

**Attention Process Training: Its Effectiveness in Remediating
Attention and Memory Deficits Following
Mild Traumatic Brain Injury**

by

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Abstract

Attention Process Training: Its Effectiveness in Remediating

Attention and Memory Deficits Following

Mild Traumatic Brain Injury

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Traumatic brain injury is an insult to the brain capable of producing physical, intellectual, emotional, social, and vocational changes. Statistics show a rapid increase in the number of brain injuries each decade in both developed and developing countries. Disorders of memory and attention are among those regarded as most prominent following non-penetrating traumatic brain injury (TBI). The purpose of this study was to investigate the effectiveness of Attention Process Training (APT) in remediating attention deficits and memory dysfunctions following mild TBI.

A convenience sample of four (three females, one male) automobile accident survivors with mild TBI underwent APT. Baseline data was obtained over a period of 3-6 sessions (one session per day), randomly assigned to the four subjects. The RAPT and the

PASAT were utilized to measure baseline performance in attention. To obtain baseline data for memory performance, the CVLT, the Rey CFT, and the PROMS, were used. The APT-II Questionnaire was used to obtain baseline data on perceived difficulty of attentional problems in everyday life. The intervention consisted of APT auditory and visual attention tasks administered over four alternate (ABAB) study phases, each approximately 3 weeks long, a total of 12-14 weeks. To obtain post-training performance in attention, measures included the RAPT, PASAT, DVT, and the MTVAT. The CVLT, Rey CFT, and PROMS were used to measure outcomes on memory performance. The APT-II Questionnaire, the APT-II Attention Lapse and Success Log, including probes, were used to measure generalization to naturalistic settings. To analyze data, mean outcome scores were compared with baseline scores.

Findings on the RAPT suggested increased performance in divided attention for all four subjects. Increased performance was also suggested for two subjects in sustained, selective, and alternating levels of visual attention, and for one subject in auditory alternating attention. Findings on the PASAT suggested a more general increase for all subjects. In contrast, findings on the DVT and MTVAT suggested very limited increases in performance. The rate of response was found to be a more efficient measure for assessing attention performance in the mild TBI sample. Modality specificity was suggested only by the DVT data.

Findings on the Rey CFT showed an increased performance in figure reproduction and in the organization of visual information. Data from the CVLT suggested increased performance for two subjects in immediate recall and reduction of perseverations. Limited increases occurred in short-delay recall, consistency of item recall, target recognition, and

reduction of false positive responses. There was no increase in verbal organization as determined by the semantic clustering ratio of the CVLT. Higher performance in prospective memory occurred in associative-cued compared to time-cued tasks. The Rey CFT showed better performance in delayed-recall compared to immediate and short-term recall. There was evidence of moderate generalization of behavior to naturalistic settings. In summary, findings suggested the APT was selectively effective in remediating attention and memory deficits for mild TBI. More research is recommended to validate these findings.

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GLOSSARY OF TERMS AND CONCEPTS

Attention

Attention is conceptualized as the capacity to focus on particular stimuli over time and to manipulate flexibly the information being processed. Incorporated in attention are a multiplicity of notions, including, at the most fundamental level, alertness and arousal, and at higher levels, focusing of perceptual systems (preparedness), sustaining concentration (vigilance), being more or less vulnerable to interference (distractibility), and being able to allocate attentional resources efficiently (divided attention).

Particularly pertinent to the concept of attention is the concept of working memory proposed by Baddeley (1991), which incorporates the capacity to hold information in a temporary store while mental operations are performed. Attentional capacity is a logical component of any memory model since it is this capacity that allows information to have access to the memory system (Sohlberg & Mateer, 1989, p. 139).

Attention Process Training

Attention Process Training is a process-specific, restorative treatment that is oriented towards targeting of attention deficits through auditory and/or visual sensory modalities. This approach assumes that cognitive disabilities can be remediated individually through retraining. Methods are designed to assist survivors in compensating for residual deficits, recognizing that restoration of cognitive capacity to prior functional level is not always possible.

Learning

Learning is acquisition of new information, mastery of a new skill, or developing a new habit, which requires a certain amount of practice and repetition, the primary purpose of which is adaptation to an ever-changing environment in the life of humans. It is preceded by attention and it involves memory.

Memory

The concept of memory is used to refer to the persistence of learning in a state that can be revealed at a later time. It is the capacity that permits organisms to benefit from their past experiences.

Mild Traumatic Brain Injury

Mild traumatic brain injury is defined as (The Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine, 1993):

“...traumatically induced physiological disruption of brain function, as manifested by at least one of the following:

- any period of loss of consciousness;
- any loss of memory for events immediately before or after the accident;
- any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused); and
- focal neurological deficit(s) that may or may not be transient; **but**

where the severity of the injury is marked by:

- loss of consciousness of approximately 30 minutes or less;
- after 30 minutes, an initial Glasgow Coma Scale of 13-15;
- post traumatic amnesia...not greater than 24 hours.”

Probe

A probe is defined as “the assessment of behavior on selected occasions when no contingencies are in effect for that behavior.” Probes are commonly used to determine whether a behavior not focused on directly has changed over the course of the investigation. Because the contingencies are not in effect for behaviors assessed by probes, the data from probe assessment address the generality of behavior across responses and situations (Kazdin, 1982, p. 209).

Targeting

Targeting is a concept used to indicate a cognitive therapy approach whereby a selected training technique is concentrated on a specific modality of a cognitive function as opposed to others in the same attribute. With respect to the proposed study, this term refers to concentration of training effort to either visual or auditory attention at different blocks of time during the treatment period.

Traumatic Brain Injury

Traumatic brain injury is defined as an insult to the brain capable of producing physical, intellectual, emotional, social and vocational changes (The National Head

Injury Foundation, 1985).

LIST OF ABBREVIATIONS

AFNRD	Association for Neuropsychological Research and Development
APT	Attention Process Training
CFT	Complex Figure Test
CVLT	California Verbal Learning Test
DVT	Digit Vigilance Test
FP	False positive
LTP	Long-term potentiation
MTVAT	Multiple Task Visual Attention Test
PASAT	Paced Auditory Serial-Addition Test
PROMS	Prospective Memory Screening
RCPMB	Repeatable Cognitive-Perceptual-Motor Battery
SD	Standard deviation
SO	Significant other
TBI	Traumatic brain injury

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DEDICATION

This dissertation is dedicated to the most important people in my life: my parents, Ishmael Joseph Ngoloyi and Cecilia Machafo Ngoloyi, in heartfelt appreciation of their help and support. My father, especially, has made the education of children his unwavering lifelong goal, not just in his own family but in our community as well. I will be forever grateful for his vision, and for my mother's bravery and strength. In memory of my sister, Ntombizonke Justina Moholane.

CHAPTER ONE

STATEMENT OF THE PROBLEM

Traumatic brain injury (TBI) is an insult to the brain capable of producing physical, intellectual, emotional, social and vocational changes (The National Head Injury Foundation, 1985). Overall, statistics show a rapid and steady increase in the number of head injuries each decade, both in developed and developing countries. The annual incidence of brain injury in the United States was estimated as 200 per 100,000 population (Kalsbeek, McLaurin, Harris et al. 1980). Campbell (1988) reported an annual estimate of 390 per 100,000 people in the same country. The National Head Injury Foundation estimated that each year there were more than 800,000 serious head injuries which result in brain damage (Ford 1992). The majority of these were males ranging in age between 16 and 35 (De Jong, Batavia, & Williams 1990). Of these, 50,000 to 90,000 suffer injuries severe enough to leave residual deficits that preclude their return to independent living (De Jong et al., 1990). In Johannesburg, South Africa, brain injury was estimated at 316 per 100,000 in 1986, with 5106 new cases reported in that city alone (Brown & Nell, 1991). Of these, 879 were female and 4227 were male, with 1505 cases in the 15-24 year old age group.

Attention deficits occur almost invariably in head injury (Sohlberg & Mateer, 1987; van Zomeran, Brouwer, & Deelman, 1984). There is increasing recognition that even seemingly "minor" TBI almost invariably results in cognitive impairments, contributing significantly to lasting disability (Batchelor, Shores, Marosszky, Sandanam, & Lovarini, 1988). Even seemingly "minor" neurological damage causes serious disruption

of the physiological systems critical to the regulation of cognitive functioning (Gronwall, 1977; Ponsford & Kinsella, 1988; Sohlberg & Mateer, 1989). The most salient features of the impairments include deficits of attention and concentration, disorders of recent memory and information processing, and higher cognitive dysfunction (Batchelor, Shores, Marosszekey et al., 1988).

Observations in patient populations show a reduction in the ability to shift attention efficiently from one stimulus to another. There is evidence that the speed at which head injured individuals respond is decreased in direct proportion to the amount of information to be processed (Gronwall & Wrightson, 1974; Hugenholtz et al., 1988; van Zomeran & Brouwer, 1994; Sohlberg & Mateer, 1989). Slowness in elementary psychological operations is a significant feature in complex tasks, particularly when time pressure is involved (Newcombe, 1985; Sohlberg & Mateer, 1989; Stuss, Ely, et al., 1985; Wood, 1990). Other impairments that have been reported include short-term memory and verbal retrieval problems (Lezak & O'Brein, 1990), emotional distress and fatigue (Lezak, 1988d; Wang & Goltz, 1991). When severe the patient may complain of confusion, inability to think clearly, and disorientation (Meyers & Levin, 1992). Attention deficits often underlie other cognitive disorders such as memory impairment (Baddeley, 1990; Sohlberg & Mateer, 1987;). Although the severity nearly always lessens over the course of time, residual deficits persist for many months, even years post-injury (Guentz, 1987).

Studies in cognitive rehabilitation (Batchelor, Shores, Marosszekey et al., 1988; Gronwall, 1977; Guentz, 1987; Sohlberg & Mateer, 1989; Wood & Fussey, 1987) have

suggested the benefit of structured neuropsychological techniques in promoting and enhancing cognitive recovery. It has also been suggested that attention-based memory dysfunction responds positively to Attention Process Training (APT) (Sohlberg & Mateer, 1989). Lack of conclusiveness in most such studies has raised concerns regarding the effectiveness of attention training in remediating attention deficits resulting from TBI.

Relatively few studies have been undertaken to address the effectiveness of attention training. Many of these studies investigated either the auditory modality (Sohlberg & Mateer, 1987) or the visual modality alone (Gordon, 1990). Although attention training is modality oriented, modality specificity on the outcome has not been investigated. It is not known whether targeting visual attention has a specific influence on visual skills only. The same holds true for auditory attention and auditory performance. It is also not clear whether or not performance skills learned during attention training generalize to other life situations.

Significance of the Study

In order to dispel existing concerns about the efficacy of attention training for the growth of cognitive rehabilitation as a budding science, it is important to establish, through scientific measures, facts about its techniques. By establishing facts regarding modality specificity of the approaches in attention training, clearer guidelines for cognitive rehabilitation will be provided. This knowledge in turn would enable insightful choices of approaches in clinical settings, with more benefit to the recipient of such care. Determining the effect of attention training on attention-based memory dysfunction may influence the

future of cognitive rehabilitation programs, with the possibility of increased cost-effectiveness.

Purpose of the Study

The purpose of this study was to investigate the effectiveness of ATP in remediating attention deficits and attention-based memory dysfunction following mild TBI.

Specific Aims

The specific aims of the study were addressed by the hypotheses that:

1. Following auditory APT, the rate of auditory information processing would increase and the number of correct auditory responses made would increase.
2. Following visual APT, the rate of visual information processing would increase, and the number of correct visual responses made would increase
3. Following APT accuracy in recall and recognition of verbal material would increase.
4. Following APT the number of errors made in reproducing visually presented complex figures would decrease.
5. Following APT the ability to execute assigned prospective tasks at the correct time would increase.
6. Following APT the ability to organize verbal and visual material into categories or units would increase.

7. Following APT the perceived frequency of difficulty for breakdowns in attention, and the severity of attentional problems experienced in daily life, would decrease.

CHAPTER TWO

ATTENTION AND MEMORY: THEORETICAL CONSIDERATIONS

Disorders of memory and attention are among those regarded as most prominent following non-penetrating TBI. Further, attention deficits have been implicated in some disorders of memory (Baddely, 1990; Sohlberg & Mateer, 1987). The primary purpose of this chapter is to provide some theoretical overview on the concept of attention, and illustrate the functional relationship between attention and memory, thereby laying the ground for a cognitive approach in the investigative procedures employed in this study. The chapter is divided into three main sections. The first section discusses the concept of attention and its role in information processing with the aim of promoting better understanding of attention deficits as they occur in TBI. Some views, models, and theories of attention are presented. Special attention is given to aspects of information processing that are supportive of the process specific approaches to cognitive rehabilitation and its recognition of the non-unitary nature of attention.

The second section of this chapter describes memory and its relationship to attention. The focus of this section is to identify factors that relate memory to attention and to introduce learning as a consequence of this relationship and a major principle underlying attention training. The third section is a description of the APT technique as a strategy for remediation of attention deficits in brain injury. Theoretical principles that underlie this technique are presented. Features of the Clinical Model of Attention (Sohlberg & Mateer, 1987) as it relates to the practical aspects of attention training are identified. This section also presents an overview of selected studies on the efficacy of

attention training techniques in ameliorating attention deficits in TBI.

Attention

Attention Defined

Attempts to define attention have been characterized by controversy. However, the importance of attention has been acknowledged by several investigators (Baddeley 1990; Kahneman 1973; Picton, Stuss, & Marshall, 1986; Ponsford & Kinsella, 1988; Sohlberg & Mateer, 1989). According to Cimprich (1992) attention operates to increase sensitivity to information, or selected stimuli, in the external and the internal environments. Picton et al. (1986) view attention as a process that chooses particular information for further evaluation and response, while ignoring other available information. Common to these views is the implication that attention assigns to the individual the capability to actively focus and concentrate on pertinent information in the environment, allowing some stimuli or aspects of stimulation to be attended to in preference to others (Kahneman, 1973).

Because the world is full of information that is more than can be processed by one individual, the question of how individuals interact with this information is a crucial one (Kahneman, 1973). Observations have shown that when two stimuli of equal complexity are presented at once, often only one of them is perceived, while the other is completely ignored. If, on the other hand, both stimuli are perceived, the responses that they elicit are often made in succession rather than simultaneously (Kahneman, 1973). Further, there is evidence that a person is often able to perform several tasks in parallel (Hunt & Lansman, 1986). It is generally agreed that the basic principle underlying control of information

processing can be explained in terms of constraints inherent in the attention systems of the brain. There is also growing agreement that varieties of directed attention are governed by different rules and are to be explained by different mechanisms.

Models of Attention

In their review of attention literature, Kerns and Mateer (in press) divide the mechanisms of attention comprehensively into four models, viz., neuroanatomic models, factor analytic models, cognitive processing models, and clinical models. A neuroanatomic model is described as the approach that explains attention by correlating various attentional abilities with the different brain regions that subserve those functions.

It has been proposed that the ability to direct attention depends on a global, neural, inhibitory mechanism that acts to block competing stimuli or distractions (Kaplan & Kaplan, 1982; Mesulam, 1985; Posner & Boies 1971; Posner, 1990; Posner & Peterson, 1990). In this view of attentional control, attention is carried out by a network of anatomical areas (Mesulam, 1985; Posner & Peterson, 1990) separate from the data processing systems that perform operations on specific inputs (Posner, Peterson, Fox, & Raichle, 1988). These systems carry out different functions in computations that can be specified in cognitive terms (Posner & Peterson, 1990). According to this view an incoming sensory message reaches analyzers at the cortex which match its features to neuronal models constructed by previous experience. The current study recognizes the unique role of attention in connecting the mental level of description of processes used in cognitive science with the anatomical level common to neuroscience.

cognitive science with the anatomical level common to neuroscience.

The prefrontal lobes are generally considered as the cortical suprastructure of the attentional system (Auerbach, 1986; Groswasser, Reider-Groswasser, Soroker, Machtey, 1987). Anatomically, concern is with the prefrontal region of the frontal lobe so that the motor areas are excluded (Auerbach, 1986). Literature identifies two corresponding syndromes, the orbito-frontal syndrome and the dorsolateral frontal lobe syndrome. The orbito-frontal lesions are usually associated with a disinhibition of stimulus response interactions. Impulsiveness, disinhibition, and hyperactivity, are characteristic behaviors. Interference effects found in memory testing is attributed to an inability to suppress interfering stimuli. In contrast, the dorsolateral syndrome is characterized by a pseudo-depressed state with slowness, perseveration, and lack of initiation. Memory performance is limited by interference effects, and the patient suffers from a difficulty in sustaining attention to relevant elements (Mesulam, 1981). Other areas identified include the temporal lobes (Groswasser, et al., 1987; Grubb & Coxe, 1978), basal ganglia, periventricular zones, corpus callosum, and the brainstem fiber tracts (Sohlberg & Mateer, 1989; Pang, 1989).

Although disturbances of attention are frequent with lobe damage, patients with large lesions of this area do not often show abnormalities on simple tasks such as the digit span and serial abstraction (Stuss, Benson, Kaplan, Weir, & Della Malva, 1981). Intellectual tests and the ability to make abstractions may be unimpaired (Stus & Benson, 1984). The disorder is more one of attentional control with the patient being unable to adopt or adapt appropriate cognitive strategies in response to changing task demands

of selectivity, coherence of thought and action, monitoring of performance and adapting behavior task demands (such as required in the Wisconsin Card Sorting Test), is usually severely impaired (Picton, Stuss, & Marshall, 1986).

The factor analytic model of attention is described as a model of attention based upon factor analysis of several tests thought to evaluate attention. This approach relies heavily on psychometric testing to determine attention performance (Mirsky, Anthony, Duncan, Ahearn, & Kellman, 1991). The model identifies four distinct factors of attention performance based on attention performance. These factors are identified as the focus-execute, sustain, encode, and shift. These four components are consistent with the information processing approach described in the Clinical Model of Attention identified by Sohlberg & Mateer (1989). The factor analytic model, although acknowledged, does not feature prominently in the current study. Cognitive processing models, first introduced by Broadbent (1958), 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 (Sohlberg, Johnson, Paule, Raskin, & Mateer, 1993). Arguments are derived from observations of normal individuals.

The clinical models of attention attempt to link theories of attention in cognitive psychology and neuropsychology with observations and analysis of behavior and performance of neurologically impaired patients (Sohlberg, Johnson et al., 1993). These researchers proposed a clinical model of attention with five levels of attention, namely, focused, sustained, selective, alternating, and divided attention. Each of these levels

handles a distinct aspect of information processing. The clinical model of attention is treated in some detail in a later section of this chapter. Because of the current study's interest in information processing as a cognitive function, the theoretical basis of information processing is discussed next.

