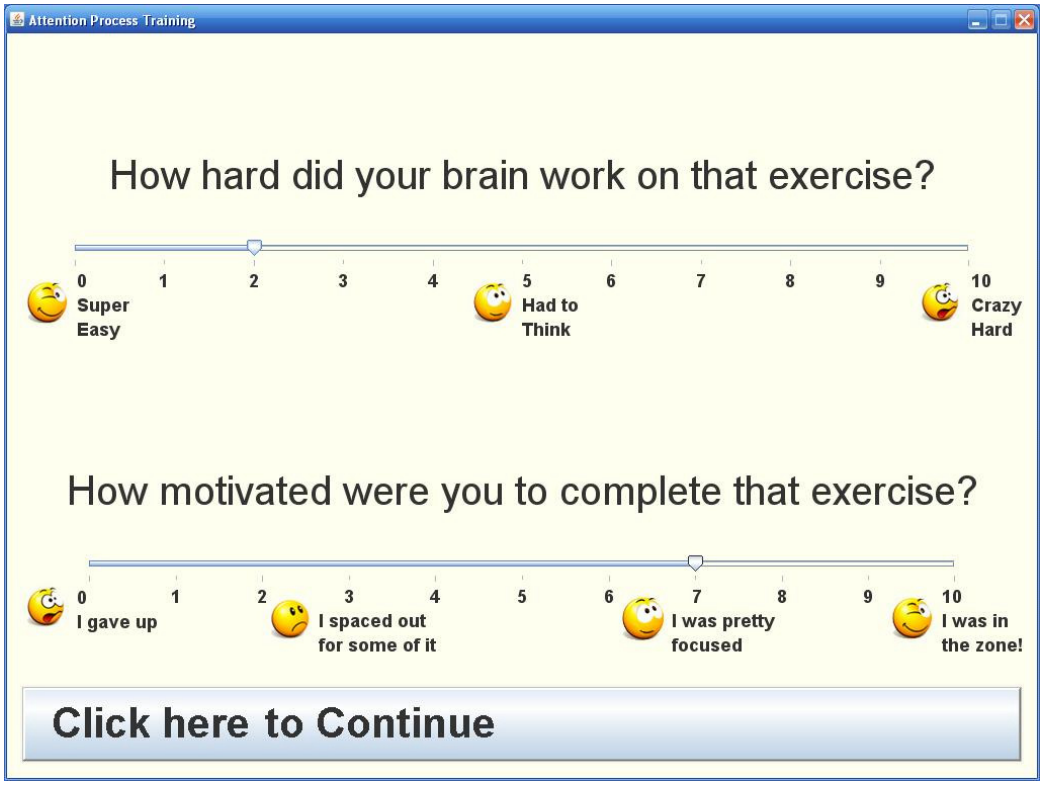
(3) Identifying specific task completion strategies to help them efficiently allocate cognitive resources,

(4) Improving self-monitoring and self-regulation during task completion, and/or

(5) Identifying strategies or types of feedback that increase motivation or effort to ensure maximum benefit from the program.

The APT-3 program provides self-rating opportunities after completion of each task as seen in Figure 4: the client is asked to reflect on his or her motivation and level of effort. These data are part of the performance data that are recorded and encourage the client to consider level of engagement and task difficulty. As described in the *Assessment Process* section, the clinician and client will have selected strategies that the client will practice with paper-and-pencil in conjunction with the computerized APT-3 tasks. There is a place on the scoresheet to record usage of these strategies. As shown in Figure 1, a printed scoresheet can be obtained under the Scoresheet column. Scoresheets are also provided in the manual in Appendix B. The clinician will want to print out the scoresheet before commencing with computer-managed tasks.

Figure 4. Self Monitoring Screen



Principle Five: Identify and Practice Functional Goals Related to Attention

The ultimate measure of success of any cognitive rehabilitation program is improvement in an individual's ability to manage work, daily living, or leisure time activities, not simply improvement on practiced therapy tasks. The assessment process should specify the types of attention that are impaired, and the impact of the impairment on the individual's daily functioning. For example, the primary effect of an attention deficit for an inpatient may be an inability to sustain attention during physical and occupational therapy activities. The primary impact for an outpatient with mild attention impairments may be mental fatigue, and the overwhelming level of effort required to complete routine vocational activities. As described in the *Assessment Process* section of this manual, every client receiving APT-3 should have functional goals that are evaluated in conjunction with administration of standardized tests of attention. Identification and practice of functional goals will serve both therapeutic and assessment purposes. Having patients engage in tasks that require the same type of processing that is being trained by the exercises will promote generalization while allowing assessment of the impact of the training on completion of day-to-day tasks. Currently, the APT-3 software tool does not manage functional goals of a patient. The clinician is required to use their own notes to track and monitor this information.

The Assessment Process

The APT-3 is designed to be implemented following an assessment of attention. This section describes a recommended approach to assessment that would lead to the selection of appropriate clients for direct attention training, and allow the clinician to administer the APT-3 program effectively. **The APT-3 software tool currently does not attempt to manage assessment, but instead supports the post-assessment therapy phase.**

Initial Assessment

Assessment of attention abilities is only one part of a neuropsychological evaluation necessary for measuring functions across a broad range of cognitive, psychological, and behavioral factors. There are three primary assessment needs when providing attention training.

First, clinicians will need to determine what type(s) of attention are impaired, and should be targeted by the attention exercises. This will usually require administration of standardized tests sensitive to different attention impairments. In addition, the clinician will want to use clinical interviews, questionnaires, and observations to identify whether there are specific subcomponents of attention that are differentially affected.

Second, clinicians will need to measure the impact of identified attention impairments on clients' daily functioning. An assessment of the functional effects of an attention deficit is important for establishing treatment goals, facilitating generalization (see *Therapy Principle Five* above), and measuring therapy progress. Structured observations, clinical interviews and questionnaires are the assessment tools that will be the most useful for this purpose.

Third, clinicians will need to assess clients' metacognitive functions with respect to their attention. Understanding a client's level of awareness about his or her cognitive profile, the client's level of motivation for improving, any strategic behaviors he or she uses to compensate for deficits, and any improvements in self-regulation that occur during task completion are critical for establishing a therapy program. Assessment practices vary between treatment settings and staffing patterns, thus the manner in which these three assessment needs are addressed will depend upon the specific treatment context.

Regardless of the treatment setting, it is helpful to engage in clinical hypothesis testing during the assessment process in order to meet the above three assessment needs. There are multiple explanations for why a person might have difficulty performing a given real-world task, one of which is attention deficits. There are also numerous contextual variables that may affect an individual's performance. To understand the nature and effect of an attention impairment, the clinician will want to test hypotheses generated during the initial assessment. For example, if an initial clinical interview suggests that a client's primary difficulty is with sustained attention, or maintaining attention over time, the clinician would hypothesize that the client may have more difficulty completing a test that uses a continuous performance task (e.g., *Conners' Continuous Performance Test-II*; Conners, 1992), and that there would be an error pattern on tests and home activities showing increased errors over time. On the other hand, if the clinician thought the primary difficulty was with working memory, particularly suppression or inhibition, the clinician might hypothesize lower performance on a test requiring inhibition (e.g., *Stroop Color and Word Test*; Golden, 1978) and would expect to observe impulsivity during everyday task performance.

Coelho, Ylvisaker and Turkstra (2005) describe a dynamic assessment process they call *collaborative contextualized hypothesis testing* that is very useful for evaluating cognitive and behavioral changes following brain injury, and encourages involving natural supports in the assessment process using observations of performance on authentic tasks in natural settings. They suggest that assessment should be ongoing, and should rely on multiple observations of behavior in naturalistic settings, and should involve relevant people who interact with the client in his or her daily life.

Standardized attention tests can provide important information about the nature and severity of an attention deficit, and may provide a baseline indicator of overall function. However, clinicians should have a rationale for selecting particular attention tests as well as hypotheses that drive the test selection and analysis of performance. Also, the relationship between standardized tests and functional behavior is far from clear so it would be necessary to use informal assessments that capture a client's functioning in real-world settings.

The clinical bottom-line for assessment is that the clinician must engage in a process that elucidates the client's individual attention profile including the type of impairment(s), the affect of the attention impairment on the client's everyday functioning, and the client's ability manage his or her impairment with behavior regulation and adaptation.

Tools to assist with this include static standardized attention tests, clinical interviews and observations, and dynamic assessment using standardized tests or informal activities where the clinician manipulates the context (e.g., adding potential distracters or prompts) to determine potential effects on performance. Table 1 provides examples of standardized tests and formal questionnaires. Table 2 provides sample clinical interview questions designed to elicit information about a client's attention, and the impact of any impairments on daily living. It is paramount that clinicians have training in assessment in order to administer and interpret both formal and informal tests, and to conduct clinical interviews. Note these lists are meant to provide exemplars of the types of assessment and interview questions, and are in no way comprehensive.

TABLE 1

Sample Standardized Tests of Attention, Attention Questionnaires, and Measures of Awareness

Sustained Attention/Vigilance
▪ Digit Span-Forward (*Wechsler Abbreviated Scale of Intelligence*; Wechsler, 1999) ▪ Conners' Continuous Performance Test-II (Conners, 1992)
Working Memory and Executive Control
▪ Trail Making Test B (Reitan, 1969) ▪ Paced Auditory Serial Addition Test (Roman, Edwall & Buchanan, 1991) ▪ Stroop Color and Word Test (Golden, 1978)
Mixed Batteries (Subtests assess sustained, selective and alternating attention, and working memory)
▪ Test of Everyday Attention (Robertson, Ward, Ridgeway & Nimmo-Smith, 1994)
Attention Questionnaires
▪ The Cognitive Failures Questionnaire (Broadbent, Cooper, FitzGerald & Parkes, 1982) ▪ The Moss Attention Rating Scale (Whyte, Hart, Bode & Malec, 2008) ▪ The Rating Scale of Attention Behavior (Ponsford & Kinsella, 1991)
Metacognitive/Awareness Assessments
▪ Patient Competency Rating Scale (Prigatano, 1986) ▪ Self Awareness of Deficits Interview (Fleming, Strong & Ashton, 1996) ▪ Strategies Assessment (counting number of strategies client learns and retains) (Butler et al., 2008)

TABLE 2 Sample Structured Interview Questions

Questions to Determine the Type of Attention that is Affected
▪ Your responses on the attention questionnaire suggested you have the most difficulty with (*maintaining your attention/distractibility/slowed thinking/switching between activities/easily becoming overwhelmed with information* etc.) How does that match or not match your perceptions of your attention challenges? ▪ Your wife described instances when you (lose focus/don't hold on to what she says, etc.) Can you give me some other examples of when that happens? ▪ I noticed when you were taking all these tests you tended to make more errors (*at the beginning/end/when you were getting fatigued* etc.) Would this be typical for you?
Questions to Determine the Impact of an Attention Deficit
▪ What bothers you the most about your attention/memory difficulties? OR ▪ What activities does your difficulty with attention affect the most? OR ▪ When do you notice your attention deficit the most? OR ▪ When is your attention problem the most frustrating? OR ▪ What kinds of conditions make the attention problem worse?
Questions To Probe What Strategies Might be Useful
▪ When do you NOT notice your attention deficit? OR ▪ When do you feel like you perform your best? OR ▪ What kinds of things do you do or others do that lessen the problem?

Evaluating Metacognition

The literature supports the importance of metacognitive strategy training in conjunction with structured attention exercises. There are three related, but distinct goals for the metacognitive strategy training component of APT-3:

(1) Increase the client's awareness of attention deficits and strengths to increase adaptive behavior,

(2) Increase the client's motivation (and thus level of effort expended) to participate in attention training, and

(3) Identify and train specific strategies that are useful for increasing an individual client's attention functioning.

The initial assessment process will assist in determining the client's self-awareness regarding his or her overall cognitive functioning and level of motivation to participate in therapy. The initial interview and awareness/strategy questionnaires will assess the client's perceptions of his or her own functioning. Table 1 gives examples of questionnaires to help assess awareness and metacognitive abilities, and Table 2 lists sample interview questions to elicit ideas for helpful strategies. Additionally, the initial assessment will include observations of the client's reactions to testing. Hence interview, observation, and questionnaires will provide helpful tools for evaluating awareness and relevant affective variables such as motivation and compensatory strategy use.

The selection of specific strategies to compensate for attention deficits will also be based on the clinician's observations with the client. The aforementioned hypothesis testing process is an excellent method for identifying potentially effective strategies for individual clients. During the assessment process, the clinician will generate hypotheses about what types of strategies might be most useful for the client given his or her specific attention impairment. The client can then be asked to complete therapy tasks, or functional activities that require use of the impaired attention system. The clinician will ask the client to try specific strategies and evaluate the impact of strategies and observe any changes in performance. From these observations, a list of potential strategies can be generated. This dynamic assessment process allows the client and clinician to evaluate together whether the strategies are doable for the client and whether they are effective. Clients with intact awareness will be able to participate more fully in the strategy selection process. For example, a client may be able to rate the perceived utility of several potential compensatory strategies. Table 3 lists common strategies used to improve performance on activities with high attention demand.

TABLE 3 Sample Metacognitive Strategies

Task Completion Strategies
▪ Re-auditorization (verbal mediation) ▪ Visualization (mental imagery) ▪ Self cues (verbal prompts to self) ▪ Counting on fingers, marking place ▪ Closing eyes ▪ Breathing and focusing ▪ Pacing, taking breaks ▪ Body alert (sitting straight, facing material) ▪ Looking at screen ▪ Double-checking performance ▪ Using an agenda and checking off completed items ▪ Set a timer or auditory cue for switching tasks
Strategies to Increase Motivation or Decrease Anxiety
▪ Working toward a goal (e.g., setting a task objective; trying to beat a score) ▪ Self-talk (e.g., positive verbal self-reinforcement) ▪ Rewarding self (e.g., giving self a predetermined treat at end) ▪ Breathing, relaxation techniques ▪ Reviewing previous performance ▪ Predict easy/hard task components
Strategies to Increase Task Understanding
▪ Repeating instructions ▪ Written reminders ▪ Asking for a model

Measuring the effect of strategies will be important during the initial assessment, and throughout treatment and generalization training. A clinician will record this information on the APT-3 scoresheets described under the administration of the APT-3 program. Ideas for how to measure the impact of strategy use are listed below.

- Number of errors when using the strategy to perform a target task or activity
- Number of accurate solutions generated when using a particular strategy
- Frequency of occurrence of attention failures or other difficulties targeted by the strategy
- Perception of stress or burden following strategy training

Measuring Treatment Progress

Measuring performance changes on tasks over time will be important for monitoring ongoing treatment effects, and are discussed in the *APT-3 Task Administration* section of this manual. Additionally, evaluation of performance on untrained, but related, objective measures will provide an indication of treatment effects. Post-treatment re-administration of tests and questionnaires in order to evaluate potential change from baseline levels is a traditional method for measuring treatment progress. Summative assessment using standardized and/or norm-referenced measures has the advantage of being objective, and often provides a normative index. In addition to evaluating impairment-level changes, it will also be important for the clinician to assess generalization of treatment effects to daily functioning. This may be done on an ongoing basis or after a predetermined therapy period, but will require the clinician to identify generalization activities or therapy impact indicators during the initial assessment process.

Goal Attainment Scaling

It is important to plan for generalization from the beginning of treatment by setting meaningful, functional outcome measures. Measuring goal achievement allows a clinician to evaluate a client's progress towards meeting individualized goals and ensures that treatment is of value to clients. Goal Attainment Scaling (GAS) is a systematic, concrete goal measurement process that encourages clients to establish a continuum of possible treatment outcomes (Malec, 1999; Schlosser, 2004). It involves clients in the rehabilitation process, and can facilitate engagement in the therapy process. We recommend including GAS with the APT-3 training, and establishing it during the initial assessment period. The steps for developing and using GAS are listed in Table 4.

TABLE 4 Six Steps for the Development and Implementation of Goal Attainment Scaling

1 Goal selection
2 Weighting/prioritizing goals
3 Designation of follow-up time period
4 Articulation of the “expected” level of outcome in objective, behavioral terms
5 Articulation of other outcomes levels, both desirable and undesirable
6 Assessment of GAS at the beginning of attention training and at designated follow-up periods

Malec (1999) describes the benefits of GAS for measuring rehabilitation goals in clients with TBI, and details the above steps.

The first step in the GAS process involves the identification of goal areas that are then shaped into more specific goal statements. Typically between three and six goals are described and endorsed by the client.

The second step is to weight the goals or prioritize the importance of each goal. If they are equally important they are all given a weight of 1.

The third step is to define the time period after which GAS will be assessed, which is referred to as the follow-up time period.

The fourth step involves delineating the “expected” level of outcome, which is assigned a score of "0".

Typically, the “expected” level of outcome is a level that is realistic and that the client can achieve in the specified time with reasonable degree of effort. Following specification of the expected outcome level, other less desirable and more desirable outcomes are defined:

“Better than expected” (+1);

“Much better than expected” (+2);

“Less than expected” (-1);

“Much less than expected” (-2).