Cognitive Theories of Attention

Information processing is based on the assumption that in interacting with its environment, the organism needs to control the choice of stimuli that will be allowed to in turn control its behavior (Kahneman 1973). Processing of information as a cognitive function can be explained in terms of two theories of attention, viz., the bottleneck theory, and the capacity theory.

The bottleneck theory of information processing. The bottleneck theory holds that just as human sensory and motor performance is constrained by some bottlenecks in human biological constitution, similar bottlenecks exist in the central nervous system, permitting the processing of only one piece of information at a time (Kahneman 1973). In this theory three levels of information processes are identified, viz., sensory registration and storage, perceptual analysis, and response selection. Differences appear concerning the locus of the bottleneck, giving rise to two models that operate within this theory.

The first model assumes a bottleneck is situated at or just prior to the stage of perceptual analysis, so that only one stimulus at a time can be perceived. When two stimuli are presented at once, only one of them is perceived immediately, while the sensory

information that corresponds to the other is held briefly as an analyzed echo or image. In this model attention controls perception. The observer can attend to the images and echoes, and perceive their content, but only after the perceptual analysis of the first stimulus has been completed.

The alternative model proposes that the bottleneck is located at or just prior to the stage of response selection. According to this model, the meanings of all concurrent stimuli are extracted in parallel and without interference. In other words, perception is non-discriminative. The bottleneck that imposes sequential processing is only encountered later at the response level, where it prevents the initiation of more than one response at a time. At this point, only the response that best fits the requirement of the situation is selected (Kahneman, 1973). Although the model has been criticized for its failure to account for the flexibility and highly responsive allocation of attention (Duncan, 1984; Kahneman & Henik, 1981; Neisser, 1967; Treisman, Kahneman & Burkell, 1983), it pioneered thinking in terms of information processing.

The capacity theory of attention. The capacity theory of attention provides an alternative for the bottleneck theory. The main assumption in this theory is that there is a general limit on human capacity to perform mental work (Kahneman 1973). Three basic concerns addressed by this theory are: how attention is allocated, what controls the total amount of attention capacity available at any one time, and what makes one activity more demanding than another. The two central elements of the model are the allocation policy and the evaluation of demands on the limited capacity.

The evaluation of demands is the governor system that causes capacity (or effort) to be supplied as needed by the activities that have been selected by the allocation policy. The allocation policy itself is controlled by four factors: (1) enduring dispositions which reflect the rules of involuntary attention (for example, allocation of capacity when one's name is mentioned, to objects of sudden motion, to novel signals); (2) momentary intentions, (for example, calculating the number of times a targeted sound is made); (3) evaluation of demands when two activities are demanding more capacity than is available; (4) effects of arousal.

In this model it is proposed that different mental activities impose different demands on the limited capacity of attention, i.e., an easy task demands little effort and a difficult task demands more effort. Automatic processing of a task may occur as a result of extensive practice with consistent stimulus-response relations, rendering a task that was once difficult easy. Because it is insensitive to capacity limits, automatic processing can occur concurrently with controlled processing of information with no decrement in performance (Strayer & Kramer, 1990). However, two concurrent tasks, with equal demands for controlled processing will compete for attention. When the supply of attention does not meet the demands, performance falters, or fails entirely. An activity can fail either because there is altogether not enough capacity to meet the demands or because the allocation policy channels available capacity to other activities. An action can also fail because the input of relevant information was insufficient. Alternatively, a person may fail to detect or recognize a signal because of lack of interest. Failure to detect signals can also be due to mechanical failure in the sensory apparatus, poor quality of the signal itself, or

high levels of arousal. In high arousal, attention tends to be concentrated on the dominant and most obvious aspects of the situation irrespective of their relevance. Thus, while arousal is necessary for performance, high levels may impair judgement (Kahneman, 1973; Norman & Bobrow, 1975).

In summary the capacity theory credits humans with ability to decide what stimuli in the environment are relevant and nonrelevant. The theory proposes that as long as the joint attentional demands of two tasks (automatic and controlled) do not exceed attentional capacity, the two tasks can be executed together with no decrement in performance. Consequently, performance falters at the point where the combined attentional demands of the two tasks exceed the available capacity. It is evident that due to a less than normal complement of attention capacity, a brain-injured person would manifest unusual problems in the handling of concurrent tasks. Although the capacity theory is a step ahead of the bottleneck theory, it also fails to account for information processing in higher cognitive functioning such as personal organization. Higher cognitive functioning is associated with the central executive system (Lezak, 1982; Sohlberg, Mateer, & Stuss, 1993; Stuss, 1991) which is often impaired in brain injury.

The central executive system. Although the central executive system is commonly described as a component of working memory, its role in attention control is a crucial one (Sohlberg, Mateer, & Stuss, 1993). The role of central executive system first suggested by Baddeley (1990, 1992) has been acknowledged by other researchers (Lezak, 1982; Sohlberg, Mateer, & Stuss, 1993; Strayer and Kramer, 1990). Attentional control

by the central executive system has been described as an interplay between automatic and controlled processing (Strayer and Kramer, 1990). The executive control adjusts and directs the ongoing automatic behaviors of the perceptual modules (Sohlberg, Mateer, & Stuss, 1993). The automatic processes form the basis of "unconscious" daily routine behavior. They tend to be related more to the nonfrontal brain regions (Stuss & Benson, 1986) and do not necessarily involve executive control or supervisory function. However, in unusual circumstances, or under conditions of fatigue or emotional distress, the central executive system may need to come into play as the supervisory structure over processing (Sohlberg, Mateer, & Stuss, 1993). Of particular significance in this view is the role of the executive control in "contention scheduling". Contention scheduling is the term describing the process of selection for routinized actions or thought processes (Norman & Shallice, 1986; Shallice, 1988) determining allocation of attention.

The role of the executive control system on voluntary or controlled attention is associated with the functions of goal formation, planning, carrying out purposeful activities, and self-monitoring of performance (Lezak, 1992; Sohlberg, Mateer, & Stuss, 1993). Lezak submits goal formation requires self-awareness on several levels involving internal states, experience, relation to the environment, and the ability to conceptualize purposes before acting. Goal-directed activity requires sustained focus and control of interference or distraction. Planning requires the ability to think of alternatives, to make choices, and to construct a conceptual structure that serves to guide action. Carrying out purposeful activity involves directed attentional capacity in initiating and maintaining the intended activity, and in stopping in an orderly manner. Directed attention is crucial for

self-monitoring, including keeping track of what one is doing, perceiving mistakes, and for adapting behavior to meet intended goals (Cimprich, 1992). The capacity to be aware of oneself and the ability to reflect on thinking appear to be dependent on the prefrontal region, and is dependent on input from sensory, perceptual, and executive control systems (Sohlberg, Mateer, & Stuss, 1993).

As a controller of memory, the central executive allows information to be held in short-term storage while attention is temporarily shifted to other stimuli, thus facilitating divided attention (Baddeley, 1990). Divided attention seem to interrelate the frontal lobes, the hippocampus, and the associative pathway (Baddeley, 1990). Difficulties with the executive control system are common after TBI and they are typically associated with damage to the frontal and prefrontal cortex (Sohlberg, Mateer, & Stuss, 1993). Damage to the cortical and subcortical systems associated with the executive system commonly result in difficulty with anticipation, goal selection, organization, initiation, execution, and self-regulation of goal-directed activity (Stuss & Benson, 1986). Attention deficits in brain injury tend to manifest themselves in forms that interfere with the functioning of these control mechanisms.

The Clinical Model of Attention

In this model attention is considered as a multilevel cognitive capacity critical to memory, new learning, and all other aspects of cognition (Sohlberg & Mateer, 1989). The model addresses five levels of attention: focused attention, sustained attention, selective attention, alternating attention, and divided attention. The identified levels of attention

each seem to be representative of the diverse manipulations involving attentional skills required in different situations of information processing. In contrast to its counterparts, the clinical model of attention, was derived by examining the cognitive theories of attention in concert with clinical observations, thus providing the basis of assessment and rehabilitation for individuals with brain injuries (Sohlberg, Johnson, et al., 1993). The proposed five in this model form the basis of treatment tasks for the APT. Like the levels, treatment tasks are considered hierarchical (Sohlberg & Mateer, 1987). However, Sohlberg and Mateer did not define how these hierarchy levels relate to one another. Following is a description of the five levels of attention as defined in the clinical model of attention:

Focused Attention is defined as the ability to respond directly to specific visual, auditory, or tactile stimuli. Though this level of attention is often disrupted in the early stages of emergence from coma, almost all patients recover it.

Sustained Attention which incorporates vigilance refers to the ability to maintain a consistent behavioral response during continuous and repetitive activity. It will be recalled that this level is associated with short-term memory storage, for which the central executive system is responsible. Deficits at this level interfere with the efficiency of working memory. Patients with a deficit at this level can focus on a task or maintain responses for a few seconds or minutes only. They also fluctuate dramatically in performance over even brief periods.

Selective Attention is regarded as "freedom from distractibility" and refers to "the ability to maintain a behavioral or cognitive set in the face of distracting or competing

stimuli" (Sohlberg & Mateer, 1989, p.121). Individuals with selective attention deficits easily get drawn away from target tasks by extraneous and irrelevant stimuli. Kahneman (1973) attributes distractibility to excessive levels of arousal. In high arousal attention tends to be concentrated on dominant and most obvious stimuli, impairing the ability to discriminate relevant from irrelevant aspects of information, thus interfering with judgement. Such persons manifest with the effects of the so-called "speed-accuracy trade-off", i.e., they tend to be faster but less accurate in their response-reactions (Kahneman, 1973).

Alternating Attention is the capacity for mental flexibility that allows individuals to shift their attention and move between tasks having different cognitive requirements, thus controlling which information will be selectively attended to. Real life demands for this level of attentional control are frequent e.g., a student having to shift between listening to a lecture and taking notes. Inability to alternate attention is associated with increased reaction time (Mack 1986, Kahneman 1973) and the subjects' tendency of being unsure of their detections during testing (Kahneman, 1973). Increased arousal causing delays in orientation may also be a factor.

The fifth level is **Divided Attention**, the ability to respond simultaneously to multiple task demands. This level of attentional capacity is required whenever multiple simultaneous demands must be managed. Performance at this level may take the form of rapid and continuous alternating attention or dependence on more unconscious automatic processing for at least one of the tasks (Sohlberg & Mateer, 1989). A divided attention deficit results from the limited capacity of the system for controlled processing. If too

much task-relevant information is presented too quickly, the system can no longer cope, the relevant signals are missed, and the required responses cannot be carried out (van Zomeran & Brouwer, 1994). The role of the central executive in influencing performance in divided attention was outlined in an earlier section.

The levels of attention identified in this model form the basis of treatment tasks for the APT. Like the levels, treatment tasks are considered hierarchical (Sohlberg & Mateer 1987). It is not defined however, how these hierarchy levels relate to one another.

Memory

Literature identifies two major orientations from which studies of memory have been approached. The earlier, neurobiological approach was concerned with structure and mechanisms. In this context, memory is described as a synaptic event and refers particularly to the temporal sequence of events leading to stable changes in synaptic efficacy (Squire, 1987). Later approaches have progressively shifted emphasis from mechanisms to processes that describe the activities of learning and remembering entirely in terms of mental processes and focusing on mental systems (Craik, 1984). Characteristic of this latter approach is the removal of focus from sequential events at individual synapses, focusing instead on how brain systems function. Squire (1987) points out that since the two approaches are reconcilable, both should be adopted into an interactive mixture of structure and process approaches, in order to provide for a more comprehensive model. This approach is relevant to cognitive clinical intervention, such as the APT.

Memory Defined

The concept of memory refers to the persistence of learning in a state that can be revealed at a later time. While it is said to be a consequence of learning, memory has generally been defined in broad terms to include both phenomena (Squire, 1987).

According to Tulving (1985) memory is the capacity that permits organisms to benefit from their past experiences. These experiences are not "stored", but change the way we perceive, perform, think, and plan. They do so by physically changing the structure of the nervous system, altering neural circuits that participate in perceiving, performing, thinking, and planning (Carlson, 1991). Because most organisms can change in response to the events that occur during their lifetimes, the experiences that an animal has can modify its nervous system, causing it to behave differently as a result (Carlson, 1991; Kandel, Schwartz, & Jessel, 1991; Squire, 1987).

Learning as an Aspect of Memory

Learning is acquisition of new information, mastery of a new skill, or developing a new habit that involves remembering (Baddeley, 1990). Learning must be preceded by attention and requires a certain amount of practice and repetition (Baddeley, 1990; Luria, 1963; Sohlberg & Mateer, 1987; Squire, 1987). The primary function of learning is the development of behaviors that are adapted to an ever-changing environment (Carlson, 1991).

Memory and Synaptic Plasticity

Nerve plasticity is of great significance to the process of neuronal recovery and adaptation following brain injury (Kandel & Spencer, 1968). The concept of synaptic plasticity as a factor in accounting for memory make explicit the hypothesis that the synapse is the critical site of plastic change in the nerve structure (Kandel, 1977). The basic idea is that memory involves a persistent change in the relationship between neurons, either through structural modification or biochemical events within neurons, causing a change in the way in which neighboring neurons communicate (Squire, 1987). The ability for nerves to change, often in a lasting way, affords the organism the ability to learn and remember. This adaptive capacity is evidenced in such diverse phenomenon as drug tolerance, enzyme induction, sprouting of axon terminals after a brain lesion, and in such synaptic events as facilitation and depression (Squire, 1987).

Long-Term Potentiation

The formation of long-term memory depends on changes in synaptic connectivity (Carlson, 1991; Squire 1987). Studies of long-term potentiation (LTP) provide evidence for the ongoing structural modification in the nervous system (Carlson, 1991; Kandel, Schwartz, & Jessel, 1991; Squire, 1987). LTP is defined as a sustained increase in synaptic efficiency brought about by tetanizing afferent fibers at high frequency (Morris & Baker in Squire & Butters 1984). It is a long-lasting increase in the strength of a synaptic response following electrical stimulation of a neural pathway, which can be produced by brief, high frequency stimulation of the perforant path or similar stimulation of the Schaffer

collaterals that project from the CA3 region to the CA1 region of the hippocampus (Carlson, 1991). Tests have shown that LTP in CA1 of the hippocampus result in two types of structural change in dendrites.

First there is an increase in the number of synapses situated between axon terminals and the shafts of dendrites. Because most axon terminals from the stimulated pathway end on dendritic spines, and not on the main dendritic branches themselves, this change is very small in terms of the total number of synapses in the area. The second type of change is that the spines become rounder. Both synapse formation and dendritic spine modification can occur within a few minutes of stimulation. The change in spine shape appears temporary, disappearing within 8 hours, but the increase in synaptic number persists. LTP can also be elicited in the neocortex and possibly at other sites (Squire, 1987), and can persist for days and even months.

Although the role of the LTP is not yet clear, it has been suggested that following intense synaptic activity, calcium concentrations increase in dendritic spines, activating a membrane-associated proteinase, calpain (Lynch & Baudry, 1982). Calpain functions by degrading fodrin (a structural protein in the membrane), which in turn causes dendritic shape changes revealing previously hidden receptors, to which neurotransmitters can bind.

The possible role of these events in synapse formation, as opposed to the more transient dendritic shape changes, has not yet been identified. However, increased synaptic activity is considered to recruit a novel sequence of intracellular events, which operate only when long-lasting synaptic modifications are made. This biochemical process appears to occur only in the phylogenetically recent brain regions, and not in the brain stem or the

cerebellum. Since the cerebellum has been suggested as one area where neural changes related to learning may occur (Thompson, Berger, & Madden, 1983), it is possible that more than one cellular mechanism exists for learning and memory.

Encoding, Storage, and Retrieval

A more neuropsychological approach views memory as a multidimensional information processing system, conceptualized according to levels of processing rather than a storehouse for information (Baddeley, 1992). These levels involve the mental processes of attention, encoding, storage, and retrieval (Sohlberg & Mateer, 1989). The concept of **encoding** refers to the level of analysis performed by an individual on material to be remembered, which affects the likelihood of it being recalled or recognized later (Craik & Lockhart 1972; Tulving 1983). **Storage** refers to the transfer of a transient memory to a form or location in the brain for permanent storage or access. This may be facilitated by consolidation, a theoretical construct that provides for integration of new memories within the individual's existing cognitive/linguistic schema or framework (Sohlberg & Mateer, 1989). Efficiency of storage is manifested in the information being accessible in the right form and at the right time (Baddeley, 1990 p.7). **Retrieval** implies search for or activation of memory traces and consistent monitoring of the accuracy and appropriateness of memories pulled from storage (Sohlberg & Mateer, 1989). Following TBI survivors may manifest with abnormalities affecting these areas of performance.

Levels of Memory Processing

Within the systems of memory, information processing is divided into several diverse levels or stages. For the purposes of this discussion only three levels will be considered, viz., immediate, short-term, and long-term. "Immediate" memory has a time course measured in seconds, "short-term" memory has a time course measured in minutes, and "long-term" memory has a time course measured in days or years (Squire, 1987). The terms refer not so much to underlying mechanisms of memory as to the areas of memory to be explored in a thorough mental status examination. They are simply descriptions of performance levels of processing (Squire, 1987), and not the names of the processes employed by the nervous system to accomplish learning and memory (Baddeley, 1990). The concept of "immediate memory", sometimes regarded as a component of short term memory (Squire, 1987), has clinical significance in determining whether perception is registering and can be immediately retrieved by having the individual recall material said in the immediate past.

In neuropsychology these terms are regarded as systems level concepts. In this tradition short term memory refers to memory that is retained temporarily in a special status while it becomes incorporated, or transfers, into a more stable, potentially permanent long-term store. In this context, short term memory embodies such concepts as rehearsal, attention, and distraction, and is a spared component of neural system damage in amnesia (Squire, 1987). In neurobiological terms, the short-term/long-term classification of memory is temporal, and refers to the sequence of events at the synaptic level. As a result of LTP and in certain circumstances, perceptual material is consolidated

into a state of permanency yielding long-term memory.

Within the domain of short-term retention, some investigators (Atkinson & Shiffrin, 1968; Carlson 1991 p.481; Craik & Rabinowitz ,1984; Squire, 1987) identify "primary-memory" and "working-memory" tasks. Squire (1987) refers to primary memory as the information that forms the focus of current attention and that occupies the stream of thought. Craik and Rabinowitz (1984) refer to primary-memory as situations in which small amounts of material are held briefly in memory and are then retrieved in a relatively untransformed fashion. Examples of primary memory tasks include digit span, the recency effect, and the Brown-Peterson paradigm. In contrast to primary memory, working memory refers to situations in which the subject must hold, manipulate, and transform the material before responding (Craik & Rabinowitz ,1984), implying simultaneous storage and processing of information. Similar to Craik and Rabinowitz (1984), Baddeley (1992) describes working memory as the brain "system" that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning. In this study, the term "immediate memory" will be used to refer to this group.