GAS may be used for a variety of cognitive and behavioral rehabilitation targets for one client. The examples here refer to the domain of attention. In our clinic, we begin the GAS process with respect to attention training by asking the client, “If these exercises are useful to you, how would you know?” or “What do you hope will improve in your daily functioning by working on these attention exercises?” Two examples of GAS for attention are provided in Tables 5 and 6 below.

TABLE 5 Sample Goal Attainment Scales for Improving Sustained Attention

	Goal: I will be able to maintain my attention long enough to complete tasks at my desk and be able to read the newspaper.
+2	I will be able to read the paper for 45 minutes in the morning and sort the mail, including paying bills and responding to correspondence, for a minimum of 45 minutes in the afternoon.
+1	I will be able to read the paper for 30 minutes in the morning and sort the mail, including paying bills and responding to correspondence, for a minimum of 45 minutes in the afternoon.
0	I will be able to EITHER read the paper for 30 minutes in the morning OR sort the mail, including paying bills and responding to correspondence, for a minimum of 30 minutes in the afternoon.
-1	I will be able to EITHER read the paper for 30 minutes in the morning OR sort the mail, including paying bills and responding to correspondence, for a minimum of 30 minutes in the afternoon with breaks every 5-10 minutes.
-2	I will not be able to sit down and continually read the paper or do desk tasks and my mind will just wander when I try to do these things.

TABLE 6 Sample Goal Attainment Scale for Improving Working Memory

	Goal: I will be able to hold on to information better and have fewer attention slips.
+2	My wife will not have to repeat information during our conversations as I'll be able to hold on to what she is saying.
+1	My wife will only have to occasionally repeat information during our conversations — less than once a day.
0	My wife will only have to repeat information during our conversations one time a day.
-1	My wife will have to frequently remind me what we are talking about during most of our conversations.
-2	My wife will always have to remind me of what we are talking about during our conversations.

Whether or not a clinician uses the systematic GAS process, it is critical to establish functional goals that would be expected to improve as a result of attention training. The APT-2 program referred to functional goals as "Generalization Activities". They are activities that are affected by attention deficits, and are expected to improve with attention training. They may be used as part of the GAS process and/or to facilitate generalization by having the client become more aware of how he or she is attending or encoding during these tasks. Examples of functional tasks that may be used to measure treatment outcomes, and facilitate generalization include:

- Increasing the amount of time the client can engage in a specified productive activity (e.g., reading, computer work, vocational task)
- Decreasing the amount of cognitive effort it takes to complete a specified productive activity
- Adding a desired, attentionally-demanding activity to one's repertoire that has not been previously possible (e.g., driving)
- Decreasing errors on specified activity
- Decreasing completion time for a specified activity

Baseline levels of performance will be established through the use of logs or home reporting mechanisms (e.g., e-mail log, spouse/client phone-in; data collection sheet; simulation in the office). A schedule and mechanism for continuing to measure performance will be established in collaboration with the client and/or caregiver. It is essential that the activities are meaningful to the client, are quantifiable, and that the reporting system is not overly burdensome.

Treatment Components

Designing Clients' APT-3 Programs

The initial assessment process will lead to the identification of the three components necessary for designing a client's APT-3 program:

(1) Specific attention exercises,

(2) Metacognitive strategies, and

(3) Functional goals/generalization activities.

The APT-3 program provides the administration of the attention exercises with corresponding self ratings, and tracks performance. The clinician, in collaboration with the client, will additionally have selected metacognitive strategies and generalization activities as described in this section to use with the APT-3 exercises.

Selecting Starter APT-3 Training Tasks

The client's individual attention profile—determined through careful assessment, interviews, and observation—will guide the selection of the specific attention tasks.

There are two clinical decisions that must be made when selecting tasks. First, the clinician selects which tasks to use. Second, the clinician selects task parameters so that the tasks are at a difficulty level appropriate for that client.

The clinician will use the APT Manager to select the tasks and the specific parameters. See the *Using the Computer Program* section or the *Client Example* for demonstration on selecting tasks to create an APT-3 program.

Some clients will have a dominant impairment in a particular type of attention. The most common subtypes of attention impairments are difficulty with: sustained attention; selective attention (i.e., distractibility); and suppression (impulsivity). Other clients will show a decrement across a number of areas with no one area appearing dominant. Perhaps the most frequently occurring profile after traumatic brain injury is reduced working memory that affects all the areas requiring executive control. The APT-3 task framework includes a collection of tasks that focus specifically on working memory through retaining and manipulating information. However, the other executive control attention areas including suppression, selective attention, and alternating attention also require working memory. The clinician will want to select tasks that focus on the type of attention that is most deleterious to the client's performance. If the assessment process reveals that a subtype of attention is predominantly impaired, the clinician will want to select attention exercises that stimulate that type of processing. **The APT-3 program has several pre-programmed starter attention programs in which 40% of the tasks focus on a particular subtype of attention and 20% of the tasks focus on each of the three other subtypes.** The starter sets are listed in Appendix A and appear in the "Create APT Program" screen of the APT-3 Manager.

The APT-3 tasks are designed to be hierarchical. Some tasks are designed to be easier than others. However, an individual client's impairment profile may affect how challenging a given task is for him or her. There are also parameters that can be easily manipulated to change difficulty level including speed at which stimuli are presented, and the number of stimuli presented. Again, there are pre-packaged starter APT-3 programs listed in Appendix A that were compiled based on clinical pilot trials, but ultimately the clinician will need to evaluate which tasks provide a level of difficulty that stimulates processing, but is not so difficult that the client is frustrated or does not continue to put forth sufficient effort.

Accuracy and level of effort required will be the factors that the clinician and client use to judge whether a task is at the right level. **In general, we use 80% accuracy with a medium to high level of effort as an indicator that a task is at an appropriate level.** That said, a client may exhibit a higher accuracy rate with a corresponding high level of effort, and the client and clinician may decide the task is at a level that still taps the processing. Observations of attentiveness (e.g., leaning forward to the screen, closing eyes to process) may also give an indicator of effort.

Clinical Bottom Line for Task Selection

Task selection should be driven by the assessment process, and should be dynamic. The clinician may sample the attention exercises to find those that are at the most appropriate level for the client. The goal is to select tasks that focus on the attention area in need of remediation at a level that the client has to work hard to complete (medium level of effort on the rating scale).

Strategy Selection

As reviewed above (see *Evaluating Metacognition* under the *Assessment Process* section of this manual), interviews, observations and questionnaires will lead to the identification of compensatory or metacognitive strategies that can increase performance, motivation, and awareness as needed for individual clients. A dynamic assessment process where the client is asked to try strategies that are hypothesized to be helpful will be completed, and will facilitate the identification of specific strategies. (See Table 3 above.) Every client will be engaged in self reflection to increase self monitoring and awareness. Following completion of each task, the client will rate motivation (i.e., his or her level of engagement) and level of effort (reflecting task difficulty). See *Running the APT Program* in the "Using the Computer Program" section. The clinician will additionally coach the client to use the strategies in conjunction with the exercises and record performance on strategy usage on the scoresheet.

Clinical Bottom Line for Strategy Selection

It is critical to address metacognitive skills with the attention training in order to teach clients to allocate their cognitive resources effectively and efficiently. The selection of appropriate strategies will require a dynamic assessment where clients are observed using strategies that have been selected based on the assessment.

Selecting Goals and/or Generalization Activities

Before administering the APT-3 program, the clinician and client will have collaborated to identify functional goals and/or generalization activities that will be used during the training.

The purpose is threefold:

(1) They provide a functional outcome measure;

(2) They can provide motivation and purpose for treatment; and

(3) They actively promote generalization of improved attention to real-world contexts.

A goal attainment scaling (GAS) process was described in detail in the previous section on *Assessment*. GAS provides a functional outcome measure for APT-3. Additionally, it will be important to have functional activities that are part of the client's current or desired daily repertoire that require the type of attention being addressed and that would be expected to become easier or performed superiorly if the attention training is successful. These activities may be similar to those on a GAS or may represent a separate set of activities that are selected to actively encourage generalization. For example, if a client is working on sustained attention, the client may generate the first GAS listed in Table 5 above, and may have an additional set of sustained attention activities that include: (1) playing an entire game of "Go Fish" card game with a grandchild, and (2) working on word search puzzles for as long as possible before needing a break or beginning to lose focus. A log of the number of minutes the client engages in these activities can be generated, and the client can be instructed to do these activities, and record the amount of time he or she is able to pay attention.

Clinical Bottom Line for Goal Selection

It is important to identify activities in the client's everyday life that would be expected to improve if the attention training were effective. These activities can be used as treatment goals to provide a treatment outcome measure, and may also encourage and motivate clients to engage in the therapy. Ongoing completion of everyday activities that have similar attention demands encourages the generalization of improved attention process.

Administration of APT-3 Tasks

When implementing the APT-3 program, the clinician will want to monitor five task administration features:

(1) Therapy dosage,
(2) Pacing of exercises,
(3) Pairing with strategy training,
(4) Documenting performance, and
(5) Decisions about when to modify tasks.

Unfortunately, none of these task administration characteristics have been evaluated empirically in order to derive standardized protocols. Hence the clinician will need to analyze client performance data to make rational clinical decisions about when to change the program.

Therapy Dosage

One of the key therapy principles underlying direct attention training is provision of sufficient intensity of exercise (see *APT-3 Therapy Principles*). Different treatment settings will have different therapeutic constraints; clinicians may need to adapt the attention training to fit their specific setting. Based on the current research, and our own clinical work using APT-3 with people who have had brain injuries, we suggest APT-3 training sessions for a minimum of 40 minutes, three times a week. Most of our outpatients can only receive once weekly sessions, thus we supplement the clinic sessions with either home practice and/or use a distance modality—such as "Skype"—to provide additional support. Often we enlist natural supports in settings including spouses, educational assistants, or paid caregivers. We give a prescribed APT-3 set of exercises, and have the client complete them at home on their own computers. This requires having a second USB drive with the program. Alternatively, clinics may have a computer for client drop in use and clients could check out the APT-3 drive. Another option would be to assign the self paced, working memory tasks that can be administered verbally by a support person by reading the stimuli on back of the scoresheets.

> *Product Note:* Because the intensity of practice is critical, a dedicated "homework" drive is under development that will allow clinicians to upload a client's specific APT-3 home exercises.
>
> All purchasers of APT-3 will receive notice when it becomes available as a supplement to the APT-3 program. If a clinic already purchased a second APT-3, they can trade in their second drive for the homework version and rebate.

Therapy Pacing

Exercises need to be administered at a sufficient pace within a session to:

(1) Provide adequate stimulation/practice, and
(2) Keep the client maximally engaged.

Again, there is no standard metric for how many tasks to administer in a given time period as it varies based on the client, and is a treatment component that has not been systematically evaluated. The clinician will need to make treatment decisions based on client's level of engagement and processing ability. In general, we try to make sure that the client is actively processing and working on the APT-3 activities for at least 30 minutes in one session. This, in turn, requires a 45-minute session in order to allow time to solicit client feedback on effort and motivation, and to encourage use of metacognitive strategies. We try to keep discussion concise and related to the attention intervention during this time period. The APT-3 software allows calculation of how long a set of exercises will take, and also tracks the history of activities on the Performance Data screen. Most of the exercises are 3 minutes in duration, and designed to tax sustained attention.

Metacognitive Strategy Training

Clients will have been instructed in how and when to use particular strategies prior to beginning attention process training. Some strategies are completed before task initiation (e.g., predicting performance, breathing). Others are completed during tasks (e.g., closing eyes to facilitate concentration), or after the task (e.g., reviewing progress or rewarding one's self). The clinician will prompt the client as needed to use the trained strategies and record level of prompting on the Task Scoresheet (see Appendices with Scoresheets). The goal will be to provide decreasing prompts so that the client becomes more automatic using the strategies. Part of the generalization training will be to have clients practice using the relevant strategies during the real-world tasks. The logs for generalization activities described in the previous section can also contain places to record strategy use and perceived effectiveness of the strategy.

Documenting Performance

It is important to track task performance, as the client's performance guides the clinician's treatment decisions. There are five possible types of performance indicators:

(1) Accuracy/time,

(2) Error patterns,

(3) Level of perceived effort,

(4) Level of perceived motivation,

(5) Use of strategies, including accuracy and level of effort.

The Task Scoresheets (see Figure 6) are provided in the Appendix B section and also available for printing from the APT manager and allow recording multiple performances on particular tasks incorporating all five of these indices, and then making decisions about when to alter tasks. An example of a completed scoresheet for an APT-3 therapy task is shown and described in the Client Example section detailing the case of Julien and shown in Figure 33. In addition to task scoresheets, generalization logs and the GAS designed by the clinician will be used to evaluate generalization of training.

Clients who have the same accuracy ratings may have very different performance profiles. Therefore, evaluation of error patterns will be important for understanding performance. As indicated on the Task Scoresheet, there are four types of error patterns that are commonly displayed:

(1) More errors in the beginning of a task, indicating difficulty establishing a ready set or understanding the directions,

(2) More errors over time, indicating difficulty with sustaining attention,

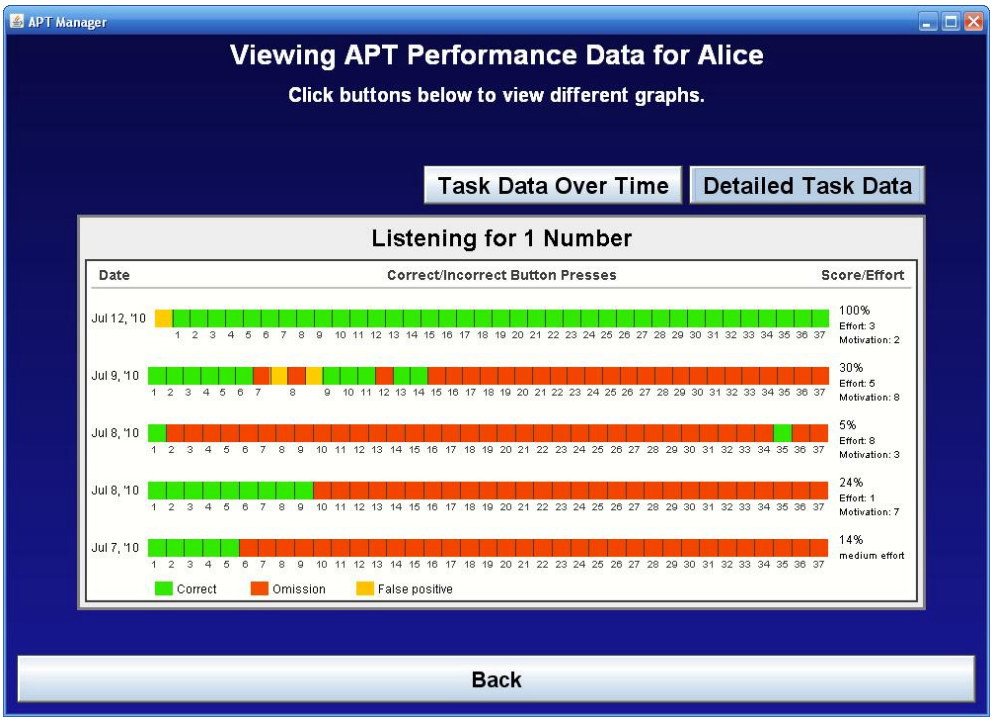
(3) Errors caused by a late response, indicating difficulty with latency or speed of processing, and

(4) A high number of random errors, indicating poor task understanding or high task difficulty level.

Clinicians will want to form and test hypotheses as to the cause of any observed error patterns in order to modify treatment so that it is more effective. For example, if the client is making errors in the beginning of a task, and the clinician determines that the client has a hard time switching between activities or beginning a new activity, the client may be taught a "ready set" strategy: verbalize the task directions, and visualize doing the task before starting. In addition to facilitating increased accuracy on APT-3 tasks, this strategy may also generalize to functional activities. Again, a completed example of a task scoresheet is described for Julien under the Case Example section and shown in Figure 33.

The computerized APT-3 program will collect accuracy data, motivation self-ratings, and effort self-ratings that the clinician can print or transfer to the Task Scoresheets. As described, the APT-3 program provides several types of performance data. The task performance bars that are shown after each task allow analysis of error patterns. Green indicates a correct response, yellow indicates an error response (commission error-button pressed in error) and red indicates an omission error. The client must press the button PRIOR to the presentation of the next stimulus so if a button is pressed late, the error patterns will look like a red bar followed by a yellow bar as can be seen in Figure 5. The other error profiles such as more errors committed over time are easily viewed on this color performance bar. If there are many yellow bars, then this indicates that the client may be randomly pressing the button in hopes of getting a high score.

Figure 5. Performance Data



Program Modification/General Decision Rules

Once again, knowing when to stop or change a particular APT-3 activity requires rational clinical decision-making, and is not backed by a standardized rule. Below we provide the general "Decision Rules" for task alteration based on clinical experience and accepted treatment heuristics.