Prospective Memory

Memory can also be classified temporally as retrospective or prospective. Prospective memory can be defined as the cognitive attribute that requires a person to perform a particular action at a specific time in the future based on a self-initiated and internally generated plan of action (Sohlberg, Mateer, & Stuss, 1993). Prospective

memory is memory for activities to be performed in the future (Einstein & Mc Daniel, 1990). It is the ability to remember to do things at the appropriate time (Winograd, 1988). It is perceived as a means to a goal (Meacham, 1982), and an active process of laying down a memory trace and then initiating scanning for that memory or intention at a future time (Furst, 1986). Harris (1984) describes this type of memory as "the ability to remember to remember". Unlike retrospective memory, in which information is requested from an external source, prospective memory requires an internally generated, cognitive behavioral response. Being dependent on the ability of the person to remember, prospective memory demands the greatest degree of self-initiation (Craik, 1986).

Winograd (1988) provides that: (1) retrospective memory is concerned with what is remembered or the contents of memory, whereas prospective remembering relates more basically to whether a person remembers a task; (2) retrospective memory contains information usually presented and retained in a verbal form, whereas prospective memory is usually demonstrated by the execution of an action, and (3) the act of retrospective memory is usually initiated by an external cue whereas prospective memory requires that individuals 'cue themselves'.

Relationship Between Attention and Memory

Based on the theoretical consideration already discussed, a case can be made for the existence of a relationship between attention and memory. On more practical aspects, the simplest point in support of this view is the observation that unattended information is poorly remembered (Sohlberg & Mateer, 1989). This is supported by discussions on the

executive control system. Episodic memory for unattended events in such situations is notoriously poor (Sohlberg & Mateer, 1989; Tulving, 1987).

There is also evidence that the amount of attentional capacity that is allocated to stimuli determines how well the subject will be able to recognize those stimuli. Although it is possible that previously existing memory representations may be activated and thus be made more accessible even when attention is directed elsewhere, the acquisition of new information is strongly dependent on attentional processing (Eich, 1984; Sohlberg & Mateer, 1989; Squire, 1987). Thus, assessment of memory for unattended stimuli utilizing explicit tests of memory shows virtually no learning on the part of subjects or retention of a repeated stimulus sequence within a reaction-time task when the task is performed under divided attention conditions (Nissen, 1986). This relationship is further suggested by signs of shared neuroanatomical correlates and pathological manifestations of cognitive behavior associated with the two mental processes.

Remediation of Attention and Memory Deficits

Cognitive rehabilitation is "the therapeutic process of increasing or improving an individual's capacity to process and use incoming information so as to allow increased functioning in everyday life. This includes both methods to restore cognitive function and compensatory techniques" (Sohlberg & Mateer, 1989, p.3). The question of whether impairments of attention and memory acquired after TBI can be remedied is critical to this study. According to the synaptic plasticity theory (Carlson, 1991 chap 14 &15; Squire, 1987; Kandel, Schwartz, & Jessel, 1991), cognitive recovery is possible. It is also known

that although spontaneous recovery occurs largely within the first six months following the injury, some recovery can still be achieved several years post-injury, albeit at a reduced rate (Guentz, 1987).

Two broad theories underlie the conduct of cognitive rehabilitation programs (Sohlberg & Mateer, 1989). The first proposes that rehabilitation is primarily useful in promoting spontaneous recovery. Clinicians with this view prefer to work with patients during the more acute phases of their recovery, when the operation of spontaneous recovery mechanisms is most intense. The second group of clinicians advocate that cognitive rehabilitation efforts stand alone in their efficacy and should be attempted regardless of the time post-injury. The latter view generally states that regardless of the natural healing processes, cognitive rehabilitation will facilitate a functional reorganization of brain ability. Studies by Gronwall (1977), Guentz (1987), and Sohlberg and Mateer (1987) have shown that both views have merit. It has been reported that rehabilitative techniques such as retraining and compensation have been beneficial in this respect (Raskin & Gordon, 1992; Sohlberg & Mateer, 1987).

Luria (1981) provided what may be regarded as the most basic theoretical principle in support of attention training. This investigator hypothesized that since the brain is in a state of disinhibition following insult, repeated taxing of the same neurological system would facilitate and guide the reorganization of function in that system, improving the rate and level of recovery. This view gave birth to the concept of cognitive retraining by targeting the system of concern. Some notable models of cognitive retraining include a comprehensive outpatient day treatment program that includes intensive cognitive

remediation and guided occupational trials (Ben-Yishay, Rattock, Lakin, et al., 1985); a neuropsychological approach that emphasizes rehabilitation, psychotherapy, and occupational trials (Prigatano, Fordyce, Zeiner, et al. 1984); management of psychological problems using a combination of token economies, reinforcement, and time-out procedures to control maladaptive behaviors that have resulted in institutional placement (Eames & Wood 1985). The model proposed by Lewis, Burke, and Carrillo (1987) systematically integrates applied behavior analysis, social skill training, and vocational training into neuropsychological rehabilitation.

In contrast, Sohlberg and Mateer (1987) developed a process-specific model which emphasizes restorative treatment based on the assumption that cognitive disabilities can be remediated individually through retraining. The model advocates methods that assist the individual in compensating for residual deficits. It recognizes that restoration of cognitive capacity to a functional level is not always possible. The essential strategy in this approach is the repeated administration of hierarchically organized treatment tasks that target distinct, theoretically motivated components of a cognitive process. It also accommodates non-hospital based programs.

The APT technique by Sohlberg and Mateer (1987) is based on a five-component model of attention, mentioned earlier. The design consists of a set of specific exercises/tasks targeting attention deficits. The aim is to challenge the patient's attentional resources. At higher levels of attention training, there are greater and greater demands on mental control and information processing. This technique is discussed fully under the methods chapter.

Efficacy of Attention Training Techniques

One of the greatest setbacks in the area of attention training is the lack of conclusiveness of research reports regarding outcome intervention programs (Batchelor et al., 1988; Ponsford & Kinsella, 1988). An analysis of 10 studies investigating the efficacy of attention training programs (Niemann, Ruff, & Baser, 1990) indicated 7 studies showed improvement of cognitive behavior, while findings in 3 studies were negative. From this analysis the following were cited as shortcomings with respect to procedures: (1) heterogeneous patient samples in terms of etiology of brain dysfunction; (2) nonrandom assignment of subjects to treatment conditions; (3) controlled outcome evaluation on training tasks only; (4) inadequate statistical procedures or no control for multiple statistical comparisons; (5) limited range of tasks; (6) limited or no involvement of therapists; and (7) neglect of measures of attentive behavior during daily activities (Niemann, Ruff, & Baser, 1990).

Computer-assisted designs. Niemann et al. (1990) conducted a study to assess the efficacy of computer-assisted attention retraining program, and to overcome some of the shortcomings of the previous studies, on a sample of 29 patients with moderate to severe traumatic brain injuries, who were at least 12 months post-trauma. These subjects were assigned at random to the experimental or control group. To control for nonspecific treatment effects, the control group received memory training of equivalent duration and intensity. The experimental group improved significantly in comparison with the control group in measures of attention. However, an attempt to ease generalization by verbally

instructing the patient about the relationship of their training behavior to real-life situations did not appear to be sufficient.

Batchelor, et al. (1988) conducted an experimental study on 34 closed-head-injury subjects (17 experiment, 17 control), designed to compare the effect of computer-assisted cognitive retraining with other comparable non-computerized cognitive treatment techniques, in remediating the cognitive sequelae of severe head injury. Findings from this study failed to support the hypothesis that computer-assisted cognitive therapy is any more effective in remediating disorders of memory, attention, information processing, and higher cognitive function in severely head injured patients than are non-computerized techniques. However, the fact that both groups of patients appeared to improve over the six-week therapy period suggested that there was some credit to the effectiveness of cognitive training techniques.

In contrast, Ponsford and Kinsella (1988) undertook a multiple baseline study to evaluate a computer-mediated program for the remediation of deficits in speed of information processing in 10 severely head-injured subjects. The study compared the effectiveness of computer training alone with that combined with therapist feedback and reinforcement in separate training phases, each lasting 3 weeks. The final phase involved a return to baseline conditions. Although the results indicated that subjects improved significantly over the course of the program, they showed that once spontaneous recovery and practice effects were controlled the patients showed little response to intervention. Since, at the time of the study, the subjects were less than 12 months post-injury, the effect of spontaneous recovery as a confounding factor, could not be ruled out.

An experimental study by Wood and Fussey (1987) evaluated the efficacy of a computer-based procedure, taking into account the need to base treatment on an information processing model. Three groups of 10 subjects each were involved; one severely brain-injured group using the computer, one brain-injured group not using the computer, and a non-brain-injured group. This study did not find evidence for improvement in cognitive tasks as a result of attentional training using computerized techniques. Although improvements in behavioral aspects of attention were noted, this change was not directly associated with cognitive change as measured by independent outcome tasks.

Criticisms against computer-assisted designs. Computer-assisted programs have been criticized for their lack of relationship designs. Investigators have attributed this problem to a lack of relationship to an established theory of cognitive function (Sohlberg & Mateer, 1987; Wood & Fussey, 1987) making it difficult to predict outcome on the basis of the training tasks and the behaviors associated with the cognitive process involved. A further criticism is that the few treatment programs which do exist tend to be task oriented, addressing restricted components of attentional requirements (Sohlberg & Mateer, 1987).

Weaknesses pointed out concerning the materials themselves include lack of rationale for the use of given pieces of software (Kreutzer, & Boake, 1987). Also, much of the software that is available for use in cognitive remediation was developed for use in either early childhood education or special education, and not designed specifically for

individuals with TBI (Kreutzer & Boake, 1987). As such the programs are often not sufficiently flexible for use with TBI individuals. In many instances such basic features as the speed of presentation of stimuli and the gradations of learning make the software difficult to use in these individuals (Gordon, 1990). Further, because the software often lacks the sophistication needed to engage adults in computer games, patients may be offended by being presented with activities that appear to them to be "child's play". Above all, computer games usually bear little relationship to real-world behavior. Such training is seen to focus on a splinter skill, making generalization difficult. For these reasons, Gordon (1990) cautions against injudicious use of computer-assisted training.

Non-computer-assisted designs. Although fewer in numbers non-computer-assisted studies of both group and single case designs have shown better prospects.

Three case studies by Raskin and Gordon (1992) compared the effectiveness of retraining techniques, compensation strategies, and a combination of both on generalization in cognitive remediation. The first subject, a 30-year-old man complaining of slowness of thoughts and difficulty reading, five years post-injury, was placed on compensation training. The second, a 52-year-old woman, six months post-injury, treated for memory loss, slowness of her thoughts, and inability to do two things at once, was placed on a retraining technique. The third subject, a 36-year-old man, was placed on a combination of compensation and retraining techniques, two years after the injury. He was found to have severe aphasia and very little spontaneous speech, and could not follow commands consisting of more than one step. He also exhibited severe visual attention

impairments, with severe deficits in both visual and verbal memory. Findings showed all patients benefitted significantly from the respective intervention techniques. There was no improvement in neuropsychological functioning outside of the domain remediated. It was also shown that cognitive remediation can be successful even when patients are many years past the onset of their brain injury. Further, results confirmed that generalization is achieved only when it is built into the training program.

Sohlberg and Mateer (1987) conducted a single-case, multiple baseline study to examine the relationship between the implementation of an attention-training model and changes in attentional skills as measured by the Paced Auditory Serial Addition Task (PASAT). Four brain injured subjects, who were all participants at the Center for Cognitive Rehabilitation, a post acute, day treatment brain-injury program, took part in this study. They varied widely in both nature of injury and time post onset. At the time of the program entry, each subject underwent a 2-week comprehensive cognitive and psychosocial evaluation including assessment of attention, visual processing, memory, and reasoning. Results from the testing were used to determine which cognitive processes should be addressed and at what level of difficulty. Subjects then underwent intensive cognitive remediation including 5 to 10 weeks of specific attention training. A multiple baseline was used in which simultaneous changes in a second cognitive area (i.e., visual processing) were observed. To establish a functional relationship, changes in attention were noted and improvement plotted over time.

Findings on completion of the study showed an increase in attention abilities as measured by the PASAT. In subjects who presented with mild to moderate attention

deficits (02 and 03), indicated by PASAT scores within 2 standard deviations (SD) of the mean, attention skills increased to within normal limits. The subjects with severe attention impairments (01 and 04), whose PASAT scores were greater than 3 SD below the mean, achieved scores within the mildly impaired range. In all cases, improvements in attention remained above baseline levels for periods as long as 8 months following cessation of attention training. All participants were able to demonstrate improvement in their independent living status. It was concluded that appropriate attention training appeared instrumental not only in improving scores on untrained attention tests but in improving capacity at the initial stages of information processing for memory, with resultant increases in memory function. Like the Raskin and Gordon (1992) study, it confirms the need for cognitive treatment to be skill-specific and domain-specific.

Although credited for its multifaceted approach to remediation of attention, this study has been criticized for failure to control for the effects of other forms of therapy (Ponsford & Kinsella, 1988). Another criticism is that it failed to assess objectively the impact of training on the patient's everyday attentional behavior (Batchelor et al. 1988, Ponsford & Kinsella 1987). The above account indicates some steady progress has been made among cognitive rehabilitation researchers to address concerns such as those raised by Niemann et al. (1990) questioning the efficacy of attention training. Despite this effort, several aspects in this area have not received adequate attention. In reviewing studies on the efficacy of attention training, it appears none of these studies were conducted on a homogenous mild TBI sample. It is also not known whether targeting a modality of attention has any specific effect on the attention performance served by that modality. In

addition, the finding that attention training reduces memory attention-based memory dysfunction, (Sohlberg & Mateer, 1987) has not been further investigated.

Summary

Attention is characterized as a limited, selective effort-demanding, and allocable reserve of mental capacity necessary for processing information. Allocation of attention is automatic during execution of routinized behavior. Alternatively, there is controlled attention which is called upon during the execution of novel and complex tasks. Three theories of information processing and attention control have been described. The bottleneck theory proposes that information processing is controlled by structural constraints that hold back some information while allowing other information to go through. The capacity theory of information processing proposes control based on the available attention capacity, and the executive control system is said to be responsible for controlling information processing for higher cognitive functions. These mechanisms of control are found to be inadequate in survivors of TBI. Based on these theories, various rehabilitation techniques have been developed to facilitate relearning of lost cognitive skills. The clinical model of attention (Sohlberg & Mateer, 1987) has given rise to the process-specific APT technique.

The APT technique employs the principle of repeated practice recommended by Luria (1981). Learning through repeated practice draws from observations linking memory and learning to attention. For one to remember, one has to pay attention. For learning to take place, one has to remember. Based on this view, the APT technique

targets recovery of attention skills to facilitate relearning of cognitive functions following brain damage.

A few studies have investigated the efficacy of attention training techniques. Criticisms directed at these studies require that further research be conducted to investigate the efficacy of attention training techniques. The next chapter is a presentation of the research methodology used in the current study to investigate the efficacy of the APT.

CHAPTER THREE

METHODS

In this chapter the purpose and aim of the study and the methods of investigation are presented. The chapter discusses the hypotheses and the design of the study including procedures for attention training. This is followed by a description of the investigative tools that were used in the study.

Purpose of the Study

The purpose of this study was to investigate the effectiveness of ATP in remediating attention deficits and attention-based memory dysfunction following mild TBI.

Specific Aims

The study addressed several questions:

Question 1: Does auditory attention training selectively reduce auditory attention deficits? This question was addressed by examining the rate of auditory information processing and the number of correct responses made following auditory attention training. It was hypothesized that following auditory APT, the rate of auditory information processing would increase and the number of correct auditory responses made would increase.

Question 2: Does visual attention training selectively reduce visual attention deficits? This question was addressed by examining the rate of visual information

processing and the number of correct visual responses made following visual attention training. It was hypothesized that following visual APT, the rate of visual information processing would increase, and the number of correct visual responses made would increase.

Question 3: Does attention training increase the ability for recall and recognition of verbal material? This question was addressed by examining accuracy in recall and recognition of verbal material. It was hypothesized that following APT accuracy in recall and recognition of verbal material would increase.

Question 4: Does attention training increase visual memory? This question was addressed by examining the number of errors made in reproducing visually presented complex figures. It was hypothesized that following APT the number of errors made in reproducing visually presented complex figures would decrease.

Question 5: Does attention training increase prospective memory? This question was addressed by examining accuracy in executing assigned prospective tasks. It was hypothesized that following APT the ability to execute assigned prospective tasks at the correct time would increase.

Question 6: Does attention training increase the level of organization of information in memory? This question was addressed by examining the ability of the subject to organize verbal and visual material into categories/units. It was hypothesized that following APT the ability to organize verbal and visual material into categories or units would increase.

Question 7: Do attention behaviors acquired following APT transfer to settings outside of training situations? This question was addressed by examining the frequency of perceived difficulty for different types of breakdowns in attention, and the severity of attention problems experienced. It was hypothesized that following APT the perceived frequency of difficulty for breakdowns in attention, and the severity of attentional problems experienced, would decrease.

Design

This study is a single-case design of the ABAB type with multiple-baselines across subjects. A non-random sample of four survivors of mild TBI (3 females, 1 male), aged 27-39 years, participated in the study. Subjects were recruited through the Washington State Head Injury Foundation newsletter Focus, local head injury care clinics, and support group meetings. All four participants reported existing attention deficits following an automobile accident in the past. On admission to the study, post-injury duration ranged from 2.25 years to 7.75 years. All subjects met the criteria for admission. Three subjects (2 females, 1 male) completed the study. One female dropped out at the end of the second phase.

The study occurred in two stages: (1) the pre-treatment stage, during which baseline measures for attention and memory performances were established; (2) the intervention phase, during which APT measures for attention training were implemented and neuropsychologic tests were administered to assess the effects of treatment. Evaluation of attention performance was done following each intervention phase. Post-

assessment of intervention effects on memory was done once only, at the end of training.

Baseline Measurement

To establish baseline measurements, auditory and visual attention performance scores for the four subjects were plotted over three, four, five, and six pretreatment assessment sessions. The number of assessment sessions for each subject was randomly assigned. To obtain baseline data on memory performance, verbal memory, visual memory, and prospective memory tests were administered at the onset of the study, prior to assessing attention. Prospective memory was assessed on the first day of collecting data. Then, verbal and visual memory were tested on the next day, followed by attention performance testing over the assigned baseline period for each subject. Baseline assessment was initiated on the same day for subjects 02 and 03. Subjects 01 and 04 followed one day and thirteen days respectively, thereafter. As a general rule, baseline data was collected daily except when subject's needs did not permit.

As shown in Table 1, the following tests (described later in this chapter) were used to determine baseline performances in auditory and visual attention: the Paced Auditory Serial-Addition Task (PASAT) (Gronwall, 1977) and the Revised Attention Process Test (RAPT) (Raskin, Rearick, Sohlberg, & Mateer, in press). Verbal recall and verbal recognition were tested using the California Verbal Learning Test (CVLT) (Delis, Kramer, Kaplan, & Ober, 1987). The Rey Complex Figure Test (Rey CFT) (Rey, 1941; Osterrieth, 1944; Corwin & Bylsma, 1993) was used for testing visual memory and perceptual organization. To assess the ability to execute assigned prospective tasks at the correct

time, the Prospective Memory Screening test (PROMS) (Sohlberg, Mateer, & Geyer, 1985) was used. To obtain information on the perceived degree of difficulty for different types of breakdowns in attention and the severity of attention problems experienced, each subject completed the APT-11 Questionnaire (Sohlberg, Johnson, Paule, Raskin, & Mateer, 1993). In the case of subjects 01, 02, and 04, the participant's significant other also completed this questionnaire, based on his/her observations of the subject.

Table 1. Baseline Assessment Protocol.

Attention Ability Assessed	Test Used	Participant/s
Auditory attention	Paced Auditory Serial-Addition Test; Revised Attention Process Test	Subject
Visual attention	Revised Attention Process Test (visual component)	"
Verbal recall, recognition, and organization	California Verbal Learning Test	"
Prospective memory	Prospective Memory Screening	"
Visual recall and organization	Rey Complex Figure Test	"
Perceived attention breakdowns and problems severity	APT-II Questionnaire	Subject and significant other

Intervention Procedures

Training was done based on the clinical model of attention, proposed by Sohlberg and Mateer (1987). Tasks were designed to target: sustained attention, selective attention, alternating attention, and divided attention. Intervention consisting of APT auditory and visual attention procedures followed immediately on completion of baseline assessment. This intervention took place over a period of twelve weeks, divided into four phases (ABAB) (see Table 2). Three training sessions per week, one session per subject per day, were undertaken over a total of twelve weeks. Each session lasted between 40 and 60 minutes. Training was done on alternate days, except when needed to make up for a missed session. In the latter case, only two sessions in succession were allowed. Based on random assignment, Phase A of the intervention consisted of auditory attention training for two of the subjects, and visual attention training for two others. For Phase B, the training mode consisted of the one that the individual did not get in Phase A. At the end of Phase B, training was switched back to the initial mode, thus providing the second Phase A. The fourth and last phase consisted of the same training as was used in the initial Phase B, thus completing the ABAB design. No training was done on memory.

Table 2. Intervention Mode Assignment.

Subject No.	Gender	Phase A	Phase B	Phase A	Phase B
1	Female	Visual	Auditory	Visual	Auditory
2	Female	Auditory	Visual	Auditory	Visual
3	Female	Auditory	Visual	Auditory	Visual
4	Male	Visual	Auditory	Visual	Auditory

Auditory attention training tasks. Description. Material for APT auditory attention training consists mainly of audiotaped stimuli requiring non-visual responses. The subject is required to listen to commercial, pre-taped auditory stimuli and press the buzzer to identify targets. There are 30 possible correct responses (targets) in each tape. To be correct, the buzzer needs to be pressed after a target is given, but before the next stimuli item is uttered. The tapes represent a wide variety of content and difficulty. Each task is available in a slow and a fast version. The slower version is followed by the faster version on the same side of the tape. This allows the instructor to target the speed of information processing. Instructions for the use of both taped and non-taped stimuli are given in the APT-II Manual (Sohlberg, Johnson et al., 1993).

Auditory sustained attention tasks. Tasks for sustained attention present a 3-series tape package - A, B, and C. Series A tapes contain stimuli that require visualizing of objects or space. Series B tapes contain semantically based stimuli, and Series C tapes

contain spelling-based stimuli (Sohlberg, Johnson et al., 1993). All tapes require the subject to hold on to information in his/her head, thus providing practice in sustained attention for mental control exercises. In addition, there is a paragraph listening series, in which the subject listens to stories or paragraphs followed by choices for the last sentence in the paragraph. The task for the subject is to select the most appropriate sentence or phrase to end the paragraph that was just heard. The tapes require holding on to auditory information, thus providing practice with sustained attention.

Other sustained attention exercises include four-, five-, or six-word sentence stimuli, number mental control stimuli, and mental math stimuli. These tasks address the mental control aspect of sustained attention. The goal is to have the subject practice holding on to and manipulating information in his/her head. Tasks are printed in the first columns of the stimuli sheets, with correct answers listed in separate columns of the sheet.

For the sentence stimuli exercise, the instructor reads a sentence from the chosen level to the subject. The subject is required to give back words in the sentence, in alphabetical order, reverse order, or arrange the words in the sentence in progressive order according to the number of letters they contain. The Number Mental Control Stimuli feature three levels of tasks: 4 numbers 1-30; 4 numbers 1-100; and 5 numbers 1-100. The instructor reads a string of numbers from the chosen level to the subject. The subject is instructed to give the numbers back in either ascending, descending, reverse, alternate number order, or a combination of any two orders, for example, ascending and reverse. Mental Math Activity, a sequence of numbers, is read to the subject. The subject applies target math operations (e.g., adding 1, subtracting 6) to each number read, and gives back

the new series.

Auditory selective attention tasks. Series E, F, and G, of the APT tapes contain auditory selective attention training material. Tapes contain the same stimuli as Series A, B, and C, targeting sustained attention, with the addition of background noise providing a distractor. The subject is required to screen out the background noise and identify the target, thus, providing practice with selective attention. There are slow and fast versions for each exercise. Series E contains stimuli taped with cafeteria noise in the background. Stories or text reading provide distractors for Series F tasks. The distractors on Series G are provided by a string of alphabet letters. The subject listens to auditory stimuli and presses a buzzer to identify target stimuli.

Auditory alternating attention tasks. The taped stimuli for alternating attention are featured in Series D of the APT tapes. The subject listens to auditory stimuli and alternates between pressing the buzzer for one set of stimuli and then pressing it for a different set. Tasks include: alternating between multiples of 2 and 3; alternating between fruit and clothing; alternating between 1 and 2; alternating between before and after a previous letter in the alphabet; and alternating between odd and even numbers. For each task there are slow and fast versions. To make tasks harder, more challenging tapes and tapes with faster speed are available.

Auditory divided attention tasks. Materials for auditory divided attention tasks consist of Attention Tapes Series A, B, or C, and any of the following: Semantic Categories (set A, B, or C), Math Calculation or Text Cancellation Sheets. The subject listens to the auditory stimuli and presses a buzzer to identify target stimuli. While listening and responding to the tape, the subject is also completing a worksheet activity. The task requires the subject to attend to two tasks simultaneously, thus receiving practice with divided attention ability.

Non-taped alternating attention tasks involved a Serial Numbers Activity, Number Change Exercises, and Sentence Change Exercises. The Serial Numbers Activity requires adding or subtracting numbers, and alternating two or three arithmetic rules. For example, Series I of a two-step task requires the subject to start at $1+9-4$. The subject continues till he/she reaches number 130. Series II of a three-step task requires the subject to start at $97-5+1-3$. This continues till the number 2 is reached. The Number Change Exercise requires the subject to alternate between giving back the sequence of numbers (read by the investigator) in ascending and descending or reverse order. Sentence Change exercises come in a series of four-, five-, or six-word sentences. Complexity is added by selecting higher number sentences. The exercise requires alternating between alphabetizing target sentences and giving words in reverse order. By requiring switching between two different task rules, these tasks allow practice with alternating attention or mind flexibility.

Administration of auditory attention exercises. On average, a single auditory training session consisted of four taped exercises (usually the slow and fast versions of two tasks), followed by one or two non-taped exercises. For all subjects, auditory training started at the level of Sustained attention, continuing to Selective and Alternating attention levels. None of the subjects progressed to taped Divided Attention tasks, or the Mental Math Activity exercise. Training started with "simple" tasks and continued to "complex" levels. The level of difficulty of training tasks was not predetermined instead, training for all subjects started with the first auditory sustained attention task prescribed in the APT-II manual (Sohlberg, Johnson et al., 1993). Tasks were given in the same order for all subjects. How fast each subject moved from one level the next depended on their performance on earlier tasks. The number of errors (i.e., omissions) and false positive responses (FPs) (i.e., commission errors) was interpreted as indicating difficulty experienced with each task. The criterion for good performance was defined as two or less errors in a task. For this purpose both omissions and commissions counted as errors.

Individual training sessions were held with each subject. Before being administered, each task was explained to the subject. Taped tasks were preceded by taped instructions. At the end of the instructions, the tape was paused to make sure the subject understood them. If not, the instructions were repeated and further explanation or demonstration given. In administering taped tasks, the slow version was played first, followed by the fast version of the same task. If two or more errors occurred in a task, the subject was required to repeat the task until desirable performance was achieved. If poor

performance occurred in one version, only that version was repeated. Where subjects showed temporary inability to cope with a task, the task was suspended and resumed later. In the case of persistent poor performance, the task was completely abandoned. Additional tasks were given in cases of individuals showing a willingness to continue. Similarly, sessions were cut short if a subject showed inability to continue to the end. The non-taped tasks were time monitored.

Scoring. Scoring of daily performance on training tasks was essential for planning of further training. For scoring performance on **Sustained Attention taped** tasks, the number of errors and FPs was identified. For **Paragraph Listening**, the number of correct responses was recorded, as well as the number of times a paragraph was repeated; then, the percent correct for the 10 paragraphs was calculated and recorded. For **Sentence Stimuli** exercises, the percent correct and the cumulative number of minutes taken to complete 10 sentences was recorded. Any cuing or prompting as well as pertinent behavioral observations and error patterns were noted. For the **Number Mental Control Stimuli**, the percent correct and the cumulative number of minutes taken to complete each defined unit was recorded. Any cuing or prompting as well as pertinent behavioral observations and error patterns were noted. All scores were recorded on relevant APT-11 scoresheets.

For **Selective Attention** tasks and **Alternating Attention** tasks, the number of errors and FPs including patterns of errors, were recorded on the appropriate scoring sheets. In the case of alternating attention, scoring of switching errors (i.e., number of

errors that were due to problems switching sets) was also done. If a taped task was not completed due to the subject's inability to continue, all targets in the "not attempted" section were counted as omission errors.

Visual attention training tasks. Description. Visual attention training, like auditory attention tasks, addressed sustained, selective, alternating, and divided attention levels. Training materials consisted of APT-based paper and pencil tasks requiring cancellation of targets on a stimulus sheet. Two groups of tasks were used for this purpose.

The first group consisted of unmodified tasks obtained directly from the APT Manual (Sohlberg & Mateer, 1986), and the APT-II Manual (Sohlberg, Johnson et al., 1993). Tasks from the APT Manual included Set Depended Activities 1 and 2, contained in Stimulus Sheets 10 and 11, and the Card Sort Activity. Those from the APT-II Manual were: Semantic Categories, Alternating Alphabet, and the Read and Scan articles. Except for semantic categorization, which was used for sustained attention training, tasks in this group comprised activities for visual alternating and divided attention training. Semantic Categories tasks are actually meant for use in conjunction with taped tasks to train for divided attention, but were used alone as options for sustained attention tasks since subjects were progressing slowly.

The second group of training tasks consisted of tasks developed by modifying existing tasks. This was done to provide complexity when participants appeared to find the single-target tasks easy. Modifications consisted of alterations in the number and type of

responses required, not the physical format of stimulus sheets. Tasks modified were selected from the APT and APT-II training material which originally required cancellation of single targets. This was done based on the APT literature recommendation for user creativity to create challenges for and to meet the individual subject's needs. The Mesulam Verbal and Nonverbal Cancellation Test tasks were also modified to provide for variation of training tasks.

APT material used for this purpose consisted of APT Stimulus Sheets 1 and 2; Stimulus Sheets 3 (A, B, and C), 6, and 8 (Sohlberg & Mateer, 1986). Designated targets were numbers already identified as such by the original designers of the stimulus sheets. Changes consisted of: (1) increasing the number of targets from one to two or three in a task, (2) adding instructions to have tasks completed by working from the bottom upwards, and (3) working up and down in vertical columns instead of horizontal rows. The difficulty level increased with the complexity of the task and the amount of information to be held at a time.

Each new task was assigned an identity based on the stimulus sheet from which it was developed, with the addition of a descriptive word or letter (e.g., Stimulus Sheet 6 (Intense) for the complex task developed from the APT Stimulus Sheet 6, Sohlberg & Mateer, 1986; MNCT (B1) for the task developed by modifying the Mesulam Nonverbal Cancellation Task). The content of tasks in these two major groups is discussed in the next section. In line with the APT model of attention processing (Sohlberg & Mateer, 1987), tasks for each level of training are discussed separately. The order of presentation presupposes successively more complex levels.

Visual sustained attention tasks. All task, used for sustained attention training were modified by the investigator from existing tasks as explained above. Stimulus Sheets 1 and 2 of the APT featured solid circles, squares, triangles, stars, and arrows, variously colored red, black, and yellow; and arranged in rows. There are 50 items on Stimulus Sheet 1 and there 99 items on Stimulus Sheet 2. Items on Stimulus Sheet 1 are larger than those on Stimulus Sheet 2. Tasks on these stimulus sheets consisted of identifying shapes, color, and positions of items in relation to others, counting specified items, and adding the number to other specified items (see Appendix A). To successfully complete these tasks subjects were required to hold in mind several pieces of information thus, providing practice in several sustained attention skills simultaneously.

Stimulus Sheet 3A featured frame structures "beds" with either one or two lines, or "empty" (see Appendix A). Stimulus Sheet 3B featured arrows, dots, and diagonal lines (see Appendix A). Stimulus Sheet 3C featured pinwheels, squares, and arrows (see Appendix A). Tasks in this series required subjects to circle, check, or shade in more than one target simultaneously, count them up, and add the number to specified other targets on the stimulus sheet, thus providing practice in processing of instructions with more than one component simultaneously.

Tasks developed from Stimulus Sheets 4, 5, and 6 were number cancellation exercises. Each stimulus sheet consisted of rows of random, single digits (1-9) requiring subject to cross out two targets numbers simultaneously. The difficulty level increased from Stimulus Sheet 4 to Stimulus Sheet 6, as the size and spacing of the numbers

decreased and the volume increased. Subjects were required to work row by row, from left to right, crossing out two targets simultaneously. Complexity was further increased where one of the targets was an "every other" or "every third" number (e.g., crossing out all 6's and every 3rd 4) (see Appendix A). To reduce practice effect, targets were varied in every second or third repeat exercise.

Two additional tasks were developed, one each from Stimulus Sheets 5 and 6. The task from Stimulus Sheet 5 required crossing out each number that was 1 less or 1 more than the one above it (see Appendix A). To reduce practice effect instructions for working on the task were varied between starting at the top or the bottom of the stimulus sheet. The additional task for Stimulus Sheet 6 required cancellation of 9s and either 0s or 2s (see Appendix A). Because of the high content of 0s and 2s on this stimulus sheet, successful completion of this task required intensified sustained attention effort. To reduce practice effect target items were altered regularly. These tasks provided practice in the processing of increased amount of information by the subject at a time.

APT Stimulus Sheet 8 (Sohlberg & Mateer, 1986) provided the last number cancellation task in the modified sustained attention exercises. The stimulus sheet contains a total of 247 single- and double-digit random numbers, ranging from 1 to 99, in 17 rows. Subjects were required to work row by row, from left to right, and cross out either every other odd or every other even number (see Appendix A).

Semantic Categories (Set A, B, and C) tasks were used for training on verbal discrimination. The stimulus sheets feature groups of five words arranged in 38 to 40 rows per sheet. Each group contains a word that does not belong to the same category as the

other four. The task requires the subject to circle the word in a line that does not belong. Modification for this task consisted of its use alone as opposed to use in conjunction with the auditory tape in the divided attention task.

From the Mesulam Verbal and Nonverbal Cancellation Task (1985, 1988) two pseudo-random stimuli sheets were used to develop three sustained attention tasks, two from the nonverbal stimulus sheet, and one from the verbal stimulus sheet. In its original form, this test is designed to enhance sensitivity to inattention to the right as well as the left side of the vision field. It consists of four sheets, two nonverbal and two verbal. The nonverbal stimulus sheets feature various shapes, some open and some inked (e.g., big and little circles with and without spokes or bisecting lines, stars, triangles, etc). The target stimulus is a bisected circle. The verbal stimulus sheets feature randomized letters for which the target is A. One of each ordered format contains 374 items arranged in columns and rows. The other format contains fewer items scattered over the page in a pseudo-randomized manner. Each side of each page contains 30 target stimuli. The time limit for each sheet is two minutes.

The verbal cancellation exercise from the Verbal and Nonverbal Cancellation Task (Mesulam, 1985, 1988), identified as MVCT (A), required the subject to cross out two letters simultaneously, for example, A and S or S and I. Letters chosen were those that occurred 20 or more times on the stimulus sheet. To reduce practice effect, targets were varied after two repeats. In addition, the order of working on the task was alternated between working from top to bottom or horizontally from left to right (see Appendix B). The nonverbal cancellation tasks, identified as MNCT (B1) and MNCT (B2), respectively,

were developed from the nonverbal component of the same test (see Appendix B). The first task required the subject to cross out all "suns" with eight rays (circles or disks with eight spikes). To reduce practice effect, task instructions were alternated between working from the top or from the bottom of the stimulus sheet. The second task required the subject to cross out all triangles and stars from among other shapes on the stimulus sheet. All three tasks required the subject to hold information in his/her head and to use discrimination skills.

Visual selective attention tasks. Tasks for training on visual selective attention required cancellation activity similar to that described for sustained attention, with the addition of distractor overlays on transparent plastic sheets. Three different designs (A, B, and C), with complexity increasing from A to C, are featured on the overlays. The overlays provide "visual noise" that the subject must screen out in order to successfully complete the task. The object is to cancel out target numbers (marking on the overlay) and inhibit responding to the additional design. The content of the tasks consisted of APT Stimulus sheets 4, 5, and 6 (simple version) with targets being the same as for sustained attention training. The most dense overlay design "C" was used over Stimulus Sheet 4 which has wider spaces between numbers. Overlays A and B were used over Stimulus Sheets 5 and 6, respectively. Visual distraction was typically seen as an increase in time needed to complete a task or as an increase in the number of errors when using the overlay compared to the basic task without the overlay.

Visual alternating attention tasks. Visual alternating attention tasks required the subject to rapidly switch reading sets, thereby exercising flexible thinking. Three categories of tasks were provided. The first, designed from APT Stimulus Sheets 4, 5, and 6, required number cancellation activity similar to that described for sustained attention with the addition of a mental flexibility component. The subject was instructed to alternate between the cancellation of two sets of targets every 10 or 15 seconds, when the investigator utters "switch." Target sets were created by a pair of numbers or chain of three numbers. An alternate set was created by substituting one number of the pair with a different number, e.g., alternating between crossing out 3s and 6s, and 4s and 6s. In a three-number chain, for example, 5, 9, and 2, the subject began by crossing out the number 5 for the first 15 seconds, then 9 in the next 15 seconds, followed by 2 in the third 15 seconds. This cycle was repeated to the end of the task (see Appendix A).