General Criteria to Move to a Harder Task

- Performance greater or equal to 90% accuracy with an effort rating of 3 or less on the first trial
- Greater or equal to 80% accuracy for three out of four trials with effort rating of 4 or less
- Client indicates he/she is bored and observation supports this perception

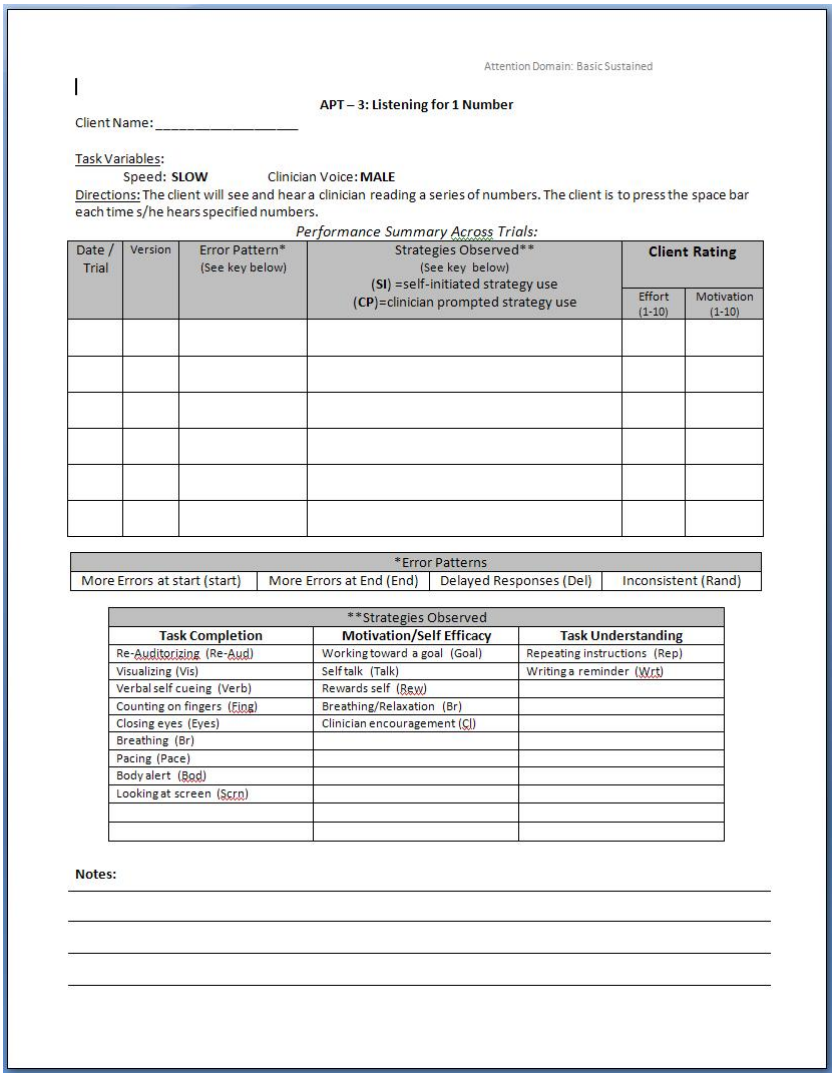
General Criteria to Move to an Easier Task

- Refusal to complete task because it is too frustrating
- Less than or equal to 50% accuracy and effort rating level greater than or equal to 5 for two trials
- Effort rating levels greater than or equal to 9 for three consecutive trials

Clinicians need to be aware that there will be many exceptions to these general decision rules. For example, a clinician may decide to continue with a task on which the client has a very low accuracy level because the client is not bothered by the low performance, and because both client and clinician feel that it is actively stimulating an area of need. In another instance, a clinician may choose to have a client continue a specific task because the scores are increasing, and the client is motivated by this trend.

The APT-3 program charts the effort rating levels and accuracy data, and provides a "history" button to allow the clinician to easily view this information in order to make treatment decisions. The aforementioned Task Scoresheets can also be used to track this information.

Figure 6. Scoresheet Example Page 1



Attention Domain: Basic Sustained

APT – 3: Listening for 1 Number

Client Name: _____

Task Variables:

Speed: **SLOW** Clinician Voice: **MALE**

Directions: The client will see and hear a clinician reading a series of numbers. The client is to press the space bar each time s/he hears specified numbers.

Performance Summary Across Trials:

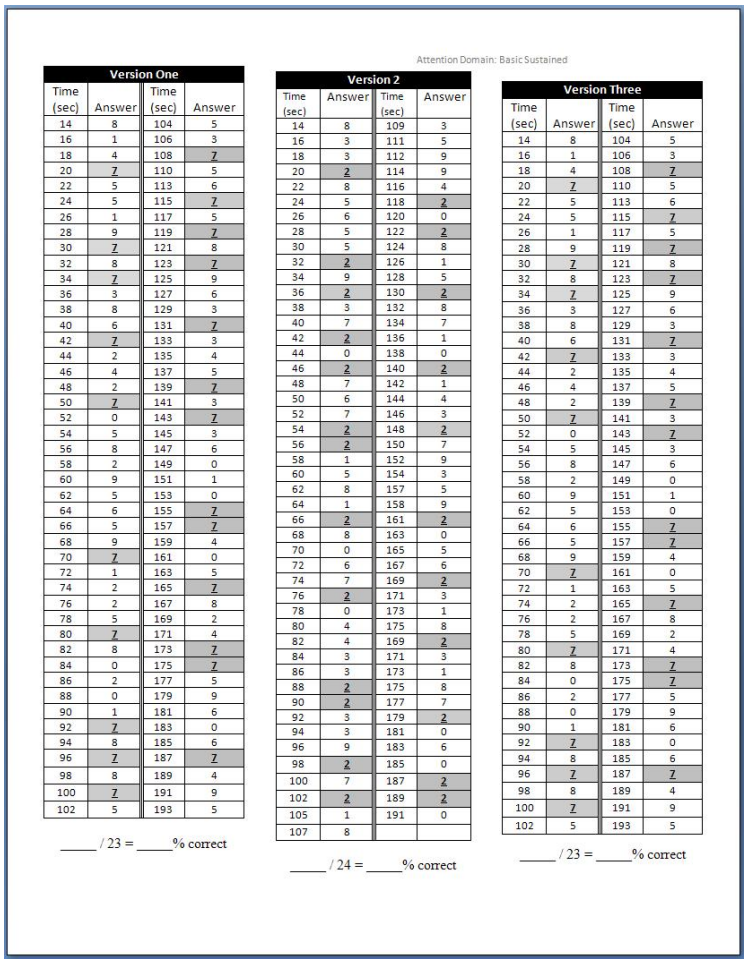
Date / Trial	Version	Error Pattern* (See key below)	Strategies Observed** (See key below) (SI) =self-initiated strategy use (CP)=clinician prompted strategy use	Client Rating	
				Effort (1-10)	Motivation (1-10)

*Error Patterns			
More Errors at start (start)	More Errors at End (End)	Delayed Responses (Del)	Inconsistent (Rand)

**Strategies Observed		
Task Completion	**Motivation/Self Efficacy**	**Task Understanding**
Re-Auditorizing (Re-Aud)	Working toward a goal (Goal)	Repeating instructions (Rep)
Visualizing (Vis)	Self talk (Talk)	Writing a reminder (Wrt)
Verbal self cueing (Verb)	Rewards self (Rew)	
Counting on fingers (Fing)	Breathing/Relaxation (Br)	
Closing eyes (Eyes)	Clinician encouragement (Cl)	
Breathing (Br)		
Pacing (Pace)		
Body alert (Bod)		
Looking at screen (Scrn)		

Notes:

Figure 7. Scoresheet Example Page 2



Attention Domain: Basic Sustained

Version One

Time (sec)	Answer	Time (sec)	Answer
14	8	104	5
16	1	106	3
18	4	108	7
20	7	110	5
22	5	113	6
24	5	115	7
26	1	117	5
28	9	119	7
30	7	121	8
32	8	123	7
34	7	125	9
36	3	127	6
38	8	129	3
40	6	131	7
42	7	133	3
44	2	135	4
46	4	137	5
48	2	139	7
50	7	141	3
52	0	143	7
54	5	145	3
56	8	147	6
58	2	149	0
60	9	151	1
62	5	153	0
64	6	155	7
66	5	157	7
68	9	159	4
70	7	161	0
72	1	163	5
74	2	165	7
76	2	167	8
78	5	169	2
80	7	171	4
82	8	173	7
84	0	175	7
86	2	177	5
88	0	179	9
90	1	181	6
92	7	183	0
94	8	185	6
96	7	187	7
98	8	189	4
100	7	191	9
102	5	193	5

_____ / 23 = _____% correct

Version 2

Time (sec)	Answer	Time (sec)	Answer
14	8	109	3
16	3	111	5
18	3	112	9
20	2	114	9
22	8	116	4
24	5	118	2
26	6	120	0
28	5	122	2
30	5	124	8
32	2	126	1
34	9	128	5
36	2	130	2
38	3	132	8
40	7	134	7
42	2	136	1
44	0	138	0
46	2	140	2
48	7	142	1
50	6	144	4
52	7	146	3
54	2	148	2
56	2	150	7
58	1	152	9
60	5	154	3
62	8	157	5
64	1	158	9
66	2	161	2
68	8	163	0
70	0	165	5
72	6	167	6
74	7	169	2
76	2	171	3
78	0	173	1
80	4	175	8
82	4	169	2
84	3	171	3
86	3	173	1
88	2	175	8
90	2	177	7
92	3	179	2
94	3	181	0
96	9	183	6
98	2	185	0
100	7	187	2
102	2	189	2
105	1	191	0
107	8		

_____ / 24 = _____% correct

Version Three

Time (sec)	Answer	Time (sec)	Answer
14	8	104	5
16	1	106	3
18	4	108	7
20	7	110	5
22	5	113	6
24	5	115	7
26	1	117	5
28	9	119	7
30	7	121	8
32	8	123	7
34	7	125	9
36	3	127	6
38	8	129	3
40	6	131	7
42	7	133	3
44	2	135	4
46	4	137	5
48	2	139	7
50	7	141	3
52	0	143	7
54	5	145	3
56	8	147	6
58	2	149	0
60	9	151	1
62	5	153	0
64	6	155	7
66	5	157	7
68	9	159	4
70	7	161	0
72	1	163	5
74	2	165	7
76	2	167	8
78	5	169	2
80	7	171	4
82	8	173	7
84	0	175	7
86	2	177	5
88	0	179	9
90	1	181	6
92	7	183	0
94	8	185	6
96	7	187	7
98	8	189	4
100	7	191	9
102	5	193	5

_____ / 23 = _____% correct

Facilitating Generalization

The clinician will want to have a plan for encouraging and monitoring performance on the generalization activities during the training. A schedule and method for recording performance will be established in a way that works for the client as well as those assisting the client. Examples of how to encourage identified generalization activities include:

- Setting a schedule and creating natural supports for the client to use a customized log—developed when designing the program—to record completion of the generalization activities and the relevant parameters (e.g., time/errors/use of strategies/end product)
- Conducting motivational interviews to help client think about situations when an APT-3 strategy would have been useful even if the client was not able to implement it
- Developing a record sheet showing improvements over time with increased attention successes or decreased attention lapses (e.g., encourage the client/caregiver to keep a diary of "attention successes" or "attention lapses")
- Developing a record sheet showing the benefit of an APT-3 strategy use (e.g., time saved; number/type of goals completed; improvements in task accuracy; duration of time devoted to target task)

Measuring Outcomes

Measurement of treatment effects has been detailed throughout this manual. Clinicians need to document treatment outcomes and will require pre-/post-treatment measures to make this judgment. Ongoing measurement of performance is also needed in order to guide treatment decisions. Below is a reminder of the different measurement options discussed in previous sections that fulfill these needs.

Pre/Post Treatment Measures

- Administration of standardized attention tests prior to and following APT-3 training
- Administration of questionnaires and structured interviews to assess attention, awareness and strategy use prior to and following APT-3 training
- Comparison of observations on naturalistic tasks requiring the target attention processing prior to and following APT-3 training
- Goal Attainment Scaling

On-Going Measures

- Task performance on APT-3 tasks (see *Decision Rules*)
- Performance on Generalization Activities

TABLE 7 Summary of APT-3 Implementation

Designing an APT-3 Program
▪ Task selection ▪ Strategy selection ▪ Goal selection ▪ Generalization activity selection
Administration of APT-3 Tasks
▪ Therapy dosage: frequency and duration ▪ Task pacing ▪ Metacognitive strategy training ▪ Documentation of performance ▪ Program modification
Measuring Outcomes: Pre-/Post-Treatment Measures
▪ Tests ▪ Questionnaires ▪ Observation ▪ Goal Attainment Scales
Measuring Outcomes: Ongoing Measures
▪ APT-3 task data ▪ Generalization activities

Using the Computer Program

The APT-3 software was developed by Personal Technologies, LLC (www.personaltechnologies.com). This section describes how the program supports the general APT-3 approach to rehabilitation.

Please note that the content and programs on the USB drive you receive are copyrighted material. It is illegal to make copies of the drive itself, or the contents on it.

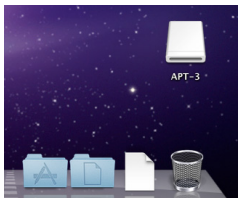
Required Hardware

APT-3 will work with computers and laptops running Mac OS 10.5 or newer, and Windows XP or newer. Your computer or laptop will also need an available USB port for connecting the APT-3 USB drive. All of the software necessary to run the tool is contained on the drive. You will run the tool from the drive, i.e., you do not have to install any software on your computer. This allows any computer to act as host for the drive, making the drive a mobile platform that can be plugged into any available computer.

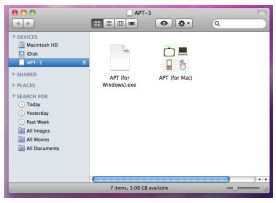
Figure 8. APT-3 USB drive.

Starting the Software

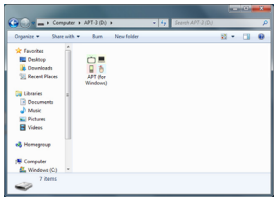
Mac: When you plug the APT-3 USB drive into a Mac computer, a drive/icon labeled APT-3 should appear on the desktop. See the image at right.



Now double-click the APT-3 icon to open up a new window (shown far right). From there, double-click the "APT (for Mac)" icon.



Windows: When you plug the Apt-3 USB drive into a Windows computer, a dialog window should appear asking what you want to do (see image at right). Select "Open folder to view files," then double-click on the "APT (for Windows)" icon (image far right). If the dialog window fails to appear, you can alternatively open the APT-3 drive by going to ***Windows Start Menu***, ***My Computer***, and then double-clicking on the APT-3 USB drive.



Exiting and Ejecting the Software

Mac: There are two means of exiting the program from a Mac:

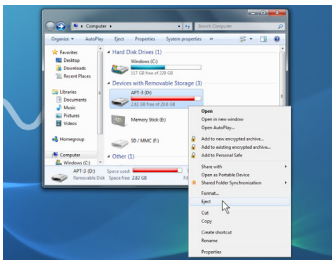
(1) If the Exit button appears at the bottom of the screen, then use it to exit. See, for instance, Figures 9 and 10.

(2) You can exit from any screen by clicking the red button at the top of the screen (i.e., the generic Mac close-window icon).

After you exit the program, it is critical that you explicitly eject the drive before removing it from your Mac computer. If you neglect to eject the drive, you may corrupt the drive, and make it unusable.

The image at above-right shows how to eject on a Mac by dragging the APT3 icon to the trash.

Windows: Similar to the Mac, you can exit by either using an Exit button, or by clicking the "X" icon at the top of any window (i.e., the generic Windows close-window icon).



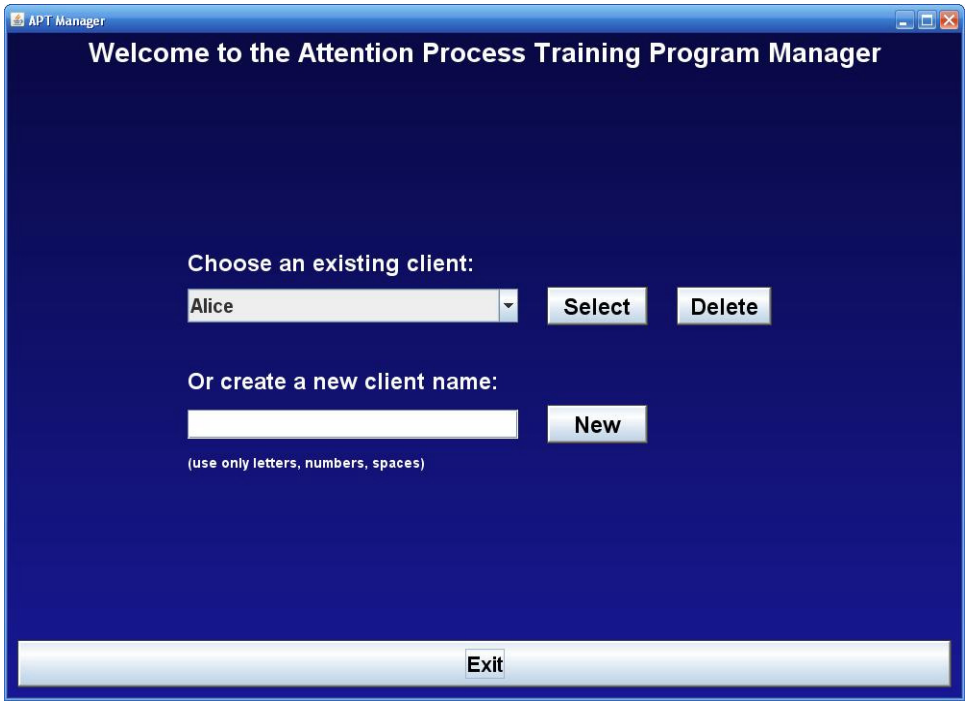
! After you exit the program, it is critical that you explicitly eject the drive before removing it from your Windows computer. If you neglect to eject the drive, you may corrupt the drive, and make it unusable.