To increase complexity, the same numbers were re-ordered to form an alternate set. For example, the numbers 5, 9 and 2 were re-ordered to 9, 2, and 5. The subject was then required to alternate between these two sets of numbers every time the investigator uttered "switch." This continued till the end of the sheet. To add more challenge, the switch period was shortened from 15 to 10 seconds. In order to keep track of the correct target, the subject had to hold onto more than two units of information continuously.

The second category was designed from APT Stimulus Sheet 8. This task required the subject to alternate between crossing out even and odd number at intervals of 10 seconds, marked by the investigator uttering "switch." To reduce practice effect,

instructions alternated between starting with canceling odd numbers and canceling even numbers. Options also involved doing cancellation in a horizontal, line-by-line fashion or in a two-line vertical column direction, after every three repeats (see Appendix A).

Original APT alternating attention tasks used consisted of Set Dependent Activities tasks 1 and 2, contained in APT Stimulus Sheets 10 and 11 (Sohlberg & Mateer, 1986), respectively, and a selection of APT-11 tasks (Sohlberg, Johnson et al., 1993). Set Dependent Activity 1 consists of a stimulus sheet containing the words "big" and "little" printed in incongruous sizes. For example, the word big printed in small letters and the word little printed in capital letters. The subject is required to begin by reading the actual words, but change to reading the size of the type, inhibiting reading of the words (saying "little" for words printed in small letters and "big" for words printed in capitals). The subject is instructed to alternate the reading sets every 15 seconds, marked by the investigator saying "switch."

For Set Dependent Activity II, the subject was presented with a stimulus sheet containing the words high, mid, and low, printed in incongruous line positions. For example, the word high appearing in the low position, and the word low appearing in the high position. The subject is instructed to read the actual words as they appear, and to change to calling the line position of the words, ignoring the words themselves. Change between sets is required every 15 seconds, marked by the investigator saying "switch." To reduce practice effect, the task beginning the activity is alternated between reading the words as they are and reading the type.

Alternating Alphabet is a time-monitored task provided in the APT-II manual (Sohlberg, Johnson et al., 1993). The subject is required to alternate between writing the letter in the alphabet that comes just before and the letter that comes just after the target letter on the provided list. The task requires rapidly switching between two rules and judgment-driven accuracy.

Visual divided attention tasks. The APT Card Sort (Sohlberg & Mateer, 1986) and the APT-11 Read and Scan (Sohlberg, Johnson, et al., 1993) tasks were used for visual divided attention training. Card Sort activity requires the subject to process two sets of information simultaneously. A deck of cards is presented to the subject with instructions to sort the cards by suit and turn face down any cards that contain a certain target letter in the spelling of their name. For example, if the letter "T" is the target, the expectation is for the following cards to be turned face down: 2, 3, 8, 10, and heart. The subject therefore attends to the visual shape information of the suit and the linguistic information required to select numbers or face cards that contain the target letters in their spelling. The task works on improving ability to process dual information (Sohlberg & Mateer, 1986).

For the Read and Scan task the subject is presented with an article (one of eight) to read for content, while simultaneously crossing out a target word, for example, the or a word ending in -ing. After reading the article, the subject is presented with questions evaluating his/her comprehension. These ready-made questions are provided at the back of each reading sheet. If desired, the article may be read a second time, and a second set of

questions answered. In line with the flexibility allowed to users of APT training material, new sets of questions were made up for articles 5, 6, and 8 (see Appendix A). Questions were set to elicit 10 distinct responses, each of which earned one point. Successful completion of the task requires the subject to divide attention between comprehension and the visual search component of the task, thus providing practice with divided attention skills.

Administration of visual attention tasks. Training was scheduled individually to suit each individual participant's needs and allow privacy. At the beginning of each task, detailed instructions and response expectations were given. Instructions were repeated for subsequent administration of all tasks. If needed, a pre-task trial was allowed to make sure the subject understood the pending task. The subject was made aware that he/she was going to be timed, and encouraged to work fast but also aim for accuracy.

Uniform content for individual tasks was maintained for all subjects. Training commenced with sustained attention and proceeded to the selective, alternating and divided attention levels, in that order. Within each level, simpler tasks were administered first. Moving to the next level depended on each subject's performance in the preceding session. Any task with more than two errors was repeated until improvement was obtained. For this purpose, both omissions and FPs were considered errors. If the subject showed signs of being overwhelmed by a task, the task was temporarily suspended, or completely abandoned in cases of extreme difficulty. Before a task was repeated, the subject was given an overview of his/her performance in the previous session, without

revealing actual errors.

Tasks designed from Stimulus Sheets 1-3C were administered twice only: during the first phase of visual attention training and on completion of the training program. This arrangement provided a two-point observation of performance with practice effect reduced to an absolute minimum. On resumption of visual attention training, a selection of previously poorly performed tasks, and those from the previous visual training phase whose performance had not yet been established, were repeated.

Prior to commencement of a task, the stimulus sheet was presented face-down to the subject. This was followed by the question, "Ready?" The task began when the subject indicated he/she was ready. The beginning of the task was marked by the subject flipping over the stimulus sheet and scanning the task material, at which point a stopwatch was started. If the subject was not ready to start, the stimulus sheet was left face-down and time allowed for the subject to get ready.

For the visual alternating attention tasks, the investigator uttered the word "switch" every 10 or 15 seconds according to the pre-determined length of intervals. The 10 or 15 s, interval was predetermined based on the complexity of the task. Ten seconds intervals were assigned for tasks involving a 2-number target set (e.g., 3s and 6s; odd/even numbers), and 15 seconds intervals were assigned for tasks involving a 3-number target set (e.g., 5, 9, and 2). First the 10 s, interval task was administered. If the subject experienced undue difficulty with this task, the interval period was increased to 15 s. The 3-number 15 s, interval task was administered only when the subject had mastered the 10 s, interval task. The subject was required simultaneously to mark every "switch" point

with a slash on the stimulus sheet. To keep track of the number of switches the subject had to make, the investigator made tally marks on a sheet of paper every time she said "switch". The subject's slash marks were matched with the investigator's tally marks for accuracy. Responses to Set Dependent Activity exercises were tape-recorded to ensure accurate scoring.

Scoring. For scoring, visual attention performance errors (omissions) and FPs (commission errors) were identified. This was done soon following each training session. Errors, FPs, and time taken to complete a task were recorded on a scoresheet using symbol key notations. Any pertinent behavioral observations and error patterns were noted. Performance on selective attention was scored by comparing markings made by the subject on the overlay with a template on which targets had been identified. Errors, FPs, and time taken were then recorded directly on the response sheet. For alternating attention performance, errors (omissions), "switching" errors (omissions due to the subject's changing to the wrong target), and the time taken were recorded on the response sheet. The subject's interval slashes were compared with the researcher's tally marks to check on the accuracy of switching. All raw scores were recorded on a graph using key symbols.

The Read and Scan task for divided attention was scored based on trial 1 only. The percent of targets canceled and the time taken to complete the task were recorded, using symbol notations. The rate of reading comprehension was assessed against a possible total of 10 points for each trial. The scale for comprehension scores ranged from poor (1-4), fair (5-6), good (7-8), to excellent (9-10). Comprehension ability was recorded on the

same graph as time and percent correct, using different symbol key notations. Time and error scores for the card and sort task were charted on the Card Sort Scoresheet.

Outcome Variables

To investigate the effectiveness of APT in remediating attention deficits and attention-based memory dysfunction following mild TBI, two categories of neurologic tests and assessment instruments were used. To evaluate attention outcomes, subjects were tested using the PASAT (Gronwall, 1977); the RAPT (Raskin et al., in press); the Digit Vigilance Test (DVT) (Lewis & Kupke, 1977; Lewis & Rennick, 1979); and the Multiple Visual Attention Task (Mekwa, 1995). The latter two measures were introduced in the study after baseline assessment. To evaluate memory outcomes, subjects were tested using the CVLT (Delis et al., 1987), the Rey CFT (Rey, 1941, Osterrieth, 1944, Corwin and Bylsma, 1993); Taylor CFT (Taylor, 1979); and the PROMS (Sohlberg, Mateer & Geyer, 1985). Except at baseline assessment, memory tests were administered after intervention was completed. To assess generalization of skills following attention training, two other measures, the APT-11 Questionnaire (Sohlberg, Johnson et al., 1993) and APT-11 Attention Lapse Log and Attention Success Log (Sohlberg, Johnson et al., 1993), were administered.

Question 1: Does the visual APT selectively reduce visual attention deficits?

To answer this question, the rate of visual information processing and the number of correct responses made following visual attention training, were assessed using the DVT

(Lewis & Kupke, 1977; Lewis & Rennick, 1979), and the visual component of the RAPT (Raskin et al., in press).

The Digit Vigilance Test

Purpose. The DVT is a cancellation task used to assess sustained vigilance and the rate of visual information processing. It is included in the Repeatable Cognitive-Perceptual-Motor Battery (RCPMB) (Kelland, Lewis, & Gurevitch, 1992), originally called the Lafayette Clinic Repeatable Neuropsychological Test Battery (Lewis, & Kupke, 1977; R.F. Lewis and Rennick, 1979).

Source. The RCPMB tests and manual are available from Ronald F. Lewis, Ph.D., 41730 Brandywine, Clinton Township, MI 48038.

Test description. The test consists of two pages, one printed in red, the other in blue, with a total of 59 rows of 35 digits. On alternate forms, the target number is 6 or 9, which have been found to yield equal time scores. This alternate form is useful for reduction of practice effects. The test is scored for total time and errors of omission only.

Normative data. Recent norms for four age groups (≤ 45 years, 45-59, 60-69, and ≥ 70 years) give means and standard deviations for the first page and for both pages (total time), and both first page and total omission errors (Lewis, Kelland, & Kupke, 1990). For the youngest age group ($n=97$), Total time $X = 344 + 62$; Total errors $X =$

7.3 +7.6. With a one-week delay between test and retest, the reliability coefficient was .88 for youthful control subjects (Kelland et al., 1992).

Administration. The DVT (Lewis & Kupke, 1977; Lewis & Rennick, 1979) was included in the study as a precautionary measure, when subjects appeared to find the RAPT (Raskin et al., in press) relatively easy even before attention training had begun. The test was administered at the end of each of the intervention phases (ABAB) irrespective of the attention modality targeted by the training. For all interphase assessments, the task consisted of cancellations of the number 6. Only one page of the test, instead of two, was given at each testing point, with an alternate page given each time. Prior to being presented with the task sheet, detailed instructions regarding task performance were given to the subject. The importance of balancing time and accuracy were emphasized. With the task section of the sheet covered, the example section was used to demonstrate the task to the subject. When it was clear that the task was understood, the task section was uncovered and the subject instructed to start. The stopwatch was started at this point, and stopped when the subject indicated he/she was done. Time taken to complete the task was recorded. Scoring of performance was based on time and omission errors.

The Revised Attention Process Test

Purpose. The RAPT (Raskin et al., in press) is designed to provide a screening measure for attentional skills conforming to the clinical model of attention on which the

APT-II (Sohlberg, Johnson et al., 1993) procedures are based. It is used to evaluate attentional impairment in persons with mild TBI.

Source. The test is published and marketed by the Association for Neuropsychological Research and Development (AFNRD), 11719 Meridian E Suite 321 Puyallup, WA 98372

Description. This is a revised version of the APT attention screening test (AFNRD, 1990) which is currently in the experimental stage. The test closely resembles APT-II training tasks and includes measures of auditory and visual attention. The auditory subtest requires the subject to listen to taped auditory stimuli and press a buzzer to identify targets. The visual subtest requires cancellation of target letters on the stimulus sheet. There are two levels of difficulty for each subtest, and 30 targets to identify. Tasks in each subtest are arranged into sustained, selective, alternating, and divided attention processes, thus giving a total of four tasks, administered in that order for each subtest.

Auditory attention component. Auditory sustained attention level I and II. Tasks consist of listening to a series of audiotaped single numbers (75 for level I, 116 for level II), read one right after the other, by a male voice. For the level I sustained attention task, the subject is required to press a buzzer each time he/she hears the number 4. The number occurs randomly or in succession. If the subject is unable to perform this task, the tester turns the tape over and continues with level I selective, alternating, and divided

attention tasks. Alternatively, if the subject misses less than 5 targets on level I sustained attention task, testing continues to level II sustained attention task. The level II sustained attention task requires the subject to press the buzzer each time he/she hears the number 2 followed by the number 5. The latter does not always occur following 2. Similarly, the number 2 is not always followed by the 5. If the subject misses five or more targets in the level 2 sustained attention task, testing changes to the level I selective, alternating, and divided attention tasks. Alternatively, if the subject misses less than five targets, testing continues to the rest of the level II tasks.

Auditory selective attention. Tasks consist of a series of audiotaped single numbers (75 for level I, 90 for level II). The numbers are read by a male voice, one right after the other, against a background of noise. The noise acts as a distractor. For the level I task, the subject is required to listen for the number 2 and press a buzzer when it occurs. For the level II task, the subject listens for the number 3 followed by the number 7. Again, there are a total of 30 targets in each task.

Auditory alternating attention. Tasks require the subject to respond by alternating attention between two targets. The level I task consists of 80 single numbers, audiotaped and read one right after the other. The subject starts by pressing a buzzer when the number 2 is heard. When the voice says "switch", the subject listens for the number 5, and presses a buzzer when that occurs. This is done to the end of the tape. The level II alternating attention task consists of 70 single numbers. The subject starts by listening for

the number 2 followed by the number 5, and presses a buzzer when this sequence occurs. When the voice says "switch" the subject listens for the number 5 followed by the number 2. The buzzer is pressed when this sequence occurs. This alternating activity is continued till the end of the tape. The switch word occurs four times in the level I task and five times in the level II task.

Visual attention component. The visual component of the RAPT consists of paper and pencil tasks requiring cancellation of printed targets. **Sustained attention tasks** feature single letters of the alphabet in rows. The level I visual sustained attention task consists of 8 rows, 15 letters each (total 158), requiring the subject to cross out the letter "E." The level II task consists of 27 rows, 38 letters each (total 1026). The subject is required to look for the letter C followed directly by the letter L, and put a slash through both letters. If the subject misses more than 25 targets, or takes over five minutes to complete the task, the tester turns to Visual Selective Attention Level I. If subject misses less than 25 targets and takes less than five minutes to complete task, the level II Visual Selective Attention task is administered.

Tasks for **visual selective attention** consist of a printed passage on a sheet of paper. The subject is required to inhibit reading the passage, but cross out target letters. The level I task appears in larger print, and requires cancellation of the letter E. The level II task, typed in much smaller print, requires the subject to put a slash through the letters A and E simultaneously. In both levels, the target letters are incorporated in words forming the passage.

Similar to auditory alternating attention tasks, **visual alternating attention tasks** require identifying alternating target letters when prompted to "switch". The level I task consists of a random mixture of 13 single letters of the alphabet, featuring mostly Cs and Ls, arranged in 8 rows, 7 letters each, (total 56). The subject is instructed to begin by canceling the letter C whenever it occurs on the stimulus sheet. When the word "switch" occurs on the sheet of paper, subject changes to making a slash through the letter L. This alternating activity continues to the end of the task.

Level II of the Visual Alternating Attention task features a mixture of the letters C and L, in 10 rows, 7 letters each (total 70). A pair of these letters together, form the target. The subject is instructed to begin by looking for the letter C followed by the letter L, and putting a line through both letters. When the word "switch" occurs, the subject changes to looking for the letter L followed by the letter C. This alternating activity continues to the end of the task.

The final task of the RAPT is the **Divided Attention Task**. This task requires simultaneous responses to auditory (taped) and visual (target cancellation) stimuli. For the level I auditory attention, the subject listens for the number 4 in a series of 88 single numbers, and presses the buzzer when the number occurs, while crossing out the letter A in a maze of 405 letters, arranged in 27 rows of 15 numbers each. For level II visual attention performance, the subject listens to a series of numbers (total 116), read one right after the other, and press the buzzer when he/she hears the number 6 followed by the number 8. The stimulus sheet for the visual component, performed simultaneously with the

taped task, consists of a total 999, letters of the alphabet set closely together in 27 rows of 37 letters each. The subject is instructed to look for the letter L followed directly by the letter C, and to put a line through both letters when this occurs.

Administration. In contrast to the DVT, the RAPT was used both in the pre-treatment and interphase treatment periods. Pre-treatment assessment provided baseline measures. Interphase testing was done following each intervention phase to determine progress. The complete test (i.e., both auditory and visual tasks) was given each time. Administration format followed the pattern described above, starting with auditory sustained attention task level I, proceeding through levels II of Auditory Sustained, Auditory Selective, and Auditory Alternating attention tasks. Next to be administered were level II tasks for Visual Sustained, Visual Selective, and Visual Alternating attention, in that order. The Divided Attention task was given last. Because subjects were able to cope with level II complexity, level I tasks (except for auditory sustained) were not administered. For the same reason, the Visual Sustained attention level I task was discontinued after the first baseline assessment session.

At the beginning of each task, instructions were read to the subject, and practice given according to need. The following instructions, for example, preceded the Auditory Sustained Attention Level II task: "You will again hear a series of single numbers, read one right after another. Each time you hear the number 2 followed by the number 5, press the buzzer. Here's an example, if you heard 9, 2, 5, you would press the buzzer, but if you heard 2, 9, 5, you would not press the buzzer. Let's practice 1, 3, 2, 5, 7, 2, 2, 5."

Successful identification of target was confirmed by the investigator and all questions, if any, were answered. The beginning of the task was signaled by the investigator inquiring "Ready?" Similar instructions were given for the visual task, stating the type of task and the response expected from the subject. The subject was always reminded to work as quickly as he/she could, while being careful to find all targets. Visual attention tasks were timed using a stopwatch. Duration of the divided attention task was determined by the end of the auditory tape. The visual attention component, if not completed by the end of the tape, was discontinued, and time taken recorded.

Scoring. For scoring auditory RAPT tasks, two types of errors were identified, omission errors, reflecting the number of missed targets, and commission errors, termed FPs. Scoring of audiotapes was done on a special sheet of paper, reflecting the exact numbers being read on the tape. Target numbers are identified by asterisks, which makes scoring during the run of the tape easy. Correct targets were check-marked and errors (both omissions and commissions) were circled. Omission errors were distinguished from FPs by the presence or absence of asterisks on circled numbers. Both types of errors were recorded on the graph using appropriate key symbols. For scoring alternating attention tasks, identifying "switch errors" was necessary. Switch errors were penalized once only. That means, following a switch error, a new series of targets was considered, to prevent faulting the subject more than once for one switch error. Switch errors, like FPs were recorded on a graph using a key symbol.