To eject the drive on a Windows computer, go to ***Windows Start Menu***, ***My Computer***, and then right-click on the APT-3 USB drive. Select *eject* when given the option. See image at right.

The Home Screen

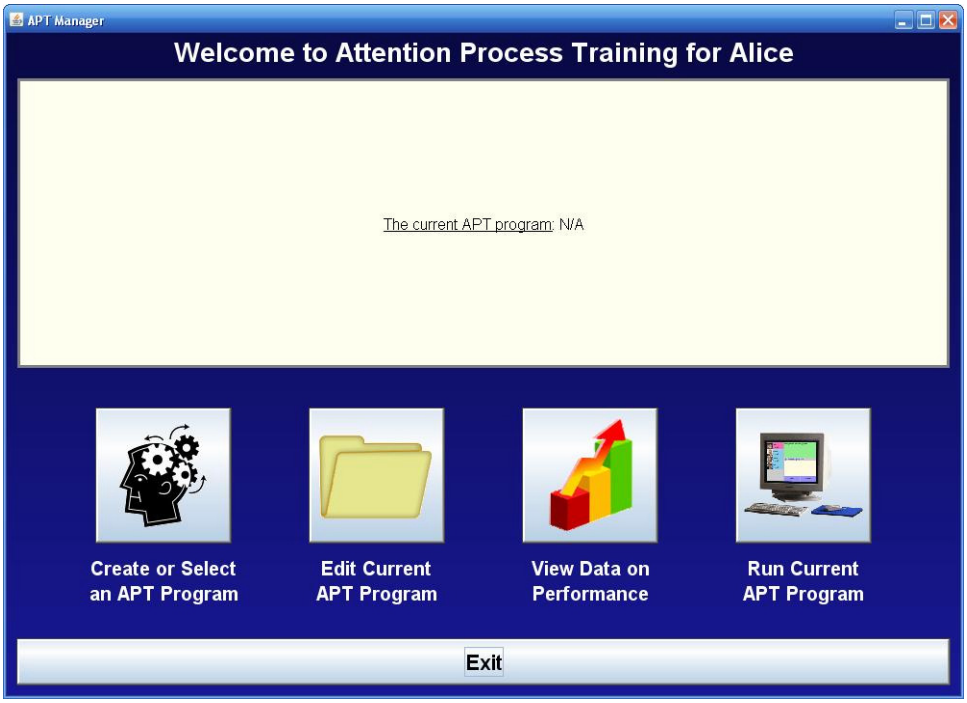
The APT-3 program is designed to support a single therapist treating one or more clients. When you run the APT-3 program, the first screen you see allows you to create a client account or select a previously created account. This feature allows you to work with multiple clients while keeping their APT programs and data separate.

Figure 9. Client Selection Screen



Once you've created or selected your client, you will be taken to the *Home Screen*. From the *Home Screen*, you can create APT programs to use with the client, edit the currently selected APT program, view performance data, and run the currently selected APT program. More information about the four *Home Screen* choices is below.

Figure 10. Home Screen



Create a New APT Program

This screen allows you to create a new set of tasks (an APT program) that will become the currently selected APT program for the client with whom you are working. In addition, you can save the program you create for later use by your client or even for other clients (standard program). This will allow you to create multiple APT programs so that you can quickly switch between different APT programs as opposed to always manually editing the current program. During the task selection process, you will be presented with information on how many times the task has been attempted. In addition, you'll be able to view performance stats on each task and view/print the worksheets associated with each task.

Figure 11. APT Program Screen 1

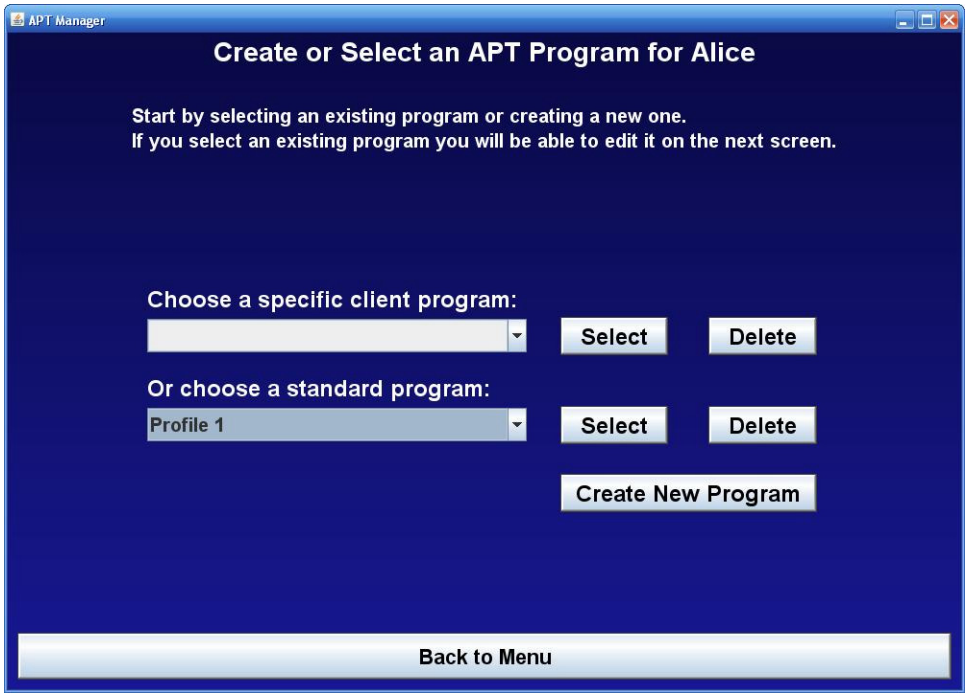


Figure 12. APT Program Screen 2

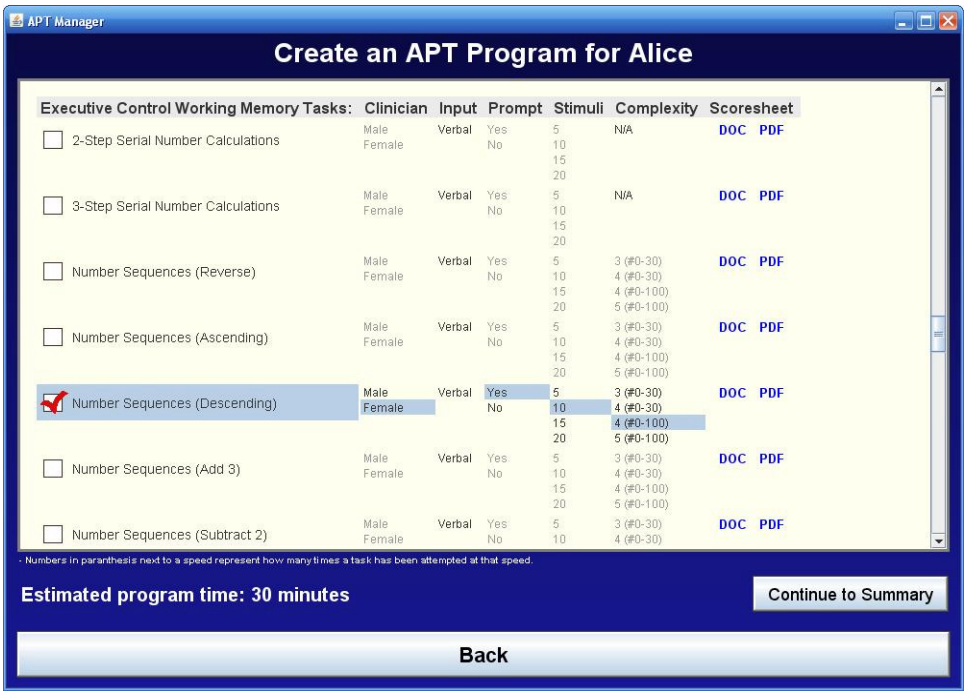
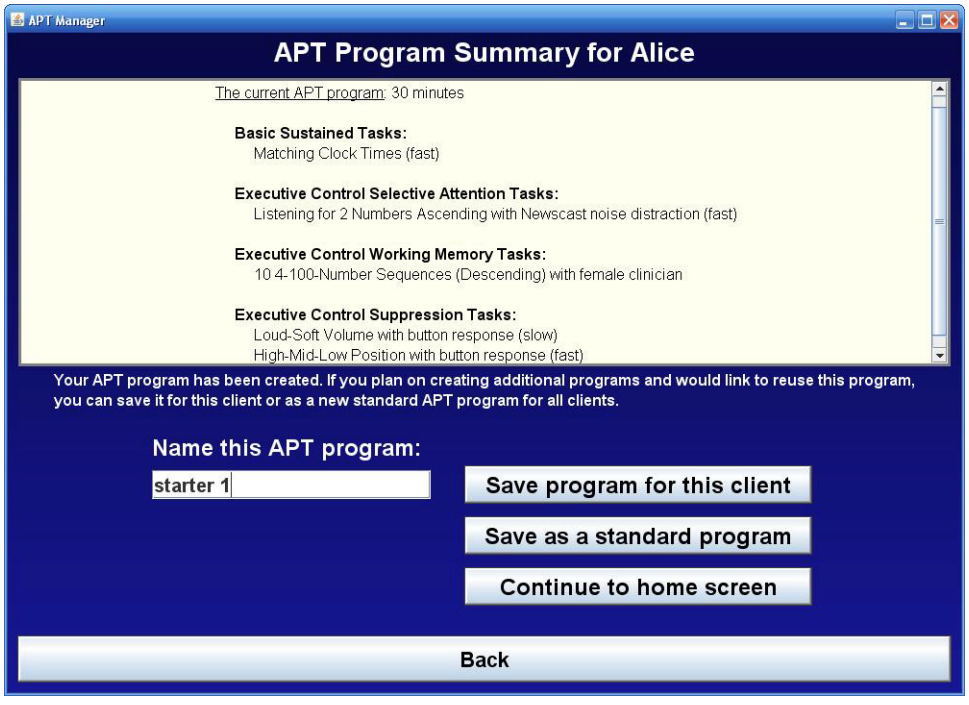


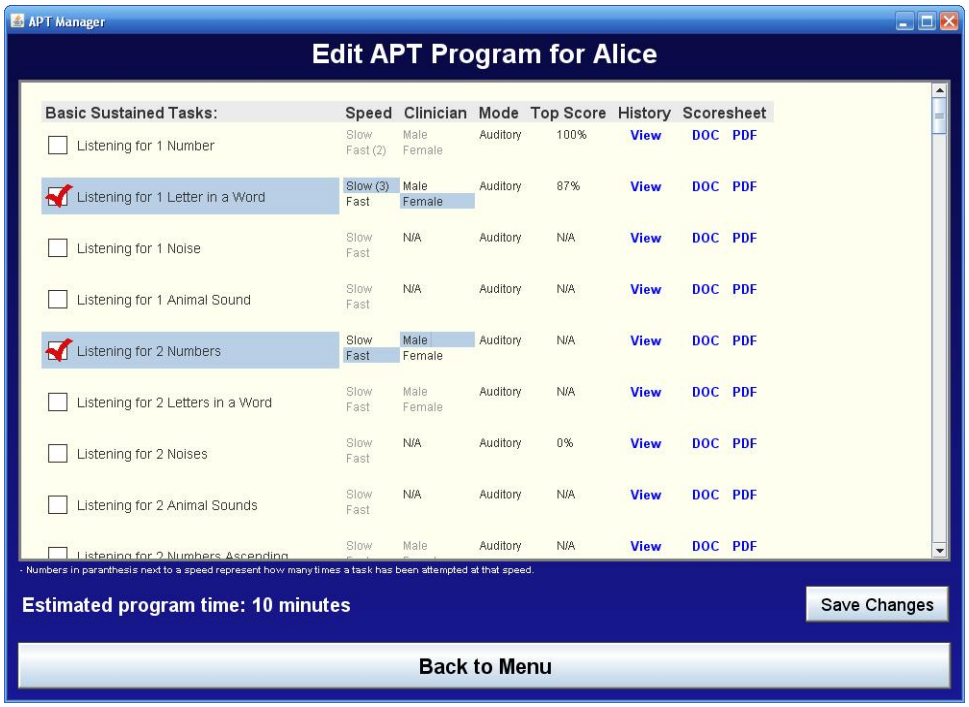
Figure 13. APT Program Screen 3



Edit Current APT Program

This screen will allow you to edit the current APT program that you have selected. This feature is often useful if you want to make small changes to the current APT program that you have selected. You can choose new tasks, remove tasks or change task options. When you are done making changes, the save button will save the changes you made to your currently selected APT program and take you back to the *Home Screen*.

Figure 14. Edit APT Program Screen



View Performance Stats

On this screen, you can view the performance data for each task for the client you selected at the *Home Screen*. The data are identical to the ones you see by clicking on the *view stats* link on the *Create/Edit APT Program* screens, but this button may provide a quicker way to access the performance stats if you are not in the process of creating or editing an APT program.

Figure 15. Performance Data Screen 1

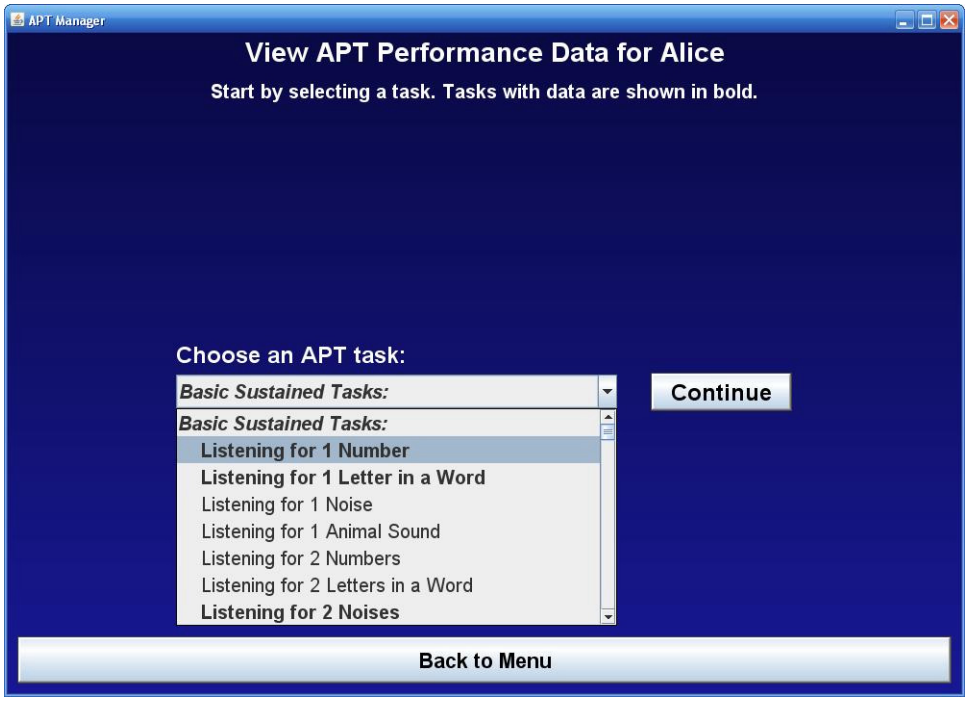
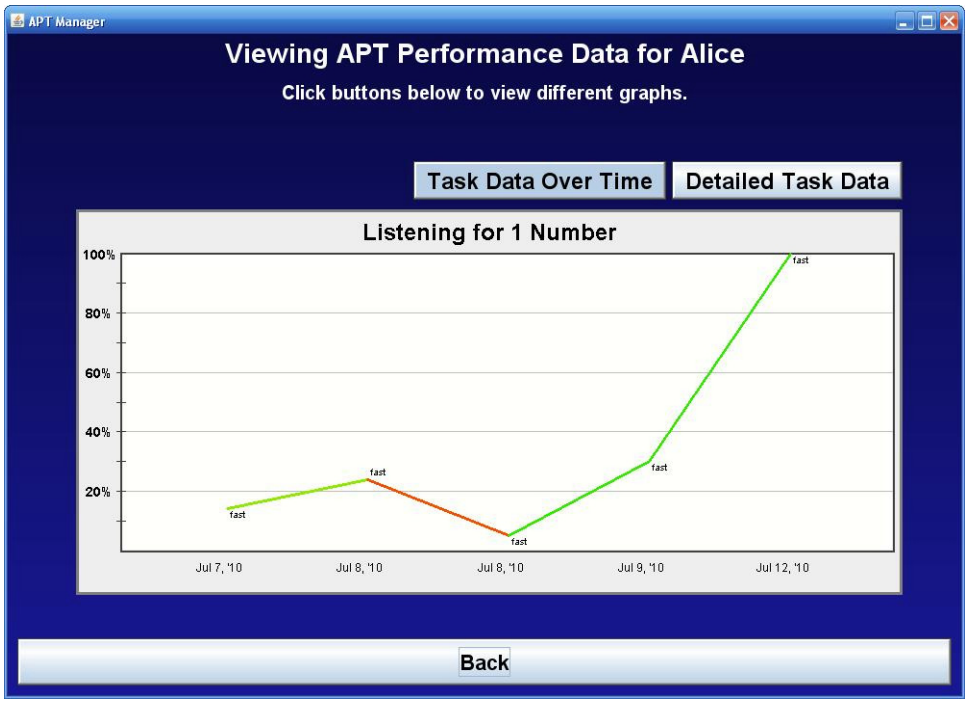


Figure 16. Performance Data Screen 2



Run Current APT Program

This button will launch a new window on top of the APT-3 Manager that runs the APT program that you selected/created in the APT-3 Manager. The client can interact with the program by clicking the buttons that appear on the screen or by simply pressing the *space bar* when there is only one button on the screen. For example, when there is a task that asks the client to respond to particular stimuli, the person can do so by either clicking the *respond* button on the screen or pressing the *space bar* on the keyboard.