Scores for visual RAPT tasks reflected omission errors, FPs, and time taken to complete a task. To enable evaluation of progress, it was necessary to obtain a single score (s per correct response) from scores on the three parameters. To do this, the following formula was applied:

s per correct response = s taken to complete task/no. correct answers
 No. correct answers = (total possible correct answers - omissions, FPs, and where applicable switch errors).

For example:

Total possible correct answers = 30

If, omission errors =2, false positive response =1, and time taken to complete task=43 s, s per correct response is $43/27 = 1.5$.

Scoring the **Divided Attention Task** of the RAPT also focused on errors and time taken to complete the task. Time recorded for the visual component was used in determining the final score. The total number of errors was calculated by adding together omission errors, FPs, and targets in the uncompleted section of the visual task. The number of correct responses was then obtained by subtracting those errors from a total of 60 possible correct responses (30 auditory, 30 visual). The final score was obtained by calculating s, per correct response, using the formula described above.

Normative data. As an evaluation measure, the RAPT is still in its experimental stage. Preliminary norms were obtained with a sample of 75 non-brain-injury adults with age ranging from <20 to 80 years. (Raskin, in press). Data was handled separately for males and females, and values are given according to the following age categories: ≤20, 21-40, 41-60, >60. RAPT norm values for the sample group in this study are given in

Tables 5-12, reflecting scores in this test for the respective subjects. Based on these characteristics, the RAPT was used to (1) establish baseline measures for attention performance, and (2) to pilot test its ability as an assessment measure for outcomes of attention training.

The Multiple Task Visual Attention Test

Purpose. This test was developed by the investigator following baseline observations that appeared to suggest the possibility of the selected attention tests becoming obsolete during the course of the study. This, plus the experimental status of the RAPT, made it necessary for an additional measure of visual attention to be introduced. The aims in developing this task were: (1) to obviate the risk of having outcomes based solely on obsolete evaluation; (2) to pilot test a visual attention task which, like the RAPT, presupposed the existence of the attention levels suggested in the clinical model of attention (Sohlberg & Mateer, 1987).

Source. Stimulus Sheet 8, from which the test was developed, is included in the APT Visual Attention package, used for alternate visual attention training. The package is produced and marketed by the AFNRD, 11719 Meridian E, Suite 321 Puyallup, WA 98373

Description. This is a pencil and paper task involving a random mixture of single- and double-digit numbers on a lined sheet of paper. The numbers range from 1-99, and are

arranged in 13 rows, each with 19 numbers (total of 247) (see Appendix D). The task requires the subject to start from the top row, working from left to right, crossing out every other odd number, and every number divisible by four. Target identification is continuous from one row to the next. To complete this task successfully, the subject has to use multiple skills simultaneously, (i) distinguishing between odd and even numbers; (ii) deciding on the alternate/non-alternate status of the occurring odd numbers; and (iii) using math skills to identify numbers divisible by 4. Because of the randomness of the numbers, targets occur in succession or randomly. In executing the task, the subject is required to engage in varying degrees of focused, sustained, selective, alternating, and divided attention skills.

Administration. Before being presented with the stimulus sheets, detailed instructions regarding the type of task and expected responses were given to the subject. The need to maintain continuity of targets from one line to the next was emphasized. Each subject was made aware that he/she would be timed, and encouraged to work as fast as he/she could. A practice session using a sheet of paper with handwritten numbers preceded the test. When it was evident that the subject understood the task, the stimulus sheet was handed face down to the subject. To signal the start of the task, the investigator announced, "Ready? Begin." If it appeared that the subject was not ready, the stimulus sheet was kept face down until he/she was ready. Starting the stopwatch was done simultaneously with the word, "Begin." The subject was allowed to work the task to completion.

Scoring. Errors (omissions and FPs) were identified by a circle. An omission error occurred when a target was missed. An FP occurred when the subject crossed two odd numbers in succession, even if the numbers were not adjacent to one another. An FP also occurred when the subject crossed out a number not divisible by 4. To identify a missed odd number or an FP odd number, a stick mark was made above the error circle on the right, to indicate the start of a new cycle. Scoring was then adjusted according to the new cycle, which would be in effect until another missed number or false positive odd number occurred. This type of scoring gave a true reflection of the subject's actual errors, and avoided a situation where a single attention lapse would be penalized more than once. This was also an effective way of checking on whether target marking was being routinized, as would be the case when the same target is missed over and over again.

To obtain the final score for each trial, s per correct response was calculated as follows: $\text{Number of s taken to complete task} / \text{number of correct responses}$. If FPs occurred, they were added to omission errors and the resulting number subtracted from total number of possible targets, thus acting as a deterrent for carelessness on the part of the subject.

Normative Data. This tool was being pilot tested thus no normative data is available to support its efficiency. Observations on the pilot data show that practice effects were reduced to a minimum. Subject performance on the pilot trials was consistent with the expectation that handling more than one piece of information simultaneously is hard

for persons with attention deficits. More trials are necessary in order to sufficiently address the parametric characteristics of this tool.

Question 2: Does auditory APT selectively reduce auditory attention deficits? To answer this question, the rate of auditory information processing and the number of correct responses following auditory attention training were assessed using the PASAT (Gronwall, 1977) and the auditory component of the RAPT (Raskin et al., in press).

The Paced Auditory Serial-Addition Task

Purpose. The PASAT is a taped serial-addition task used to assess the rate of information processing and sustained attention (Spreeen & Strauss, 1991). It reportedly provides an estimate of the subject's ability to register sensory input, rapidly process the information, and respond verbally, as well as to retain and use a complex set of instructions (Sohlberg & Mateer, 1987). It has been found useful in estimating the severity of attentional deficits following head injury (Ponsford & Kinsella, 1988).

Source. The tape for the PASAT can be ordered from the Neuropsychology Laboratory, University of Victoria, P.O. Box 1700, Victoria, British Columbia V8W 3P5, Canada

Description. This neuropsychological test consists of a tape-recorder and a commercial tape, pre-recorded by a male speaker. There is one practice list of 10 single digits recorded at 2.4 s intervals, followed by four trials of 61 digits each. The numbers 1 to 9 are used in the same random order in each trial. The trials are recorded at a rate of one digit every 2.4, 2.0, 1.6, and 1.2 s. Duration of each digit is approximately 0.4 s. At least 30 s intervals are allowed between trials.

The test requires that the testee add 60 pairs of digits so that each is added to the digit immediately preceding it, calling the answer each time. For example, if the tape reads the numbers 5-3-7-4-2, the subject's correct responses, beginning as soon as the examiner says 3, are 8-10-11-6. Administration begins with a brief demonstration with written numbers until the subject understands what she/he has to do, then an unpaced trial of 10 digits spoken by the tester. This is followed by a 10-digit taped practice series presented at the 2.4 s rate. Total time for testing is between 15 and 20 min. The performance can be evaluated in terms of the percentage of correct responses or the mean score (Lezak, 1995).

Normative data. This measure was chosen because of its apparent sensitivity to postconcussional attention deficits (Gronwall & Wrightson, 1981), its strong normative base, and its inherent test-retest reliability (Gronwall, 1977). In terms of the clinical model of attention, the PASAT presupposes the existence of the first of the five levels of attention (focused) and depends heavily on the adequacy of sustained and selective attention (Sohlberg & Mateer, 1987). Practice effects have been reported, ranging from

modest and stopping at the second administration (Gronwall, 1977), to continuing significant gains, leveling at between the fourth and fifth administration (Stuss, Stethem, Hugenholtz, & Richard, 1989).

Administration. Like the RAPT, the PASAT was used to obtain both baseline and progress measures. Administration was done in standard fashion as described above. Written demonstration and unpaced practice were done in the first two baseline trials. Thereafter only the 10-digit paced practice was maintained. Each subject was tested individually, and all four trials were administered at each sitting. Before commencing the task, the subject was reminded that, if at any point during the task he/she forgets the last number called, picking up any two consecutive numbers would get him/her going again. Intensity level was adjusted to comfortable listening for each subject. Administration of the auditory component of the RAPT was done as described earlier.

Scoring. Scoring was based on total correct at each pacing speed. To allow direct comparison of performance over trials, average time per correct response was also computed. This was done by dividing total trial time by the number correct for each of the four pacing rates, and averaging the results to give a composite score. (A table of converted scores based on pacing rates is provided by the supplier). Average time per correct response values were further used to calculate mean response times across all tasks and mean response times for individual tasks. Scoring of the RAPT auditory component was done as described earlier.

Question 3: Does APT increase the ability for recall and recognition of verbal material? To answer this question, accuracy in recall and recognition of verbal material was examined using the CVLT Adult Version (Delis et al., 1987).

The California Verbal Learning Test

Purpose. This test is designed to measure recall and recognition of word lists over a number of trials. It can be used to contribute to the diagnosis of memory impairments secondary to neurological disorders, psychiatric problems, and developmental learning disabilities.

Source. The CVLT Manual is published and marketed by the Psychological Corporation, P.O. Box 839954, San Antonio, TX 78283-3954

Description. The CVLT provides a brief, individually administered assessment of multiple strategies and processes involved in learning and remembering verbal material. Rather than presenting a list of randomly selected words, items make up two shopping lists, each with sixteen words, presented to the testee as "Monday's" and "Tuesday's" lists. Each of the 16 words on the Monday list belongs to one of four categories of shopping list items: fruits, herbs and spices, articles of clothing, and tools. The category words on the Tuesday list consists of four fruit names, four herbs or spices, with the remaining eight items split between kinds of fish and kitchen equipment. Testing is thus made more

relevant for the testee, and inferences about how the testee approaches an everyday memory task can be made more directly. The test is suitable for adolescents and adults of any age (Delis et al., 1987). It can be administered and scored in either paper-and-pencil or computer-assisted format.

Administration. Administration begins by evaluating an individual's ability to recall a list of 16 words (Immediate Free Recall) from the Monday list, over five trials. An interference list of 16 words (Tuesday's list) is then presented for one trial. This is followed immediately by free and category-cued recall of the Monday list. After a 20 min delay, during which nonverbal testing occurs, free recall and recognition of the Monday list are assessed. The Long-Delay Recognition List A is administered to test recognition. This subtest consists of a list of 44 shopping items, formed from the two lists, plus 12 new items. The items are read one at a time to the subject and the subject is required to respond "yes" if the item is from Monday's list and "no" if it is not.

Scoring. Through this procedure, the CVLT generates scores of total recall and recognition on all trials. These include: (i) total immediate recall, which is the sum of trials 1 through 5, a score that quantifies the rate of learning, one for recall consistency on the learning trials, plus scores that reflect learning strategies (i.e., semantic clustering and semantic clustering ratio, serial order clustering, and serial-order clustering ratio); (ii) serial position effects (i.e., primacy and recency tendencies); and (iii) scores for comparing free and cued recall. Scoring of intrusion and repetition errors (perseverations) yields a

reflection of the degree of vulnerability to proactive and retroactive interference. Also included are indices of recognition performance (i.e., discriminability and response bias, and FPs in recognition). Thus, in addition to measuring the amount of verbal material learned, the CVLT measures multiple aspects of how verbal learning occurs or fails to occur (Delis et al. 1987; Lezak, 1995, p.447).

Normative data. Normative data for determining an individual's CVLT scores is based on a series of multiple regression tests run on nonclinical reference groups consisting of 273 neurologically intact individuals (104 males and 169 females with a mean age of 58.93, SD=15.35, and a mean educational level of 13.83 years, SD=2.70). Norms are presented for 7 age groups (17-34, 35-44, 45-54, 55-64, 65-69, 70-73, 74-80). The midpoint for each age range is used to compute the expected mean and SD for the group. Knowing the estimated mean and SD in each age group, for each sex, makes it possible to express any raw score as a standard score that shows how far the observed score is from the mean in SD units. (Tables for converting raw scores to standard scores are provided in the manual).

Scores reflect age-associated performance decrements, particularly at age 65 and beyond (Pope, 1987), with significant age x Total Trials 1-5 correlations of $-.61$ (Delis, McKee, Massman et al., 1991). Education correlations are positive and significant, but lower ($.36$) than those for age. Women tend to perform better than men on learning and recall measures of this test, but no sex differences have shown up for the recognition trial or for error types (Kramer, Delis, & Daniel, 1988). Women appear to use a semantic

clustering strategy more often than do men (Delis et al., 1987).

Reliability. Scores from a sample of 51 males and 82 females of the normal reference groups (mean age=60.89; SD=7.8) were used to estimate internal reliability on recall (Delis, Kramer, Kaplan, and Ober, 1987). Three indices are provided. For internal consistency the Spearman-Brown formula applied on two odd-even correlations (.836 and .819) yielded an estimated reliability of .92 for the total score over five trials. The second reliability index, based on the correlation between the total (five-trial) scores on two independent halves of the test, yielded a total-test reliability of .77. The third reliability index is based on the total (five trials) score for each of the 16 stimulus words. The correlation between total scores on odd-numbered and even-numbered words was .54, yielding an estimated total-test reliability of .70; the coefficient alpha is .69. The odd-word/even-word reliability for this analysis, carried out on a mixed clinical and nonclinical sample of 87 examinees, is .85 and the coefficient alpha is .86 (Delis et al. 1987; Delis, Kramer, Fridlund, & Kaplan, 1990).

Test-retest reliability conducted on 12 males and 9 females, (mean age=33.00, SD=8.82) showed an average improvement of about two words in the total immediate recall of List A, across five trials (i.e., less than one half-word per trial). The average improvement on Short- and Long-Delay Recall Trials and on Recognition "hits" was about one word.

Validity. The CVLT has been investigated to determine the factor structure and the criterion-related validity (Delis et al. 1987). First, the intercorrelations among the CVLT variable scores have been factor analyzed. Factor analytic studies yield six factors: a general learning factor, learning strategy, acquisition rate, serial position effect, discriminability, and learning interference (Delis, Freeland et al., 1988; Schear & Craft, 1989b). In general, the results of the factor analysis indicate that the multiple indices assessed by the CVLT cluster into theoretically meaningful factors consonant with the experimental constructs they were designed to measure (Lezak, 1995 p.447). Second, the CVLT variable scores have been correlated with scores on the Wechsler Memory Scale (Wechsler, 1945). Results show that 64% of the correlations are significant at the .05 level or above, indicating that the correlation cannot be attributed to chance (Delis et al., 1987; Schear & Craft, 1989a).

Administration. In this study, the CVLT was administered at three points: during baseline assessment, on completion of training, and approximately four months after completion of the study. Testing was done in a room free from distracting noises and interruptions. The test was administered using the paper-and-pencil format as described above. Pre-training administration was interposed with the Rey CFT in the 20 min break preceding Long-Delay Free recall. In subsequent testings, the Taylor CFT and the PASAT were administered during this break. Each response made by the subject was recorded in the appropriate section of the CVLT Record Form.

Scoring. Raw scores from the CVLT Record Form were computed using microcomputer software, also obtainable from the Psychological Corporation. Computer-assisted scoring consists of a series of successive steps, one leading to another, with output produced only after raw data from all trials has been entered. Scoring involves coding types of responses on each free-recall and cued-recall trial. Correct responses are coded C, intrusions are coded I, and perseveration are coded P. A correct response is defined as the first recall of a word from the target list on each trial. An intrusion is defined as a response not on the target list. A perseveration is defined as a repetition of any response on the same trial. A repetition is scored as a perseveration only if the subject showed uncertainty regarding the item having been given before. A repetition for self-cuing is not scored. The number of correct responses, intrusions, and perseverations for each free-recall and cued-recall trials are shown.

Scores for the first five List A trials are documented separately. The observed semantic cluster scores are also documented. The observed semantic cluster occurs whenever a correct response immediately follows another correct response from the same semantic category. The maximum correct semantic cluster score for each trial is 12. From the verbatim record of the subject's responses, the order in which the words are recalled on each of the free-recall trials of Lists A and B is considered. Each response item is given a "recall-order" number.

The "correct serial cluster" scores for Lists A and B were also computed. A correct serial cluster occurs whenever a pair of recall-order numbers in a trial follow one

another in ascending numerical sequence. Each pair of such numbers earns one point. The total number of perseverations and intrusions on all free-recall and cued-recall trials of Lists A and B are identified. On the recognition test, six scores are identified: the number of correctly recognized List A words - "hits"; the number of FPs that are from List B and are from categories shared with List A - "B-Shared" the number of FPs that are from List B and are from categories not shared with List A - "List B-Nonshared" the number of FPs that are not found on either list, but that are prototypical of categories on List A - the "Neither List Prototypical" (e.g., hat for clothing); the number of FPs that are phonemically similar to words on List A - "Neither List-Phonemically similar" (e.g., drums for plums); and the number of FPs that share neither obvious semantic nor phonemic features with items on the two lists (e.g., rug). Discriminability, which reflects the ability to discriminate target words from distractors, and response bias, which indicates the extent to which the person favors either a "yes" or a "no" response were also computed.

Question 4: Does attention training increase visual memory? To answer this question, accuracy in reproducing visually presented complex figures was assessed using the Rey CFT (Rey, 1941; Osterrieth, 1944; Corwin & Bylsma, 1993) and the Taylor CFT (Taylor, 1979).

The Complex Figure Test

Source. There is no commercial source for the Complex Figure Tests. Users may refer to descriptions given by Lezak (1995), and Spreen and Strauss (1991).

Purpose. This test is used to investigate perceptual organization (visuospatial constructual ability) and visual memory (Lezak, 1995; Spreen and Strauss, 1991). It permits assessment of a variety of cognitive processes, including planning and organizational skills, problem-solving strategies, perceptual, motor, and memory functions (Waber and Holmes, 1986)

Description. The CFT was developed by Rey (1941) to investigate both perceptual organization and visual memory in brain-damaged subjects. The test was elaborated by Osterrieth (1944) and recently translated by Corwin and Bylsma (Lezak, 1995). The test material consists of a reproduction of the Rey figure or an alternate version, the Taylor figure (Taylor, 1979), blank typewriter-size paper, and five or six colored pens or pencils. Testing requires the subject to copy the figure and then, without prior warning, reproduce it from memory.

Administration. The subject is first instructed to copy the figure, which has been set out so that its length runs parallel to the subject's horizontal plane. The blank sheet of paper is also placed horizontally, and the subject is not allowed to rotate either. Colored pens are used for tracking the sequence in copying the figure. These are given one at a time each time the subject completes a section of the drawing. Alternatively, the examiner watches the subject closely and keeps a detailed record of the subject's copying sequence which may be done by reproducing the performance, numbering each unit in the order that

it is drawn. An effort-saving procedure is to use a registration sheet containing the printed Rey figure, which the examiner numbers in the order in which the subject makes his/her copies (Visser, 1973; Lezak, 1995).