All tasks will begin with an instructional video explaining what the client needs to do for the task. When the instructional video is finished or when the client selects *Click here to BEGIN*, the program will begin playing the video or audio for the task. When a task is completed, the program will automatically transition to a screen prompting the client to rate their motivation and level of effort. The performance data from the task and the client's self rated motivation and level of effort will be recorded for later viewing as seen in the *View Performance Stats* section.

Figure 16. Task Intro Screen

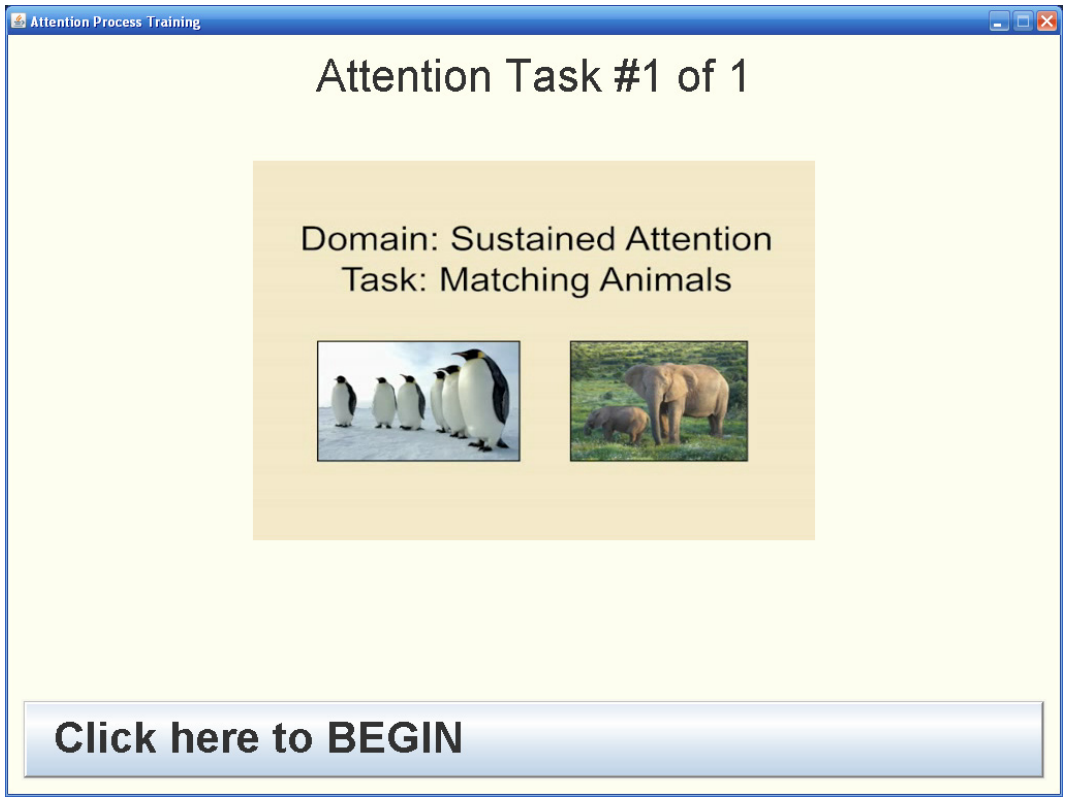


Figure 17. Task Screen

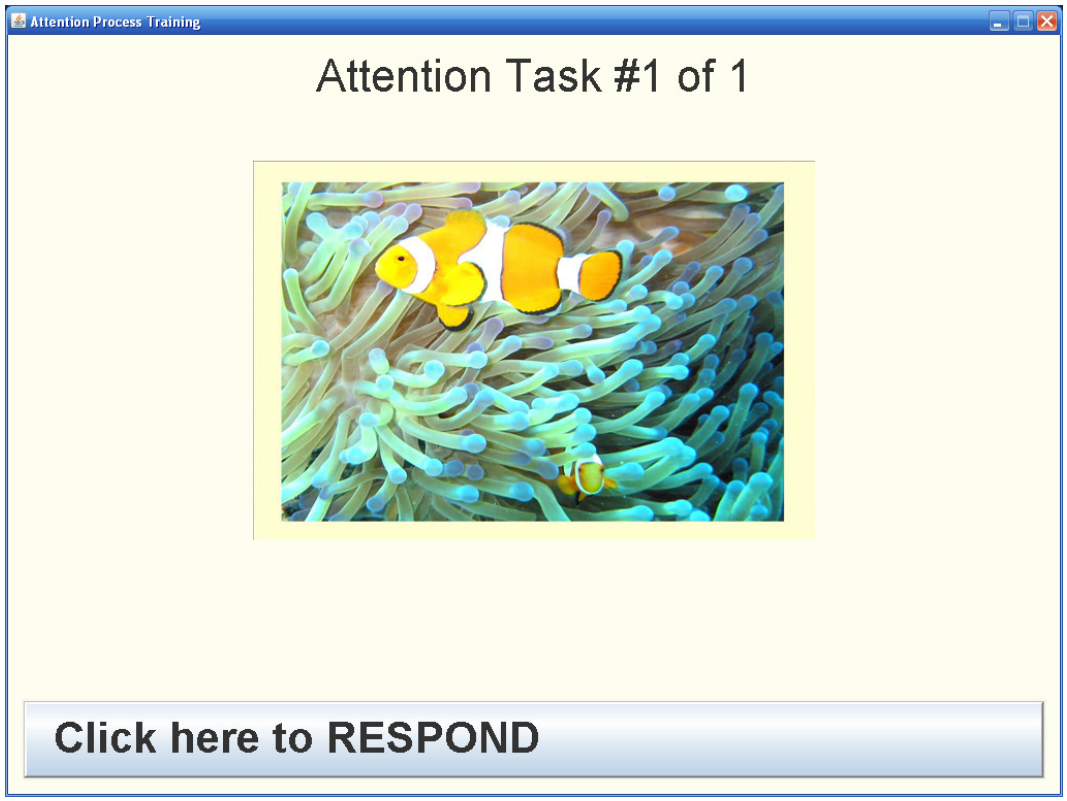


Figure 18. Self-Paced Task Screen

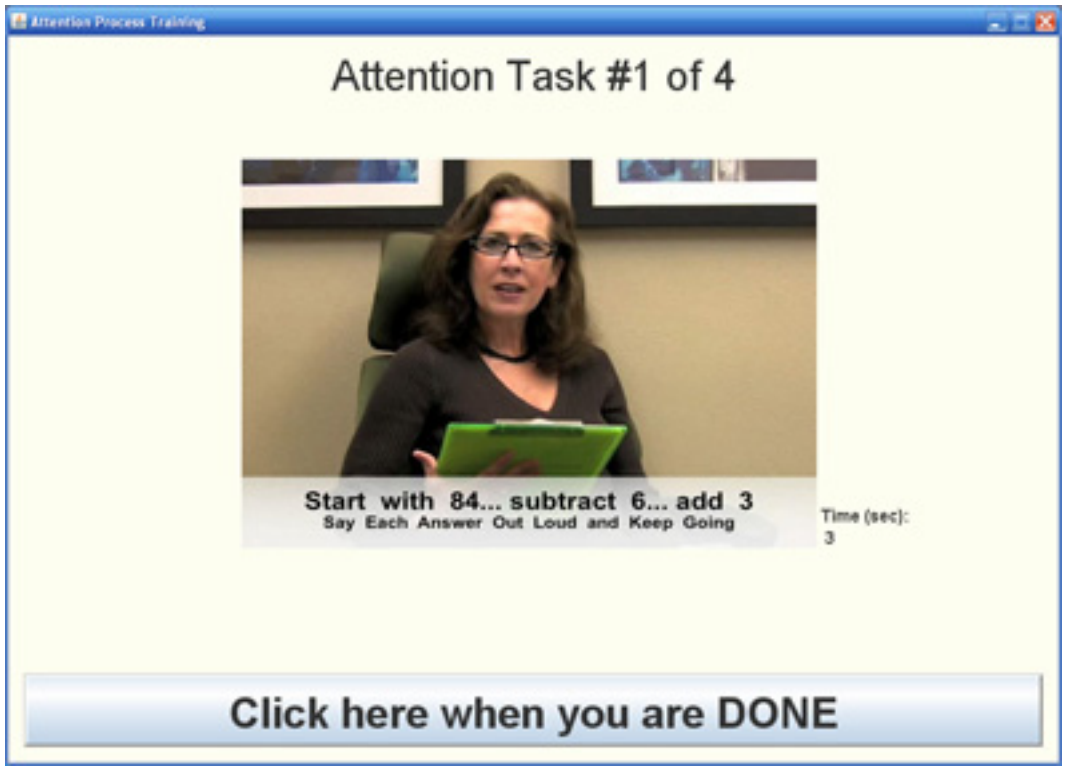
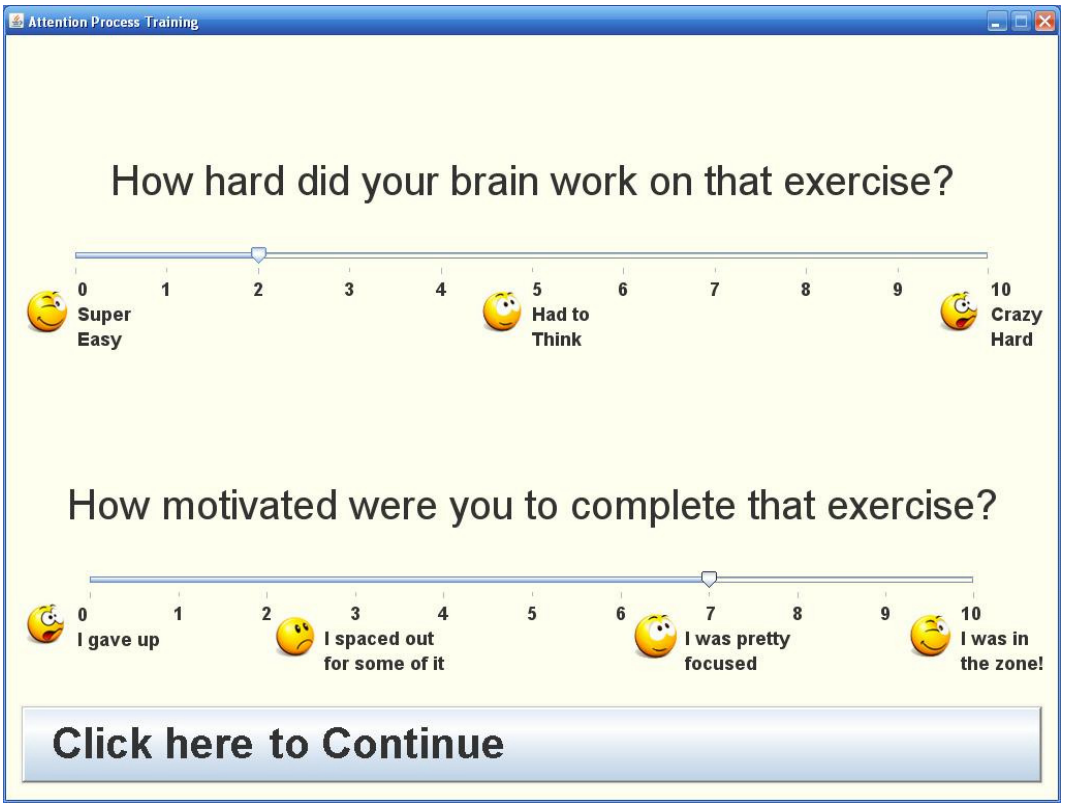


Figure 19. Self Monitoring Screen



Troubleshooting

We have created a website for up-to-date technology troubleshooting information. The website also has information about contacting Personal Technologies for technical assistance. Please visit the site if you have questions: http://www.personaltechnologies.com/apt3/faq.

Client Example: Julien

Client Description: Julien is a 23 year old male veteran with cognitive impairments due to a series of blast injuries incurred in combat while serving in the military three years prior. He also is experiencing significant difficulties with anxiety as part of his posttraumatic stress disorder (PTSD). He is attempting to complete his general education requirements at a local community college with the goal of transferring to a university, and completing his teaching credential to become a high school instructor. Prior to his military service, he had been a low-average student with no history of learning disorder. However, he was uninterested in school as a youth, and thus did not put forth effort. He was seen at a VA outpatient clinic for services related to posttraumatic stress disorder and cognitive impairments. His primary complaints interfering with his academic performance were difficulties with attention and retention of reading material, and anxiety episodes.

Assessment Results: Julien received a full neuropsychological evaluation that included a battery of tests and questionnaires designed to assess cognition and psychological adjustment. Results revealed moderate impairments in attention and executive functions, with particular difficulty noted with working memory and impulsivity. Part of an identified anxiety disorder included hypervigilance, and an inability to suppress run-on thoughts. Results from a self-awareness questionnaire suggested that Julien had insight into his strengths and limitations, and was motivated to improve. Julien was referred for counseling to address the PTSD and speech pathology services for cognitive rehabilitation.

Speech Pathology Services: A clinical interview and supplementary testing identified Julien's current study practices and challenges. He was having difficulty tracking all of the assignments, and did not use any study strategies other than excessive review. It took him a long time to complete class readings as he would have to go back over material. He appeared to have difficulty integrating what he just read to previously read material. In general, he would comprehend the material at the time, and then forget it and need to re-read it. He frequently had anxiety episodes while studying, and needed to take breaks or quit studying.

The following intervention plan was developed to be implemented during twice weekly 45 minutes outpatient sessions for a total of eight weeks.

- Design and support use of a planning system for homework using the calendar and reminder system in his cell phone. He was already familiar with how to use these phone applications.
- Teach him to use a reading comprehension strategy using preview and review strategies.
- Implement attention training using the APT-3 program.
- Practice the stress management techniques from his counseling (breathing, visualization, environmental management such as not sitting near windows) during his APT-3 program.

Goal Attainment Scaling was completed for a specific study goal.

	Goal: I will get all A's and B's on my weekly reading quizzes in my history class for the second half of the semester.
+2	I will be able to concentrate on course readings for a minimum of an hour without having distracting thoughts. When I begin my homework session and review previously read material, it will be very familiar.
+1	I will be able to concentrate on course readings for a minimum of an hour with only 1-2 short episodes of distracting thoughts where I can't remember what I was reading. I will be able to easily get back on track. When I begin my homework session, and review previously read material, it will be very familiar.
0	I will be able to sit for one study session, and do my course readings for a minimum of an hour with only 1-2 episodes of distracting thoughts where I can't remember what I was reading but it will take me awhile to get back into the reading, and I will have to start over for the whole section. When I begin my homework session, and review previously read material, I will recognize it, but it will not be very solid.
-1	I will not be able to get back on track when I get distracted, and will need to stop the reading session. When I begin my homework session, and review previously read material, I will recognize it but it will not be very solid.
-2	I will not be able to get back on track when I get distracted, and will need to stop the reading session. When I begin my homework session, and review previously read material, I will not recognize previously read material.

APT-3 Program: Julien and the therapist completed 30 minutes of the APT-3 attention drills during each of the twice weekly sessions. Julien also independently completed a third APT-3 session either by coming by the speech clinic, and checking out the APT-3 program and doing it on the patient computer, or having his girlfriend administer the verbal tasks using the scoresheets. To promote generalization, a structure for extended reading during homework sessions was established, and the steps were entered into the notes page in Julien's cell phone. The clinician and Julien developed a study log on which Julien recorded (1) use of study strategies during his homework session; (2) amount of time he was able to read; (3) distractibility ratings; and (4) ratings on retention for previously read material.

The clinician began using a standard program for Julien that emphasized basic sustained attention with a mix of auditory and visual tasks. Below is a sequence of figures demonstrating how the clinician can setup the following set of tasks that are part of that program:

- Listening for 2 Numbers Descending
- Listening for 2 Letters in a Word
- Watching for Multiples of 3
- Matching Clock Times
- Matching Faces and Emotions

Figure 20. The clinician first selects the client Julien.

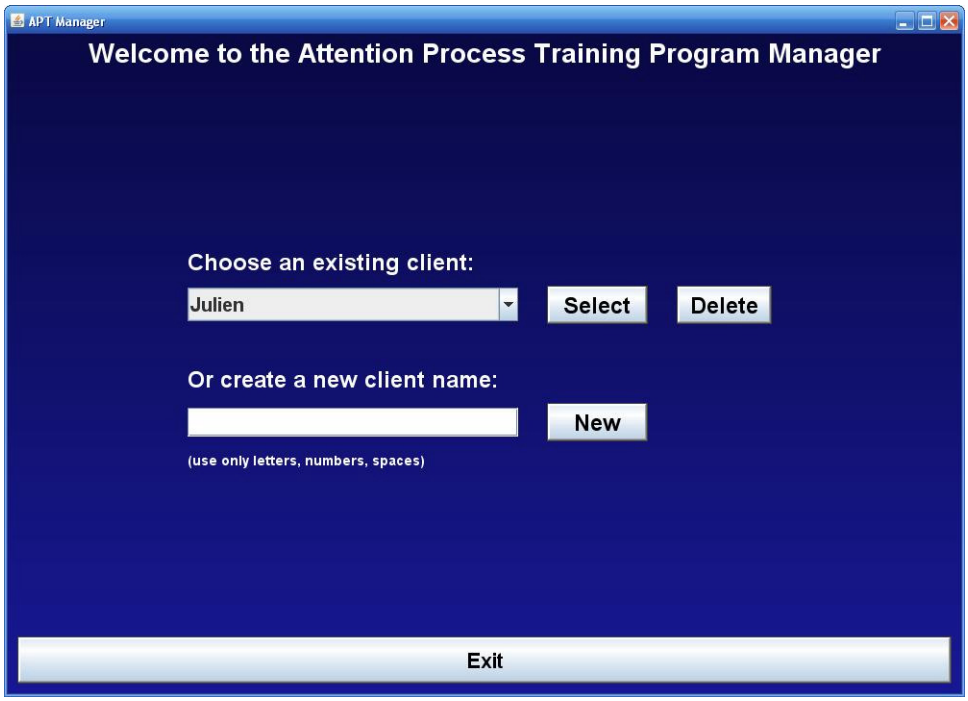


Figure 21. From the home screen the clinician can click the "Create or Select an APT Program" button to begin setting up a set of tasks.

Figure 22. The clinician selects a standard program "Basic Sustained Mix".

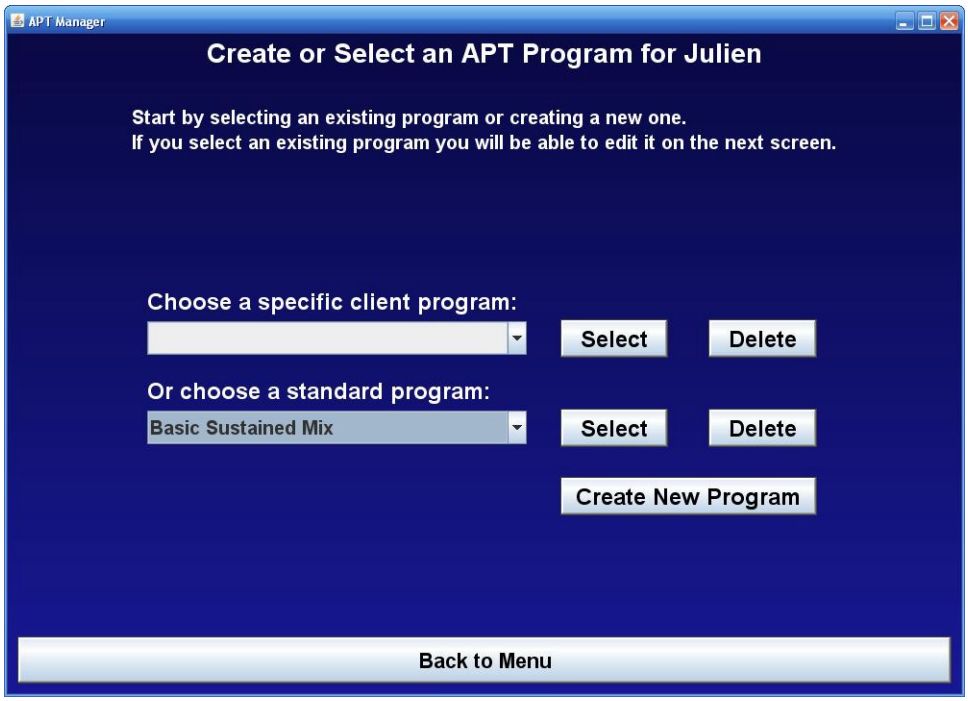


Figure 23. By selecting an existing program, many of the tasks are already selected. Optionally, the clinician can adjust the task options or add/remove other tasks.

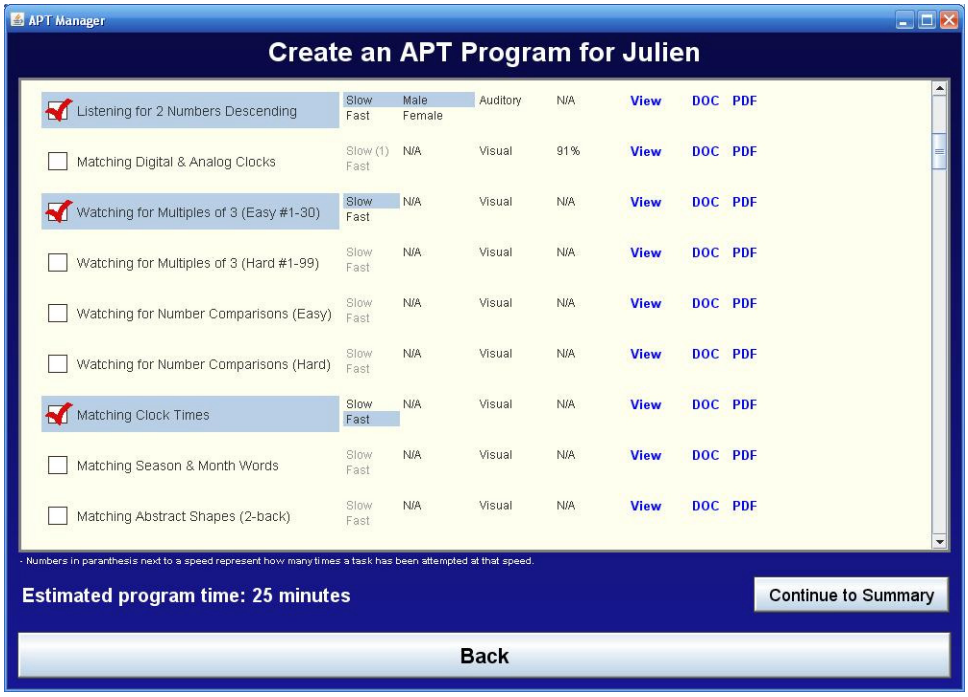


Figure 24. Once finished selecting tasks, the clinician can see the currently selected APT program in the preview window of the Home screen.

Task performance data showed steady showed quick improvement on four of the tasks. The sequence of figures below shows how the clinician is able to access the APT performance data.

Figure 25. From the Home screen, the clinician can click on the "View Data on Performance" button to begin view data.

Figure 26. Once at the "View APT Performance Data" screen, the clinician can select the task that they want to view data for. Tasks that have been attempted will be shown in bold.

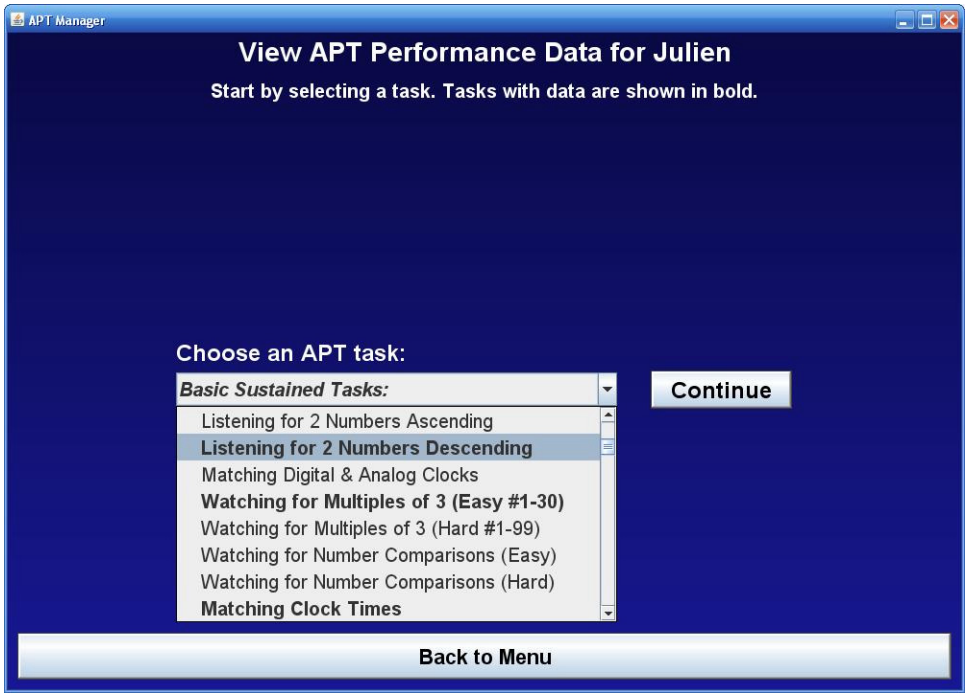


Figure 27. Once the clinician is viewing task data, they can see the client's scores over time and at what speed each task was attempted.

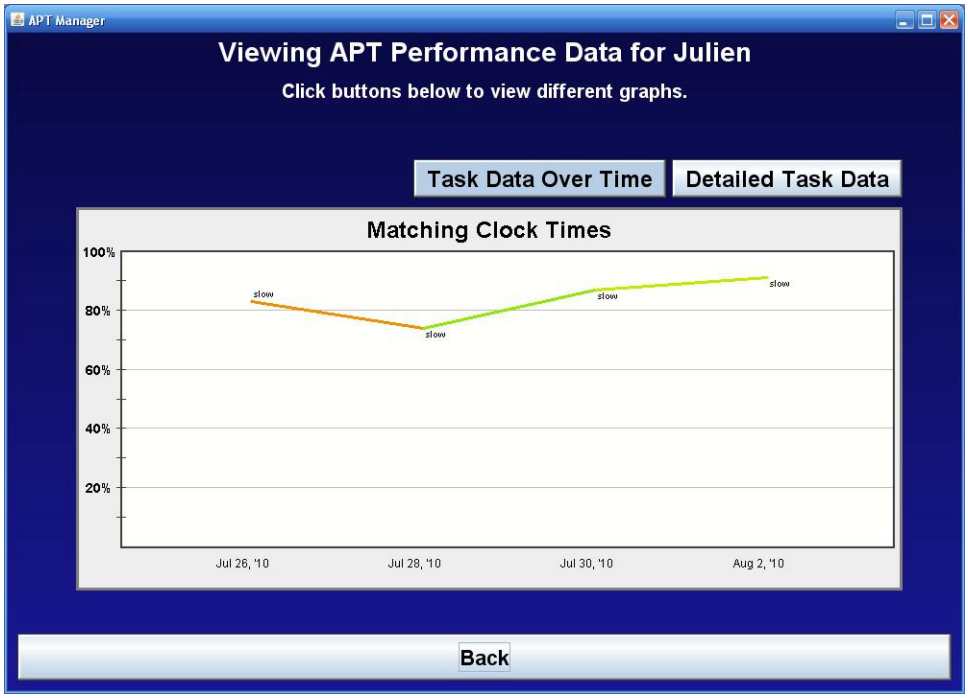
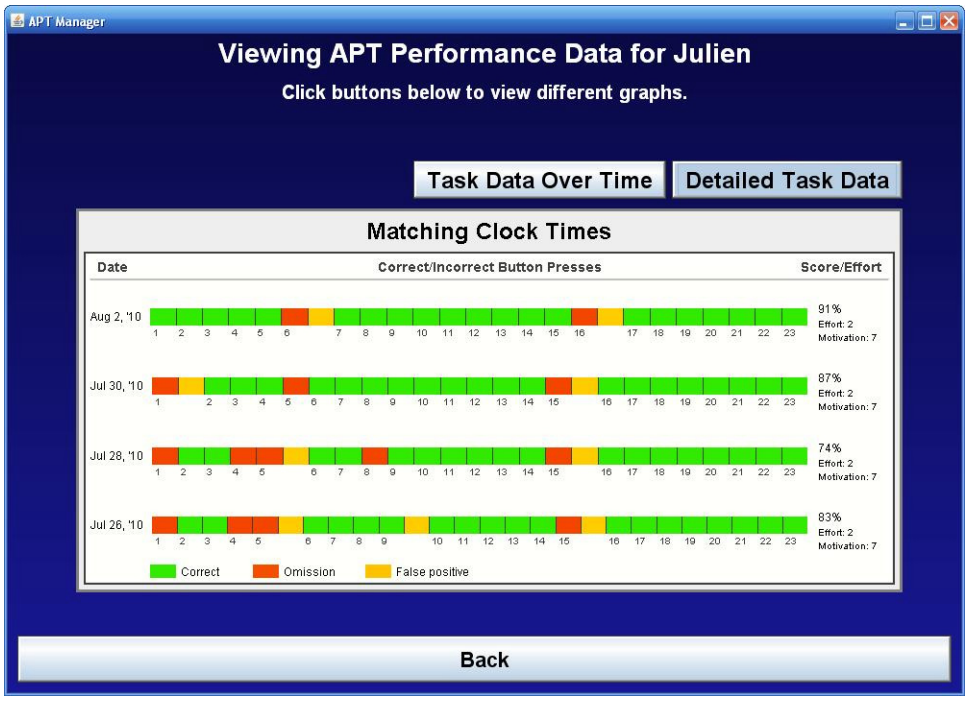
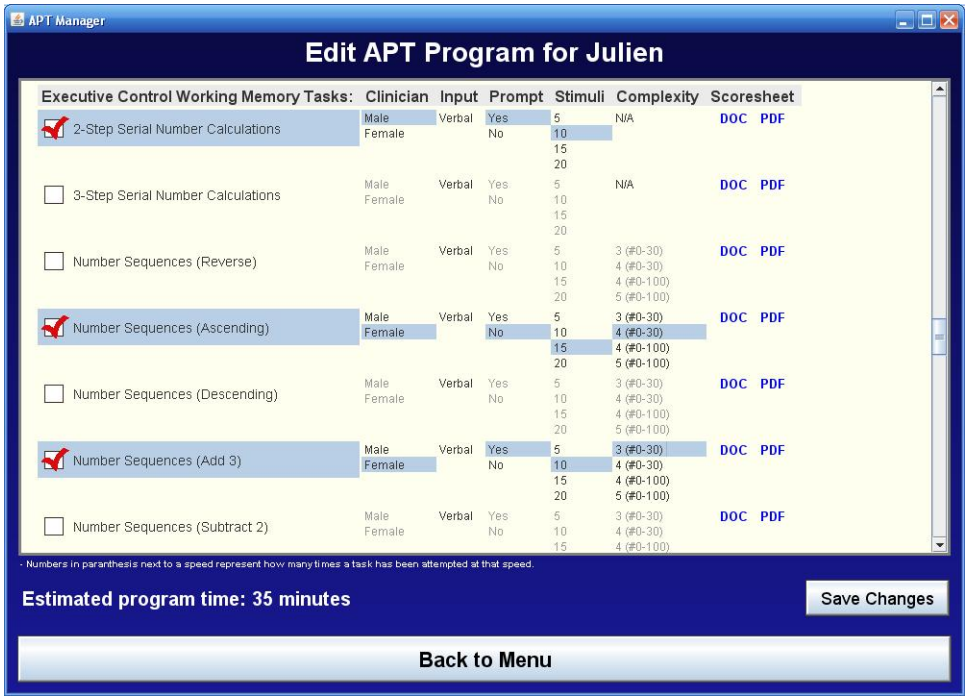


Figure 28. Selecting the "Detailed Task Data" button on the data screen will show a more detailed breakdown of task performance for each time the task attempted.



The clinician used the decision rule "Greater or equal to 80% accuracy for three out of four trials with effort rating of 4 or less", and on the third session moved to the standard program for the Working Memory tasks that consisted of the following tasks:

Figure 29. The clinician was not interested in selecting an existing program or creating a program for later use, so she selected "Edit APT Program" from the Home screen to edit the current program.