The Rey figure and the subject's copy are exposed for a maximum of 5 min and a minimum of 2.5 min (Spreeen and Strauss, 1991). If the subject is finished drawing before 2.5 min, he/she is told to check the copy over carefully to make sure it is complete. If by the end of 2.5 min, it is obvious that the subject is drawing too slowly, he/she is encouraged to speed up. However, since it is more important for a subject to complete the drawing as well as he/she can, more time is allowed when needed (Spreeen and Strauss, 1991, p. 161). Total time taken to complete the drawing is recorded.

The copy task is usually followed by one or more recall trials, although the amount of delay varies among examiners (Lezak, 1995, p. 475). The immediate recall trial has been given in as brief a delay as 30 s (Loring, Martin, Meador, & Lee, 1990) or after a 3-minute delay (Osterrieth, 1944; Lezak, 1995). The amount of time allowed for the delayed recall also varies widely from 20 min, to 30, to 45 (Lezak, 1995, p. 475). Within the limits of an hour or so, the length of the delay is apparently of little consequence (Berry & Carpenter, 1992; Freides & Avery, 1991; Wood, Ebert & Kinsbourne, 1982). No time limit is set on the delayed recall task. Interposed tests should be quite different from the CFT, in order to avoid interference (Spreeen and Strauss, 1991). Approximate time of administration is 10 min, excluding delays.

Scoring. Although several detailed sets of scoring guidelines are available, only the traditional scoring method is discussed. For scoring accuracy in reproduction, the CFT is broken down into 18 elements, each awarded two points if the unit is correct and placed properly. One point is awarded if the unit is correct but placed poorly, also if the unit is distorted but placed correctly. One half point is awarded if the unit is distorted and placed poorly; and zero points are given if a unit is absent or not recognizable. The highest possible score is 36 points.

Scoring criteria are strictly applied for both correctness of the details and their placement (Lezak, 1993; Spreen and Strauss, 1991). This is because slight drawing errors have been found to be significant in differentiating groups of patients with varying cerebral lesions (Spreen and Strauss, 1991). However, allowance is made for the fact that it is difficult to draw a straight line without the use of a ruler (Spreen and Strauss, 1991). In the event of a single error that affects more than one element, the error is penalized once only (Lezak, 1993, p.572). Both copy and memory trials are scored in the same manner. The copy score reflects the accuracy of the original copy and is a measure of visual-constructional ability. The recall score assesses amount of information retained over time.

To score planning and organizational ability the subject's copy strategy is examined. Evaluation techniques provide measures of the degree to which the figure is drawn in a conceptual, fragmented, or confused manner, and requires the examiner to record the order and direction of the drawing (Lezak, 1995). The scoring system used in this was developed by Hamby, Wilkins, and Barry (1993) and designed for use with both

Rey and Taylor figures. The subject uses five colors for the drawing, switching to another color when an element is completed, so that colors are used “approximately equally” to divide the figure into elements. Specific judging rules relate to configural mistakes, secondary mistakes, and detail mistakes (Hamby et al., 1993). Ratings are made on a 5-point Likert scale in which higher scores indicate better organization. The score represents an evaluation based on the nature and number of mistakes as shown in Table 3.

Table 3. Complex Figure Organizational Quality Scoring.

-
- 5 - No mistakes; overall organization is good
 - 4 - Detail mistakes and/or completion of upper left cross before major structures; organization is “good.”
 - 3 - One configural or diagonal (e.g., lines don’t cross in middle rectangle) mistake with or without detail mistakes, organization is “fair.”
 - 2 - Two configural or diagonal mistakes; with “poor” organization.
 - 1 - Three or more configural or diagonal mistakes, one configural or diagonal element missing, much segmentation, and “poor” organization.

Modified from Lezak (1995), previously abbreviated from Hamby, Wilkins, and Barry (1993)

Test Characteristics. The strict scoring criteria described above has been found to yield very high interrater reliability ($r=.91$ to $.98$) (Berry, Allen & Schmitt, 1991; Delaney, Prevey, Cramer, & Mattson, 1988; Loring, Martin, Meador, & Lee, 1990; Strauss & Spreen, 1990; Shorr, Delis, & Massman, 1992). Test-retest reliability using alternate forms were in the $.60$ to $.76$ range (Berry, Allen, & Schmitt, 1991; Delaney, Prevey, et al., 1988). Although the copy administration of the two figures have been found to be of equivalent difficulty, the Rey-Osterrieth figure is a little more difficult to recall than the Taylor figure (Strauss & Spreen, 1990; Casey, Winner, Hurwitz, & DaSilva, 1991; Duley, Wilkins, Hamby, et al., 1993), suggesting that the Rey figure is more sensitive than the Taylor figure to the presence of memory deficits. Both immediate and delayed recall trials have a strong visual memory component (Baser and Ruff, 1987; Loring, Lee, Martin & Meador, 1988).

It has been found that with repeated administration of the same figure (Rey or Taylor), practice effects occur in normal adults (Spreen & Strauss, 1991). In general, normal subjects show a 10% improvement in percent recall when retested after a one-month interval (Spreen & Strauss, 1991 p.164). Significant age effects on recall trials show up consistently (Lezak, 1995 p. 477). Findings by Spreen and Strauss (1991) based only on a 30-min delayed recall suggest that decline begins in the 30's, continuing steadily until the 70's, when a larger drop in scores is noticed. The 3-min short-term recall data suggest a tendency to an average decrease in scores seen first at age 41-55, becoming pronounced until around age 60, with marked decline continuing into age 65 and older

(Delbecq-Deroueshè & Beauvois, 1989).

For relatively well-educated subjects (average 14.5 years), delayed recall (30 min) scores did not drop notably until after age 69 (Boone, Lesser, Hill-Gutierrez et al., 1993). Using both immediate and delay trials, Chiulli, Yeo, Haaland, & Gary (1989) showed a stable pattern for age groups 65-69 to 75-79, with a little decline in the early 80's, and significant score decreases only for the 85-93 age group. Delbecq-Deroueshè and Beauvois'(1989) "cultural level" score reflects that the educational level of subjects contributed significantly ($p < 0.5$) to their memory score. Studies featuring persons with less than six years of schooling in a sample containing about equal numbers of persons with more than 12 years of schooling, reflect conflicting findings ($r = .37$, $p < .001$, Rosselli & Ardila, 1991; $r = .20$, Delaney, Prevey, et al., 1988). Men's recall of the figures tends to be better than women's, with the average difference generally running one to two points (Rosselli & Ardila, 1991), but no gender differences were found in college students (Freides & Avery, 1991).

TBI patients tend to have difficulty on recall trials of the CFT (Lezak, 1995 p.478). Patients with mild head injuries showed significant deficits on 3-min recall trials within the first 21 months post injury (Leininger, Gramling, Farrell et al.,1990). In contrast, two to five years post trauma, moderately injured patients (post traumatic amnesia [PTA] < 3 weeks) achieved significantly higher delayed recall scores than those whose injuries were severe (Bennet-Levy, 1984b). In Brooks's (1972) study, patients with traumatic brain damage did as well as the controls on immediate recall, but gave impaired performances after a 30-min delay. Tendencies to perseverate, confabulate, personalize, or

otherwise distort the design that first appeared on the initial copy, or on the immediate recall trial, tend to be exaggerated with repeated recall (Le Gall, Truelle, Joseph, et al., 1990).

Normative data. Norms available on CFT are from approaches using copy followed by one or two recall trials (Lezak, 1995). Osterrieth (1944) provided percentile norms for accuracy scores based on 60 adults, ages 16-60, derived from a 3-minute delayed recall. Kolb and Wishaw (1985) provided norms from samples of school children, ages 6-15, and healthy adults, ages 16-44, derived from 30-min delayed-recall trials. Spreen and Strauss (1991) provided data from 30-min delayed-recall, based on a sample of healthy, well-educated (mean=13,2 years) adults, ages 50-85. Similar data are reported by Loring, Martin, and Meador (1990). In contrast, Chiulli, Yeo et al. (1989) gave data for healthy, elderly people, derived from trials including both immediate and delayed recall.

Most studies have found that few performances using either the Rey or the Taylor figure showed more than a one or two point difference between immediate and delayed recall trials, with negligible differences between recall trial means (Lezak, 1995 p.476). Based on these findings, norms that give scores for only the immediate trial can be applied safely to the delayed trial (Lezak, 1995 p.476). However, when a short-term recall precedes a delayed-recall trial, both recall trials are apt to have a higher score than if only a delay trial is given (Loring, Martin, et al., 1990). Inclusion of an immediate-recall trial increases delayed-recall performance on average by six points in normal young adults. To

compensate for lower delay norms that are not preceded by an immediate recall trial, the examiner must make as much as a five or six point adjustment (Loring, Martin, et al., 1990). Norms applicable to the sample in the current study, as per findings by Kolb and Wishaw (1985), are:

Age 16-30 (N=67): copy 35.10 points, SD = 1.5; 30-min recall, 22.7 points, SD = 7.00.

Age 31-44 (N=26): copy 33.20 points, SD = 6.1; 30-min recall, 19.50 points, SD = 6.7.

Administration. Pre-training test material consisted of the Rey CFT, with long dimensions parallel with the long axis of a 8 ½" x 11" sheet of paper, blank white paper sheets of the same size, lead pencil, eraser and a stopwatch. Before administering the test, the investigator explained: "I am going to present to you a sheet of paper with a design on it. I would like you to copy the design on this blank sheet of paper. Please copy the figure as carefully as you can. If you think you have made a mistake, correct just what you think is wrong." When ready, the subject was presented with one blank sheet of paper, pencil, eraser, and one copy of the Rey Figure set on the table so that its length ran along the subject's horizontal plane. Timing began simultaneously with the presentation of the figure.

To record the order of line copying, the investigator used a separate copy of the figure. Each line drawn by the subject was numbered in the order it was drawn. When copying was finished, both the original and copy drawings were removed. Immediate recall trial followed wherein the subject was asked to reproduce the figure from memory.

This was followed 30 min later by a delayed-recall trial. During the 30-min delay period, part of the CVLT was administered. Time taken to complete the drawing and the sequence order were recorded in each trial.

Post-training, test material included the Taylor CFT and the Rey CFT. To introduce interference the Taylor test was administered one day ahead of the Rey test. A procedure similar to pretraining testing was followed in administering these tests. In the case of the Taylor figure the copy trial was followed by a 3-minute short-delay, and a 30-minute delay-recall trial. This was done on the recommendation of an experienced clinician. For post-training test administration, the Taylor figure and the Rey figure tests were interposed with the CVLT and the RAPT, respectively. Both pre- and post-training performances were scored for accuracy, time taken to complete drawing, and organizational ability. Interrater reliability for accuracy scoring for the four subjects was $r = .95$.

Question 5: Does attention training increase prospective memory? To answer this question, accuracy in executing assigned prospective tasks at the correct time was assessed using the PROMS (Sohlberg & Mateer, 1986).

The Prospective Memory Screening Test

Purpose. PROMS provides for the quantification of the subject's prospective memory performance.

Source. PROMS material is developed and marketed as part of a package for assessment and training of prospective memory by the AFNRD, 11719 Meridian E, Suite 321 Puyallup, WA 98373

Description. This test consists of simple, one-step commands targeting prospective memory ability at 1, 2, 10, and 20 min as well as at 24 hours. In addition to being categorized by time levels, screening items (except for the 24-hour task) are also classified as associative cue tasks or time cue tasks. Associative cue tasks are those that require the subject to perform a prospective memory task when another event occurs, for example, standing up when the examiner snaps his/her fingers. Time cue tasks require the subject to keep track of time and initiate an activity at a specified time without any cue. Tasks are assigned so that the subject is never keeping track of more than two tasks at a time.

Two standard distractor tasks come with the PROMS. The first of these is a memory questionnaire that provides information on the patient's perception of own his/her memory impairment. This distractor serves to discourage the subject from talking during the waiting period between task assignment and execution. In addition, the questionnaire may provide the clinician with information on how the patient perceives his/her memory impairment. The second distractor is a set of simple math problems involving addition and subtraction exercises. A simple drawing activity may be substituted where the subject is unable to perform simple math calculations or to read and write well enough to complete

the questionnaire (Sohlberg & Mateer, 1986)

Material for administration of the PROMS consists of a cup, a penny, an envelope, a stopwatch, a boat picture, a clock with a second hand displayed to the patient, an addressed postcard with a stamp, the distractor task sheet, and a PROMS scoresheet. Items to be used by the subject in his/her responses are placed within sight and reach of the subject as required. Administration begins with the assignment of the 20-min prospective memory task with associative cue. This task requires the subject to salute when shown a picture of a boat 20 min later. The next task to be assigned is the 2-minute prospective memory task with time cue. Here, the subject is required to observe the time and execute the assigned task (e.g., writing his/her name on a piece of paper) exactly 2 min after the instruction to begin. Should the subject fail to execute the 2-min task, the 1-min task with associative cue is assigned, otherwise testing proceeds to the 10-min time cue task.

For the 10-min prospective memory task with time cue, a penny, an envelope, and a cup are placed in full view of the subject. The subject is required to place the penny in an envelope after exactly 10 min. This task is followed by the 10-min task with associative cue, which requires the subject to tap the table when the examiner snaps his/her fingers. Assignment of this task is not done until enough time has elapsed for either the 10-min time cue or 20-minute associative cue task, whichever occurs first. To fill up the waiting time, a distractor task is administered. When either task has elapsed, the 20-minute task with time cue is given. Here the subject is required to stand up exactly 20-min after the start time. For the final task, the subject is given an addressed postcard to mail to the

examiner 24 hours later.

Scoring. Scores on the PROMS reflect response times, errors, and observations made with respect to responses. A total of 7 points can be obtained on the PROMS. One point is obtained for each prospective memory task for which the correct response is given at the target time. A score of 6-7 is interpreted to indicate absence of impairment, while a score of 5 indicates borderline impairment. A score of 1-4 is associated with impaired performance.

Normative data. Norms for PROMS were derived from performance by normal subjects, ages 20 to 59, and 25 brain-damaged patients ranging in age from 21 to 56, with a head injury sustained at least 12 months previously (Sohlberg & Mateer, 1986). Overall, 82% of the control subjects scored either 6 or 7, as compared to 36% of the brain-injured subjects who scored in this range. Five control subjects (14%) scored 5. Only one control subject scored 4 or below, compared to ten (40%) of the brain injured subjects who scored in this range.

Associative cues are generally easier to respond to than time cues. Performance generally declines with increasing time delays between the instruction and the response. This, however, may be only partially true for the 24-hour task which may reflect a separate underlying function or organization. Failures on a 1- or 10-min associative cue or a 2-min time cue might serve as an effective bedside screening measure for prospective memory (Sohlberg & Mateer, 1986). There is no evidence of age-related effects on prospective

memory as measured by this test. Comparison of performance scores between the Randt Memory Test and PROMS suggests differential sensitivity of prospective memory tasks and delayed recall tasks in neurologic patients (Sohlberg & Mateer, 1986).

Sensitivity. Due to the variability of assigned tasks, PROMS potential sensitivity is determined individually for each item as indicated in Table 4.

Table 4. Item Analysis for PROMS.

If Missed	% Impaired
1-Minute Associative Cue	100
10-Minute Associative Cue	100
20-Minute Associative Cue	70
2-Minute Time Cue	100
10-Minute Time Cue	88
20-Minute Time Cue	47
24-Hour Task	61

Question 6: Does attention training increase the level of organization of information in memory? To answer this question, the subject's ability to organize verbal and visual information into categories or units was assessed. To evaluate ability for

organization of verbal information, semantic clustering was assessed using the CVLT (Delis et al., 1993). To evaluate ability for organization of visual information, the Rey CFT (Rey, 1941; Osterrieth, 1944; Corwin & Bylsma, 1993) and the Taylor CFT (Taylor, 1979) were used. These tests were described under Questions 3 and 4.

Question 7: Do attention behaviors acquired following APT transfer to settings outside of training tasks? To answer this question, the frequency of perceived difficulty for different types of breakdowns in attention and attention problems encountered were investigated using the APT-11 Attention Questionnaire (Sohlberg, Johnson et al., 1993) the APT-11 Attention Lapse and Success Log (Sohlberg, Johnson et al., 1993).

The APT-11 Attention Questionnaire

Purpose. This questionnaire allows the rater to quantify the frequency of different kinds of common attentional problems experienced by the subject. It is designed to be given as part of the initial evaluation of attentional abilities, as well as after the implementation of attention training to measure potential changes (Sohlberg, Johnson et al., 1993).

Description. The APT-11 Attention Questionnaire consists of two parts. The first part, composed of 12 items, is a rating scale looking at the frequency of different types of breakdowns in attention. This portion is designed to provide information about the

subject's perceived degree and nature of attention impairments in daily functioning (Sohlberg, Johnson et al., 1993). Items 1-6 relate to problems with sustained attention. Items 7-8 correspond to breakdowns in selective attention, with items 9-11 directed at alternating attention ability and items 11 and 12 relating to divided attention. At the end of the items, the questionnaire features some blank spaces for additional descriptions of attentional problems. Items are scored based on the perceived degree of difficulty each type of attention breakdown presents in daily functioning. The scoring system allows the clinician to quantify the perceived impairment with an objective score. This number can then be used to measure perceptions of changes in attention ability over time by comparing scores.

The second part of the questionnaire involves an individualized attentional problem list, created by documenting the most frequent and frustrating breakdowns in attention for the individual subject. In addition to other uses, the list provides some indices to measure perceptions of change after the implementation of attention training.

The questionnaire may be filled out by the subject with adequate explanation from the clinician or completed by the clinician through interview questions. Alternatively, the questionnaire may be completed by the significant other (SO) on request by the clinician and with permission from the subject.

Administration. Subjects and their SO's were required to complete a total of five APT-11 Questionnaires. This was done individually by each participant at the baseline period before any assessment was done and periodically at the end of each training phase.

The SO's were asked to complete the questionnaire based on their observations of the subject's attentional behavior. Scores over time were compared to detect changes.

Questionnaires for subjects were given directly to them, while those for SOs were either mailed or delivered the by subjects. A similar method was used for the return of completed questionnaires.

The APT-II Attention Lapse and Attention Success Logs

To obtain information regarding the subject's specific psychological profile, each subject was required to complete the APT-11 Attention Lapse and Success Log. This log provided a daily record by the subject of his/her breakdowns in attention and the strategies used to manage them. In addition to increasing awareness of functioning in naturalistic settings, this record was used to encourage successful management of attentional problems. Initially, each subject was asked to identify five compelling problem areas and focus on them in his/her daily recording. Subjects were encouraged to make observations on these problem areas in various situations, thus facilitating judgment on whether successes in training tasks were being generalized to daily functioning. Logs were reviewed on a weekly basis during consultation with the subject.