One of the tasks was too difficult as Julien performed less than or equal to 50% accuracy, and his effort rating was 5—meeting the criteria to move to an easier task. The clinician thus opted to create a client-specific APT-3 program, and used a combination of working memory and suppression tasks.

Figure 30. The clinician goes to the Create or Select an APT Program screen and this time, chooses "Create New Program."

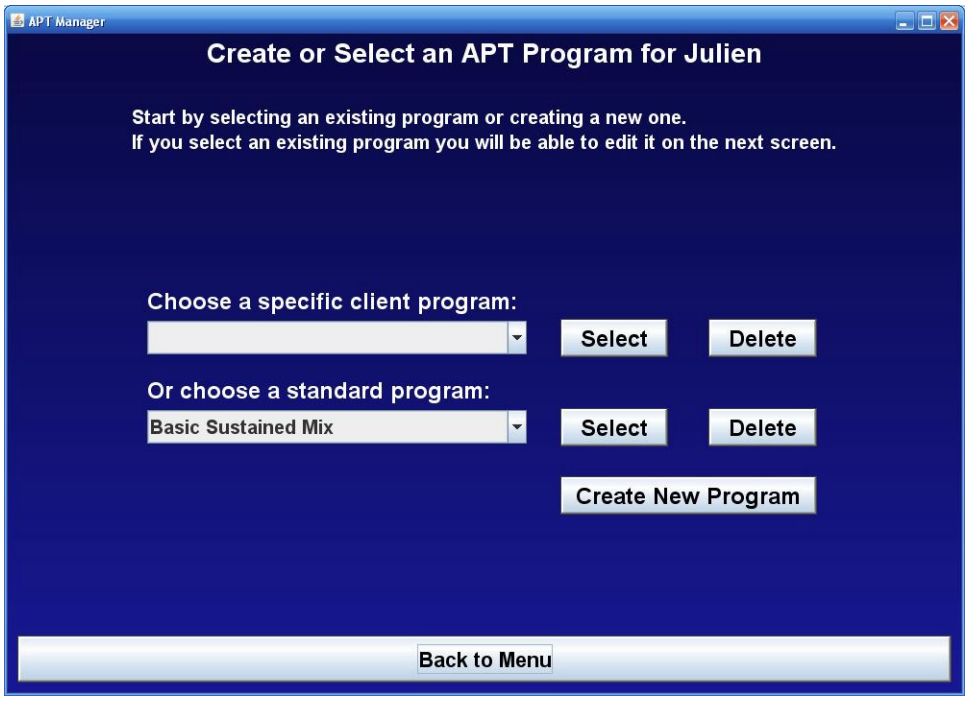


Figure 31. The clinician now gets an unselected list of all tasks, and they chose several Working Memory and Suppression tasks.

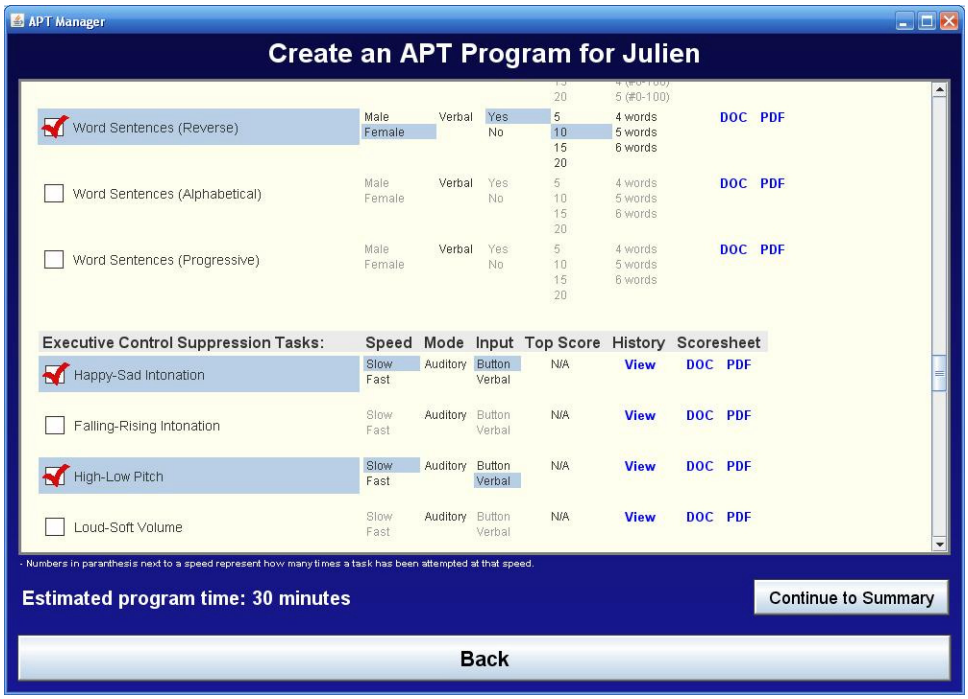
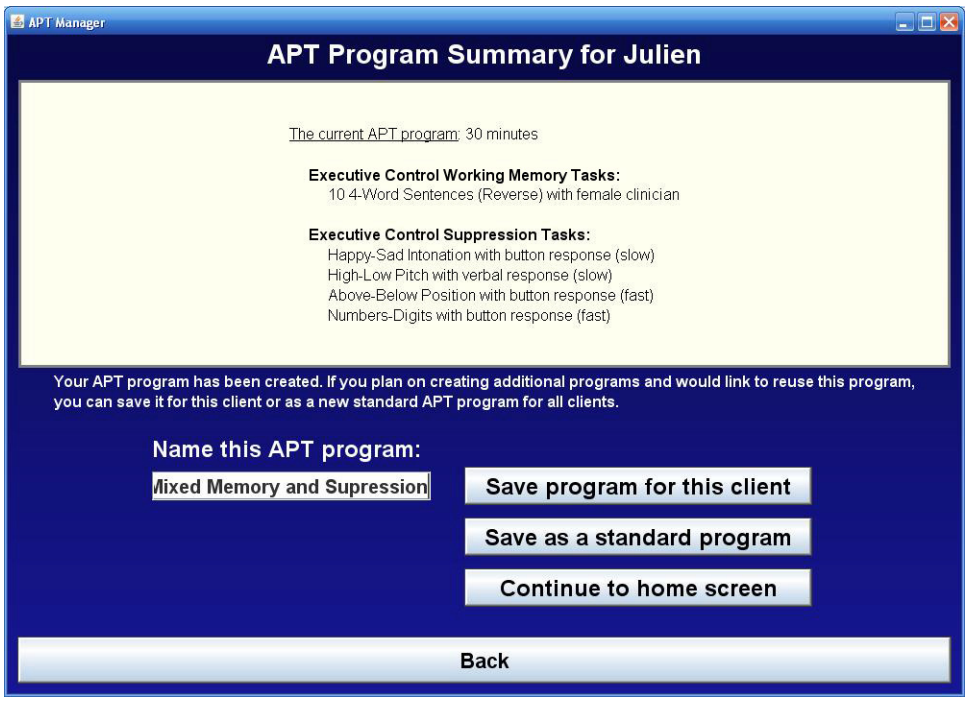


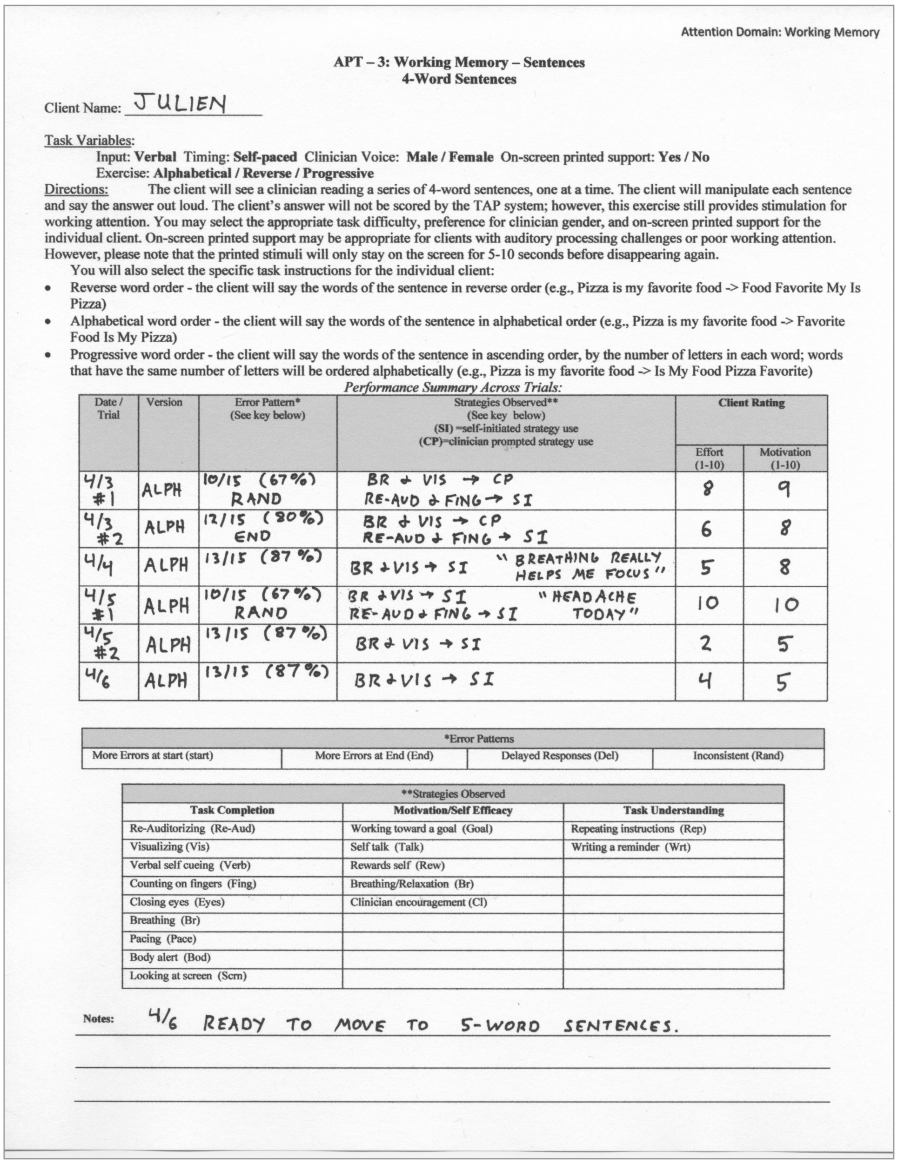
Figure 32. After creating the program, the clinician can now choose to save the program for later use by giving it a name and clicking "Save program for this client." Saving the program allows the clinician to change tasks or select other programs and then go back to this program in the future.



Completing the Task Scoresheet

Figure 33 shows a completed scoresheet for six trials administered over four different treatment days of one of Julien's APT-3 exercises that targets working memory, 4 word sentences alphabetized. The second column provides a space to indicate the version of the task that is being used—in this case the client is supposed to alphabetize the words that are given. An example of another task option would be to give the words in the sentence back in reverse order. In that condition, the clinician would have written "reverse" in the version column. The clinician uses the third column to note error patterns using the abbreviations in the key below. This clinician has also decided to put in accuracy information. For most tasks, accuracy information will be tracked by the computer and the clinician can opt to put that in this column. **However, some of the working memory tasks are self paced tasks that require a verbal response from the client. These verbal response tasks require the clinician to monitor accuracy and record it as the program cannot evaluate verbal responses.** The clinician will also note any strategies observed using the key provided on the scoresheet. The final two columns allow the clinician to input the effort and motivation ratings that Julien indicated on the computer program as he completed each task.

Figure 33. Example of Completed Scoresheet for One APT-3 Exercise



Attention Domain: Working Memory

APT – 3: Working Memory – Sentences
4-Word Sentences

Client Name: JULIEN

Task Variables:
Input: **Verbal** Timing: **Self-paced** Clinician Voice: **Male / Female** On-screen printed support: **Yes / No**
Exercise: **Alphabetical / Reverse / Progressive**

Directions: The client will see a clinician reading a series of 4-word sentences, one at a time. The client will manipulate each sentence and say the answer out loud. The client's answer will not be scored by the TAP system; however, this exercise still provides stimulation for working attention. You may select the appropriate task difficulty, preference for clinician gender, and on-screen printed support for the individual client. On-screen printed support may be appropriate for clients with auditory processing challenges or poor working attention. However, please note that the printed stimuli will only stay on the screen for 5-10 seconds before disappearing again.

You will also select the specific task instructions for the individual client:

- Reverse word order - the client will say the words of the sentence in reverse order (e.g., Pizza is my favorite food -> Food Favorite My Is Pizza)
- Alphabetical word order - the client will say the words of the sentence in alphabetical order (e.g., Pizza is my favorite food -> Favorite Food Is My Pizza)
- Progressive word order - the client 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., Pizza is my favorite food -> Is My Food Pizza Favorite)

Performance Summary Across Trials:

Date / Trial	Version	Error Pattern* (See key below)	Strategies Observed** (See key below) (SI) =self-initiated strategy use (CP)=clinician prompted strategy use	Client Rating	
				Effort (1-10)	Motivation (1-10)
4/3 #1	ALPH	10/15 (67%) RAND	BR + VIS → CP RE-AUD + FING → SI	8	9
4/3 #2	ALPH	12/15 (80%) END	BR + VIS → CP RE-AUD + FING → SI	6	8
4/4	ALPH	13/15 (87%)	BR + VIS → SI "BREATHING REALLY HELPS ME FOCUS"	5	8
4/5 #1	ALPH	10/15 (67%) RAND	BR + VIS → SI RE-AUD + FING → SI "HEADACHE TODAY"	10	10
4/5 #2	ALPH	13/15 (87%)	BR + VIS → SI	2	5
4/6	ALPH	13/15 (87%)	BR + VIS → SI	4	5

*Error Patterns			
More Errors at start (start)	More Errors at End (End)	Delayed Responses (Del)	Inconsistent (Rand)

**Strategies Observed		
Task Completion	**Motivation/Self Efficacy**	**Task Understanding**
Re-Auditorizing (Re-Aud)	Working toward a goal (Goal)	Repeating instructions (Rep)
Visualizing (Vis)	Self talk (Talk)	Writing a reminder (Wrt)
Verbal self cueing (Verb)	Rewards self (Rew)	
Counting on fingers (Fing)	Breathing/Relaxation (Br)	
Closing eyes (Eyes)	Clinician encouragement (Cl)	
Breathing (Br)		
Pacing (Pace)		
Body alert (Bod)		
Looking at screen (Scrn)		

Notes: 4/6 READY TO MOVE TO 5-WORD SENTENCES.

Julien's scoresheet reveals important performance characteristics. He improved in his task accuracy over time and on the last line (date of 4/6) he met the decision rule criteria ("greater or equal to 80% accuracy for three out of four trials with effort rating of 4 or less) for moving on to a harder task (i.e., 5 word sentences). It is noted that he always did better when given a second trial in the same session and the clinician used this second trial to help him practice his strategies as well as receive more stimulation of working memory. He does not show consistent error patterns. On the first trial he makes random errors (rand) and on the second trial most of the errors are at the end of the task (end) but these patterns do not continue, thus do not require a change in administration or strategy use. In terms of strategy use, when Julien was having a hard time, he independently used task strategies of saying the words out loud (re-aud) and using his fingers (fing) to assign the words. It was helpful to note he independently initiated these task completion strategies, although the clinician was prioritizing strategies that could be used across tasks and contexts (breathing and visualization). As shown by the CP (clinician prompted) designation, Julien initially needed to be reminded to use his breathing (br) and visualization (vis) strategies. As reviewed, these strategies had been identified to help him manage anxiety and stress when completing cognitively demanding tasks. Over time, he became independent in using these strategies as shown by the SI (self initiated) designation. His effort ratings indicate how hard he perceived he had to work at the task and provide information about perceived task difficulty. When Julien experienced an increase in task difficulty and a decrease in accuracy on 4/5, the clinician used this data to ask how he felt and he shared that he had a headache but thought it would be helpful if he could refocus and try again so they initiated a second trial. The motivation ratings give an indication of Julien's perceived level of engagement in the tasks. He appears highly engaged until the ratings begin to drop and he responds to the clinician's query saying he is getting tired of the task. In summary, the scoresheet provides a place to look at task performance characteristics over time and to help the clinician make clinical decisions.

Overview of therapy sequence: Julien worked on these tasks for six sessions. The APT-3 portion of Julien's therapy was sequenced as follows:

- At the beginning of the session, Julien and the clinician reviewed his generalization study logs described above, and checked in on how he did with his independent APT-3 session.
- Prior to beginning a task, (1) Julien would review his previous performance data and set a goal for himself, and (2) he would do his breathing and visualization techniques for managing anxiety.
- Julien would do the tasks sequentially, and rate his motivation and effort levels after each task. After 15 minutes, the clinician would stop him, and ask him to reflect on how he was doing and if there was anything he wanted to do to improve or sustain performance. (However, if he showed struggle with attention or anxiety prior to the 15 minutes, the clinician would stop him and cue him to use his techniques. Occasionally, they would try an easier task for a few trials to "warm up" and then return to the target tasks).
- Upon completion of each task, the clinician and Julien would together make notes on his scoresheet, and reinforce progress. (see Figure 33.)
- Following the APT-3 exercises, Julien and the therapist would work on reading strategies and homework planning using his cell phone.

Over the eight weeks, Julien made steady gains on all aspects of treatment. Generalization logs showed that his homework reading sessions were more productive, and he was retaining information. His quizzes were improving. Two standardized attention tests were re-administered showing an improvement in Julien's working memory. It is not possible to separate out (a) the effects of training the use of strategies, improving planning and organization of studying using the cell phone scheduling, from (b) the impact of the APT-3 exercises. However, Julien reported being able to hold on to information more easily not only for reading but for verbal information as well. He described improved recall of class lecture material.

Appendix A – Prepackaged Starter Programs

This appendix contains the list of starter programs that come preloaded on the APT-3 Manager. These sets are designed to help the clinician quickly get started in creating and running an APT program. Once a set is selected, the clinician will be able to use it as-is or change any of the options/tasks as they see fit.

Starter Set: SAMPLER

Designed to be approximately 50-minute session consisting of:

- 20% Sustained (10 minutes, 2 tasks)
- 20% Selective (10 minutes, 2 tasks)
- 20% Suppression (10 minutes, 2 tasks)
- 20% Alternating (10 minutes, 2 tasks)
- 20% Working Memory (10-15 minutes, 2-3 tasks)

Basic Sustained Tasks:	**Speed**	**Clinician**	**Mode**	**Input**
Listening for 1 Letter in a Word	**slow** fast	male **female**	auditory	button
Listening for 1 Noise	**slow** fast	n/a	auditory	button

Executive Control Selective Attention Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**Distracter**
Listening for 1 Letter in a Word	**slow** fast	male **female**	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition

Clinician/paraprofessional should choose auditory distracter.

Executive Control Working Memory Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**On-Screen Prompt**	**Complexity**	**# of Stimuli**
Matching Animals (2-back)	**slow** fast	n/a	visual	button	n/a	n/a	n/a
Number Sequences (Ascending)	n/a	male **female**	n/a	verbal	**yes** no	**3 (#0-30)** 4 (#0-30) 4 (#0-100) 5 (#0-100)	**5** 10 15 20
Word Sentences (Alphabetical)	n/a	male **female**	n/a	verbal	**yes** no	**4 words** 5 words 6 words	**5** 10 15 20

Executive Control Suppression Tasks:	**Speed**	**Mode**	**Input**
Serious-Silly Intonation	**slow** fast	auditory	**button** verbal
Above-Below Position	**slow** fast	visual	**button** verbal

Executive Control Alternating Tasks:	**Speed**	**Mode**	**Input**
Child-Adult Voices	**slow** fast	auditory	button
Big-Small Word Size	**slow** fast	visual	Button

Starter Set: SUSTAINED

Designed to be approximately 50-minute session consisting of:
40% Sustained (20 minutes, 4 tasks)
30% Working Memory (15 minutes, 3 tasks)
10% Selective (5 minutes, 1 task)
10% Suppression (5 minutes, 1 task)
10% Alternating (5 minutes, 1 task)

Basic Sustained Tasks:	**Speed**	**Clinician**	**Mode**	**Input**
Listening for 1 Number	**slow** fast	male **female**	auditory	button
Listening for 1 Letter in a Word	**slow** fast	male **female**	auditory	button
Listening for 1 Noise	**slow** fast	n/a	auditory	button
Listening for 1 Animal Sound	**slow** fast	n/a	auditory	button

Executive Control Selective Attention Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**Distracter**
Listening for 1 Number	**slow** fast	male female	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition

Clinician/paraprofessional should choose auditory distracter

Executive Control Working Memory Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**On-Screen Prompt**	**Complexity**	**# of Stimuli**
Matching Animals (2-back)	**slow** fast	n/a	visual	button	n/a	n/a	n/a
Number Sequences (Ascending)	n/a	male **female**	n/a	verbal	**Yes** No	**3 (#0-30)** 4 (#0-30) 4 (#0-100) 5 (#0-100)	5 **10** 15 20
Word Sentences (Alphabetical)	n/a	male **female**	n/a	verbal	**Yes** No	**4 words** 5 words 6 words	5 **10** 15 20

Executive Control Suppression Tasks:	**Speed**	**Mode**	**Input**
Above-Below Position	**slow** fast	visual	**button** verbal

Executive Control Alternating Tasks:	**Speed**	**Mode**	**Input**
Child-Adult Voices	**slow** fast	auditory	Button

Starter Set: SELECTIVE

Designed to be approximately 50-minute session consisting of:
40% Selective (20 minutes, 4 tasks)
30% Working Memory (15 minutes, 3 tasks)
10% Sustained (5 minutes, 1 task)
10% Suppression (5 minutes, 1 task)
10% Alternating (5 minutes, 1 task)

Basic Sustained Tasks:	**Speed**	**Clinician**	**Mode**	**Input**
Listening for 1 Animal Sound	**slow** fast	n/a	auditory	button

Executive Control Selective Attention Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**Distracter**
Listening for 1 Number	**slow** fast	male female	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition
Listening for 1 Letter in a Word	**slow** fast	male female	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition
Listening for 1 Noise	**slow** fast	n/a	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition
Listening for 1 Animal Sound	**slow** fast	n/a	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition

Clinician/paraprofessional should choose auditory distracter.

Executive Control Working Memory Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**On-Screen Prompt**	**Complexity**	**# of Stimuli**
Matching Animals (2-back)	**slow** fast	n/a	visual	button	n/a	n/a	n/a
Number Sequences (Ascending)	n/a	male female	n/a	verbal	**Yes** No	**3 (#0-30)** 4 (#0-30) 4 (#0-100) 5 (#0-100)	5 **10** 15 20
Word Sentences (Alphabetical)	n/a	male female	n/a	verbal	**Yes** No	**4 words** 5 words 6 words	5 **10** 15 20

Executive Control Suppression Tasks:	**Speed**	**Mode**	**Input**
Above-Below Position	**slow** fast	visual	**button** verbal

Executive Control Alternating Tasks:	**Speed**	**Mode**	**Input**
Child-Adult Voices	**slow** fast	auditory	Button

Starter Set: SUPPRESSION

Designed to be approximately 50-minute session consisting of:
40% Suppression (20 minutes, 4 tasks)
30% Working Memory (15 minutes, 3 tasks)
10% Sustained (5 minutes, 1 task)
10% Selective (5 minutes, 1 task)
10% Alternating (5 minutes, 1 task)

Basic Sustained Tasks:	**Speed**	**Clinician**	**Mode**	**Input**
Listening for 1 Animal Sound	**slow** fast	n/a	auditory	button

Executive Control Selective Attention Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**Distracter**
Listening for 1 Number	**slow** fast	male female	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition

Clinician/paraprofessional should choose auditory distracter.

Executive Control Working Memory Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**On-Screen Prompt**	**Complexity**	**# of Stimuli**
Matching Animals (2-back)	**slow** fast	n/a	visual	button	n/a	n/a	n/a
Number Sequences (Ascending)	n/a	male female	n/a	verbal	**Yes** No	**3 (#0-30)** 4 (#0-30) 4 (#0-100) 5 (#0-100)	5 **10** 15 20
Word Sentences (Alphabetical)	n/a	male female	n/a	verbal	**Yes** No	**4 words** 5 words 6 words	5 **10** 15 20

Executive Control Suppression Tasks:	**Speed**	**Mode**	**Input**
Happy-Sad Intonation	slow fast	auditory	Button Verbal
Loud-Soft Volume	slow fast	auditory	Button Verbal
Child-Adult Voices	slow fast	auditory	Button Verbal
Slow-Fast Speech Rate	slow fast	auditory	Button Verbal

Executive Control Alternating Tasks:	**Speed**	**Mode**	**Input**
Child-Adult Voices	**slow** fast	auditory	Button

Starter Set: ALTERNATING

Designed to be approximately 50-minute session consisting of:
40% Alternating (20 minutes, 4 tasks)
30% Working Memory (15 minutes, 3 tasks)
10% Sustained (5 minutes, 1 task)
10% Selective (5 minutes, 1 task)
10% Suppression (5 minutes, 1 task)

Basic Sustained Tasks:	**Speed**	**Clinician**	**Mode**	**Input**
Listening for 1 Animal Sound	**slow** fast	n/a	auditory	button

Executive Control Selective Attention Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**Distracter**
Listening for 1 Number	**slow** fast	male **female**	auditory	button	Visual motion White noise Environmental noise Newscast noise Auditory competition

Clinician/paraprofessional should choose auditory distracter.

Executive Control Working Memory Tasks:	**Speed**	**Clinician**	**Mode**	**Input**	**On-Screen Prompt**	**Complexity**	**# of Stimuli**
Matching Animals (2-back)	**slow** fast	n/a	visual	button	n/a	n/a	n/a
Number Sequences (Ascending)	n/a	male female	n/a	verbal	**yes** no	**3 (#0-30)** 4 (#0-30) 4 (#0-100) 5 (#0-100)	5 **10** 15 20
Word Sentences (Alphabetical)	n/a	male female	n/a	verbal	**yes** no	**4 words** 5 words 6 words	5 **10** 15 20

Executive Control Suppression Tasks:	**Speed**	**Mode**	**Input**
Child-Adult Voices	**slow** fast	auditory	button verbal

Executive Control Alternating Tasks:	**Speed**	**Mode**	**Input**
Loud-Soft Volume	**slow** fast	auditory	button
Child-Adult Voices	**slow** fast	auditory	button
Above-Below Position	**slow** fast	visual	button
Big-Small Word Size	**slow** fast	visual	button

References

Anderson, V., Anderson, D., & Anderson, P. (2006). Comparing attentional skills in children with acquired and developmental central nervous system disorders. *Journal of the International Neuropsychological Society*, *12*, 519-531.

Baddeley, A. (2001). Is working memory still working? *European Psychologist, 7*(2) 85-97.

Broadbent, D. E., Cooper, P. F., FitzGerald, F., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, *21*, 1-16.

Butler, R. W., Copeland, D.R., Fairclough, D.L., Mulhern, R.K., Katz, E.R., Kazak, A.E., et al. (2008). A Multicenter, randomized clinical trial of a cognitive remediation program for childhood survivors of a pediatric malignancy. *Journal of Consulting and Clinical Psychology*, *76*(3), 367-378.

Cicerone, K. (2002). Remediation of "working attention" in mild traumatic brain injury. *Brain Injury*, *16*(3), 185-195.

Coelho, C. (2005). Direct attention training as a treatment for reading impairment in mild aphasia. *Aphasiology, 19*(3), 275-283.

Coelho, C., Ylvisaker, M., & Turkstra, L. (2005). Nonstandardized assessment approaches for individuals with traumatic brain injury. *Seminars in Speech and Language, 26*(4), 223-241.

Conners, C. K. (1992). *Conners' Continuous Performance Test-II* [Computer software]. Toronto, Canada: Multi-Health System.

Duval, J., Coyette, F., & Seron, X. (2008). Rehabilitation of the central executive component of working memory: A re-organizational approach applied to a single case. *Neuropsychological Rehabilitation*, *18*(4), 430-460.

Fleming, J. M., Strong, J., & Ashton, R. (1996). Self-awareness of deficits in adults with traumatic brain injury: How best to measure? *Brain Injury, 10*(1), 1-15

Galbiati, S., Recla, M., Pastore, V., Liscio, M., Bardoni, A., Castelli, E., et al. (2009). Attention remediation following traumatic brain injury in childhood and adolescence. *Neuropsychology, 23*(1), 40-49.

Golden, C. J. (1978). *Stroop Color and Word Test*. Chicago: Stoelting.

Golper, L. C., Wertz, R. T., Frattali, C. M., Yorkston, K. M., Myers, P., Katz, R., et al. (2001). *Evidence-based practice guidelines for the management of communication disorders in neurologically impaired individuals: Project introduction.* Retrieved July 1, 2010 from http://www.ancds.org/index.php? option=com_content&view=article&id=9&Itemid=9#TBI

Hochstenbach, J. B., den Otter, R., & Mulder, T. W. (2003). Cognitive recovery after stroke: A 2-year follow-up. *Archives of Physical Medicine and Rehabilitation*, *84*, 1499-1504.

Kennedy, M. R. T., Avery, J., Coelho, J., Sohlberg, M. M., Turkstra, L., Ylvisaker, M., et al. (2002). Evidence-based practice guidelines for cognitive-communication disorders after traumatic brain injury: Initial committee report. *Journal of Medical Speech-Language Pathology*, *10*, ix - xiii.

Kennedy, M. R. T., Coelho, C., Turkstra, L., Ylvisaker, M., Sohlberg, M. M., Yorkston, K., Chiou, H., & Kan, P. F. (2008). Intervention for executive functions after traumatic brain injury: A systematic review, meta-analysis and clinical recommendations. *Neuropsychological Rehabilitation*, *18*(3), 257-299.

Kim, Y. H., Yoo, W. K., Ko, M. H., Park, C., Kim, S. T., & Na, D. (2009). Plasticity of the attentional network after brain injury and cognitive rehabilitation. *Neurorehabilitation and Neural Repair, 23*(5), 468-477.

Lopez-Luengo, B., & Vazquez, C. (2003). Effects of attention process training on cognitive functioning in schizophrenic patients. *Psychiatry Research, 119* (1), 41-51.

Malec, J. (1999). Goal attainment scaling in rehabilitation. *Neuropsychological Rehabilitation*, *9*(3/4), 253-275.

Mirsky, A. F., Yardley, S. L., Jones, B. P., Walsh, D., & Kendler, K. S. (1995). Analysis of the attention deficit in schizophrenia: A study of patients and their relatives. *Journal of Psychiatric Research*, *29*, 23-42.

Ponsford, J., & Kinsella, G. (1991). The use of a rating scale of attentional behavior. *Neuropsychological Rehabilitation*, *1*(4), 241-257.

Posner, M., & Rothbart, M. K. (2006). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology*, *58*, 1-23.

Prigatano, G. P. (1986). *Neuropsychological rehabilitation after brain injury*. Baltimore: Johns Hopkins University Press.

Raskin, S. & Sohlberg, M. M. (2009). Prospective memory intervention: A review and evaluation of a restorative intervention. *Brain Impairment, 10*(1), 76-86.

Raskin, S. A., & Mateer, C. A. (2000). *Neuropsychological management of mild traumatic brain injury*. Oxford: Oxford University Press.

Reitan, R. (1969). *Manual for administration of neuropsychological test batteries on adults and children*. Bloomington: Indiana University Press.

Robertson, I. H., Ridgeway, V., Greenfield, E., & Parr, A. (1997). Motor recovery after stroke depends upon intact sustained attention: A 2-year follow up study. *Neuropsychology*, *11*, 290-295.

Robertson, I. H., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1994). *Test of Everyday Attention*. San Antonio, TX: Pearson Assessment

Roman, D. R., Edwall, G. E., & Buchanan R. J. (1991). Extended norms for the Paced Auditory Serial Addition Test. *The Clinical Neuropsychologist*, *5*, 33-40.

Sbordone, R. J. (1991). Overcoming obstacles in cognitive rehabilitation of persons with severe traumatic brain injury. In J.S. Kreutzer & P.H. Wehman (Eds.), *Cognitive rehabilitation for persons with traumatic brain injury: A functional approach (pp. 105-126)*. Baltimore: Paul H. Brookes Publishing Company.

Schiffrin, R. M. & Schneider, W. (1977). Controlled and automatic human information processing II: Perceptual learning, automatic attending and a general theory. *Psychological Review*, *84*, 90-190.

Schlosser, R. W. (2004). Goal attainment scaling as a clinical measurement technique in communication disorders: A critical review. *Journal of Communication Disorders, 37*, 217-239.

Serino, A., Ciaramelli, E., Di Santantonio, A., Malagú, S., Servadei, F., & Ládavas, E. (2006). Central executive system impairment in traumatic brain injury. *Brain Injury, 20*(1), 23-32.

Sinott, M., & Coelho, C. (2007). Attention training for reading in mild aphasia: A follow-up study. *Neurorehabilitation*, *22*(4), 303-310.

Sohlberg, M. M., Avery, J., Kennedy, M. R. T., Coelho, C., Ylvisaker, M., Turkstra, L., & Yorkston, K. (2003). Practice guidelines for direct attention training. *Journal of Medical Speech-Language Pathology*, *11*(3), xix-xxxix.

Sohlberg, M. M., & Mateer, C. (2001). *Cognitive rehabilitation: An integrated neuropsychological approach*. New York: Guilford Publication.

Treisman, A. (1969). Strategies and models of selective attention. *Psychological Review. 76*, 282-299.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. San Antonio: TX: Psychological Corporation.

Whyte, J., Hart, T., Bode, R., & Malec, J. (2008). The Moss Attention Rating Scale for traumatic brain injury: Initial psychometric assessment. *Archives of Physical Medicine and Rehabilitation*, *84*(2), 268-276.

Zoccolotti, P., Matano, A., & Deloche, G. (2000). Patterns of attentional impairment following closed head injury: A collaborative European study. *Cortex, 36*(1), 93-107.