Additional assessment of attention training generalization effects consisted of observations made on the length of time the subject stayed working diligently on the math problem task that was administered during the PROMS. Where possible, individual probes were set in addition. One subject (02) was observed on two behaviors -increase in punctuality and regularity in completing the success section of the APT-II log. Subject 03

was observed on her recall of 19 items on a shopping list. The first list was obtained from the subject's favorite dinner menu which she was asked to prepare on the previous evening without being told of the intended shopping trip. The menu was discussed on the next day, after which the subject was accompanied by the investigator to the grocery store. At the store she was asked to get the non-fresh produce items for preparing the main dish without using the list. Two weeks later, this subject was asked to write out 19 grocery items, read to her by the investigator from the latter's own shopping list. At the end of the training session she was accompanied to the grocery store and asked to pick the items from memory.

Summary

The specific aims of this study addressed three major questions regarding the efficacy of attention process training (APT). The first question concerned the efficacy of attention training in remediating attention deficits in persons with mild TBI. This question was further extended to investigate modality specificity for visual attention training and auditory attention training. The second question addressed the effects of attention process training on attention-based memory dysfunction. The third question concerned the generalization of attention skills learned in attention training, to real life situations. To achieve the purpose of the study, baseline performance in attention was established using the RAPT and the PASAT. For baseline assessment of memory performance, the CVLT, the Rey CFT, and the PROMS were administered. Intervention in the form of APT auditory and visual training tasks (Sohlberg, Johnson et al. 1993; Sohlberg & Mateer,

1986) was undertaken alternately for each individual over four study phases ABAB. The alternating sequence between auditory and visual attention training for each of the four subjects (3 female, 1 male), was randomly assigned. Some of the APT visual training tasks were used in their original form and others were modified. Three other tasks were modified from the Verbal and Nonverbal Cancellation Task (Mesulam, 1985, 1988). Although the subjects followed the same intervention task order, each subject's program was individually prepared. No memory training was undertaken. To determine outcome in attention performance the DVT and the MTVAT were administered in addition to the RAPT and the PASAT. To determine outcome in memory performance the same memory test used in baseline assessment were used. To investigate the generalization effects the APT-II Questionnaire and the APT-II Attention Lapse and Success Log was used. Where possible probes were used as an additional measure to determine generalization. The next chapter presents the findings of the study.

CHAPTER FOUR

RESULTS

This chapter is divided into three sections. The first section is a general description of the study sample. The second describes data analysis for each test or tool administered, and includes a subject-by-subject account of the findings. The third section is a general summary of the findings.

Sample Description

A non-random sample of 4 survivors of TBI (3 females, 1 male), ages 27-40, were recruited through (i) the Washington State Head Injury Foundation newsletter *Focus*, (ii) local head injury care facilities, and (iii) head injury support group meetings. All four subjects reported existing poor attention performance as a result of brain injury following automobile accidents. All subjects met the criteria for mild TBI as defined in this study.

On admission to the study, post-injury duration was 2 years 3 months, 6 years 4 months, 6 years 5 months, and 7 years 9 months for subjects 04, 01, 02, and 03, respectively. None had any history of the following conditions: neurologic diseases; psychiatric disorders; substance abuse; severe visual and auditory impairments; pre-morbid mental retardation; or learning disability. All were English-speaking U.S. natives with more than eight years of formal education. Subject 01 (female) and 04 (male) were each engaged in gainful employment. Subject 02 was an unemployed housewife living with her husband and three children. Subject 03 was unemployed and living alone. None had any previous exposure to a formal neurologic rehabilitation program.

Data Analysis and Interpretation

Data for each subject was analyzed individually. Attention performance data was

handled separately from memory data. To answer Questions 1 and 2 of the study, data was examined for evidence of an increase in attention behavior that might be attributable to APT. To determine this change, baseline scores for the four independent attention tests (RAPT, PASAT, DVT, and MTVAT) were compared with inter-phase outcome scores for the same tests, at the end of training phase. Two measures, i.e., the number of correct responses made on each task and the rate of information processing are considered for this purpose.

An increase in the number of correct responses following training suggested improved performance that might be credited to APT effectiveness. Graph data was visually inspected to determine patterns, trends, magnitude of change, and immediacy or latency of change that might be due to intervention effects. An increase in auditory attention performance following the first auditory attention training phase was interpreted to suggest auditory attention training effects or, alternatively, practice effects. Subsequent to auditory attention training, continued increase in auditory attention performance following visual attention training was considered to suggest either continued auditory training effects or the effects of both auditory and visual training. A decline in the previously increased auditory attention performance after visual attention training, which improved with the reinstatement of auditory attention training, would imply auditory training specificity effects on auditory attention. Similar interpretations held in the case of visual attention training and visual attention. An increase in either auditory attention or visual attention, irrespective of the intervention modality, was considered suggestive of non-specific effects for either modality. Non-increase in either performance was interpreted as evidence of no effects from the intervention. A change of high magnitude in targeted behavior was interpreted to imply an intervention of high strength. Delayed change in desired behavior was considered to suggest a low-strength intervention.

A steep slope on the graph was seen to imply rapid increase in performance. A difference of 1.0 minute in total time to complete a task, and a difference of 0.10 second in the rate of response, between baseline and outcome performances, was interpreted to imply increase in performance.

Findings

In this section the findings of the study are given for each subject based on the tools used to measure the outcome. First discussed are the findings on attention performance determined by the RAPT, PASAT, DVT and MTVAT scores in that order. This is followed by a discussion of the findings on memory performance as determined by the CVLT, Rey CFT, and PROMS. The last section presents findings on generalization of APT learned skills based on the APT-II Questionnaire, APT-II Attention Lapse and Success Log, and other probes used to determine this factor. Tables 12 and 13 at the end of the chapter represent a summary of these findings.

Revised Attention Process Test

RAPT data consisted of separate sets of scores for auditory attention and visual attention. For determining the outcome, performance in five auditory attention and four visual attention levels was tested. Auditory attention levels included Sustained Attention Levels I and II, Selective Attention Level II, Alternating Attention Level II, and Divided Attention Level II. Visual attention performance evaluation excluded Sustained Attention Level I. Performance was scored based on a total of 30 possible correct responses each for auditory sustained, selective, and alternating attention tasks. This applied similarly for visual sustained and alternating attention tasks. Visual Selective and Divided Attention performances were scored based on a total of 60 possible correct responses. In addition to

the number of correct responses, FPs were considered. FPs are commission errors. Their occurrence implies perseveration tendencies, a common feature among some types of brain injury, for example, frontal lobe lesions (Lezak, 1995).

The second measure considered in analyzing the RAPT was the rate of responses with respect to visual attention tasks and the Divided Attention task only. The formula for this computation was given in the section describing the scoring of this test. Rate of response for divided attention was calculated from the sum total of correct responses for both the auditory and visual components of the task. In calculating the rate of response, FPs and targets not attempted due to time lapse were treated as errors.

Subject 01. History. This 29-year-old single woman had a medical diagnosis of head injury with cerebral concussion after being involved in a motor vehicle accident while riding a bicycle to work. She was unconscious at the scene of the accident but was starting to talk by the time the paramedics arrived. Other than a fractured tibia and fibula, she had an occipital scalp laceration that extended as deep as her skull. A CT scan of the head showed no blood and no shift. No fracture of the orbits was seen on the scan. There were no intraorbital masses. She was amnesic for a period of 12 hours after the accident.

She entered the study 6 years 5 months post-injury. At this time, she described her problems as difficulty in concentration, spaciness, noises sounding too loud, loss of immediate and short memory functions. She also complained of inability to pick up details when reading. Since her accident, she had obtained a Master of Science degree with difficulty compared to her previous capability. Previous treatment included some speech and occupational therapy. She had been on Ritalin treatment in 1989-92. Present occupation was described as documentation specialist. Subject dropped out of the study after completing two study phases, visual attention training followed by auditory

attention training.

RAPT data. Data on RAPT was collected over 6 baseline and 2 outcome trials. Scores for correct number of responses obtained in individual trials are shown in Tables 5 and 6 for auditory and visual attention, respectively.

Auditory attention. Auditory attention baseline performance for subject 01 showed a consistent score of 30 correct responses for all tasks, except for Alternating Attention and Divided Attention. One error and one FP occurred in Alternating Attention trial 2, with one switch error occurring in trial 4. One FP occurred in Divided Attention trial 2. Outcome assessment showed a score of 30 correct responses for all auditory attention levels, on all trials.

Due to the subject having obtained the maximum possible score from the start of the baseline condition and on more than three subsequent trials, RAPT scores for auditory attention show no significant difference between baseline and outcome performances. Compared to preliminary norms this performance was above average for normal non-brain-injured adults in the subject's age and gender group (see Table 5).

Table 5. RAPT - Auditory Attention Scores for Subject 01.

Task Level	Date	Baseline						Outcome			Norm. Values
		3/6	3/7	3/8	3/10	3/13	3/14	4/10	5/8		
Sustained: I	Correct	30	30	30	30	30	30				M = 30 SD 0.00 FP 0.14 SD 0.38
	Error	0	0	0	0	0	0				
	FP*	0	0	0	0	0	0	30	0	0	
Sustained: II	Correct	30	30	30	30	30	30				M = 30 SD 0.00 FP 0.00 SD 0.00
	Error	0	0	0	0	0	0				
	FP*	0	0	0	0	0	0	30	0	0	
Selective: II	Correct	30	30	30	30	30	30				M = 29.86 SD .38 FP 0.14 SD 0.38
	Error	0	0	0	0	0	0				
	FP*	0	0	0	0	0	0	30	0	0	
Alternating: II	Correct	30	29	30	29	30	30				M = 26.86 SD 6.72 FP 2.57 SD 5.97
	Error	0	1	0	0	0	0				
	FP*	0	1	0	0	0	0				
	Switch error**	0	0	0	1	0	0	29.66	0	0	
Divided: II	Correct	30	30	30	30	30	30				NA
	Error	0	0	0	0	0	0				
	FP*	0	1	0	0	0	0	30	0	0	

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

Visual attention. Individual task scores for visual attention appear in Table 6.

For Sustained Attention the mean number of correct responses was 29.17 for the baseline, compared to 27.5 for the outcome. No FPs occurred in all trials at both baseline and outcome levels. Since the number of errors in the first two baseline trials for the Sustained Attention task was the same as the number of errors in the two outcome trials, it is suggested that the total correct scores obtained in subsequent baseline trials might have been a result of practice effect. For selective attention, the baseline mean was 59.8, compared to the outcome mean of 54.5. Compared to one error in the initial baseline trial

and none in the first outcome trial, 11 errors occurred in the last outcome trial. Despite the reduction in time taken, this drop in the number of correct responses was interpreted to suggest no increase in Visual Selective Attention for this subject. For Alternating Attention the mean was 30 for both baseline and outcome. Average times for task completion were 27 s and 31.7 s, respectively. The absence of errors for all baseline and outcome trials rendered it impossible to determine performance status for this subject. Outcome scores for Divided Attention showed a slight increase of 0.7 in the number of correct responses, from baseline (M=26.8) to outcome (M=27.5). A comparison of baseline and outcome scores showed no difference in the number of correct responses obtained.

Table 6. RAPT - Visual Attention Scores for Subject 01.

Task Level	Date	Baseline						Outcome		Norm. Values	
		3/6	3/7	3/8	3/10	3/13	3/14	4/105/8	Avg		
Sustained: I	Correct	27	28	30	30	30	30				M = 29 SD 1.53 FP 0.00 SD 0.00
	Error	3	2	0	0	0	0	28	27		
	FP*	0	0	0	0	0	0	29.17	0	0	
Selective: II	Correct	59	60	60	60	60	60				M = 58.2 SD 2.13 FP 0.00 SD 0.00
	Error	1	0	0	0	0	0	60	49		
	FP*	0	0	0	0	0	0	59.83	0	0	
Alternating: II	Correct	30	30	30	30	30	30				M = 25.14 SD 7.17 FP 2.43 SD 4.15
	Error	0	0	0	0	0	0	30	30		
	FP*	0	0	0	0	0	0	0	0		
	Switch error**	0	0	0	0	0	0	30	0	0	
Divided: II	Correct	26	27	26	28	28	26				NA
	Error	4	3	4	2	2	4	27	28		
	FP*	0	0	0	0	0	0	26.83	0	0	

* FP = false positive responses.

**Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

For sustained attention baseline mean time for task completion was 119 s compared to outcome mean of 90 s, suggesting a gain of 29 s in outcome time compared to baseline. Selective attention baseline mean time score for task completion was 37 s compared to outcome mean of 33 s. The reduction in time, viewed against 11 errors that occurred in the last outcome trial, suggests an increase in visual selective attention performance for this subject. It is assumed that this reduction in time is accountable for the increase in errors in this trial.

Time scores for alternating attention were the same for both baseline and outcome conditions. The shorter task completion time seen at baseline (36, 34, 30, 23, 20, 21 s) compared to both outcome times (36, 27 s) was suggestive of practice effect. Average time for task completion in divided attention was 142 s at baseline compared to 116 s for outcome, suggesting an increase in performance. Baseline times for task completion showed progressive reduction from trial to trial, which might be attributed to practice effect. However, reduction in mean time in the outcome condition (142 s baseline, 116 s outcome) suggested an increase in performance.

The mean rate of response for sustained attention was 4.07 s for baseline, and 3.5 s for outcome. For selective attention this mean was 62.5 s baseline, and 60.5 s outcome. For alternating attention, it was 0.9 s for baseline and 1.05 s for outcome indicating a loss of 0.15 s. For divided attention, the baseline mean rate of response was 2.51 s, compared to 1.93 for outcome, showing an increase of 0.8 s.

Based on these data, scores for correct number of responses and those for task completion time showed no evidence of increase in performance for sustained, selective, and alternating attention. Some evidence of increased performance was shown in the rate of response sustained and divided attention (see Figures 1-4).

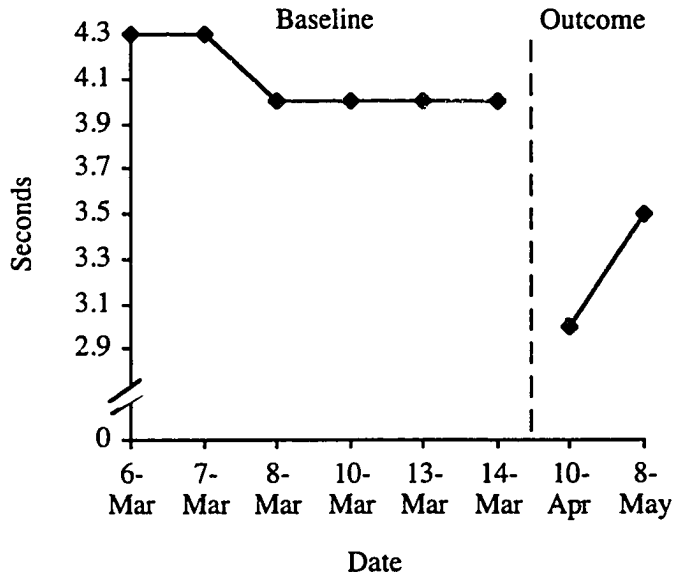


Figure 1. Subject 01 - RAPT Visual Sustained Attention Level II, Rate of Response

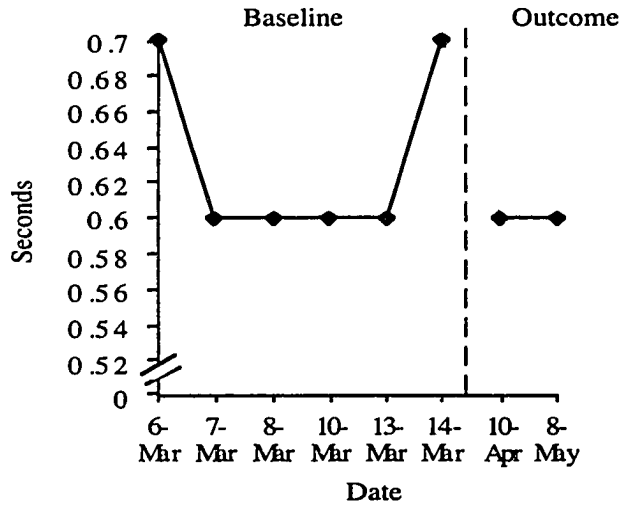


Figure 2. Subject 01 - RAPT Visual Selective Attention Level II, Rate of Response

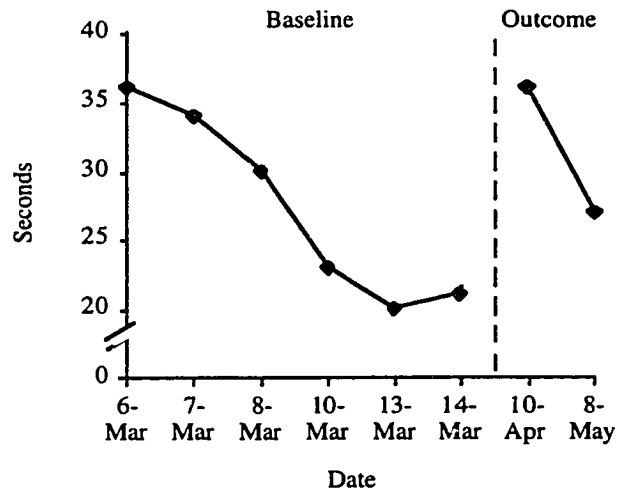


Figure 3. Subject 01 - RAPT Visual Alternating Attention Level II, Task Completion Time

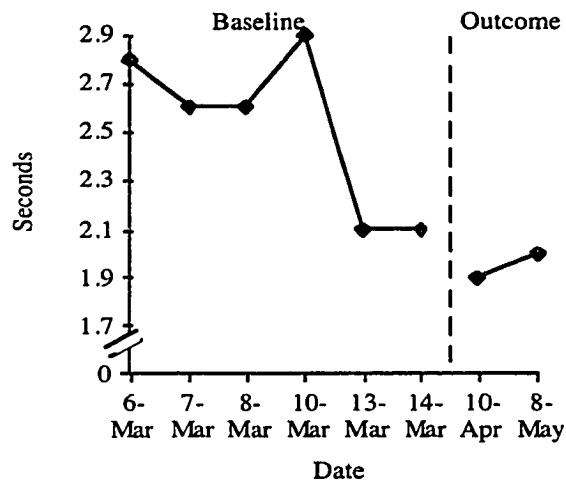


Figure 4. Subject 01 - RAPT Divided Attention Level II Rate of Response

Modality specificity. Data on the RAPT showed no specific effects for auditory or visual attention training. Because the subject was able to obtain total possible scores on repeated baseline trials, it was concluded that the drop in visual attention performance, following auditory attention training, was unrelated to the targeted modality of training (auditory) at that time.

Subject 02. History. This 39-year-old mother of three sustained a closed head injury after a car behind her was hit by a truck and then both hit the back of her stationary car while she was stopped on the freeway because of traffic. She recalls seeing the vehicles coming through her rearview mirror and she tensed up. At the time of the impact she felt her head go backward against the headrest and then forward. She had immediate pain at the back of her head and in the forehead region. There was also pain at the base of her neck shortly after the accident. The subject recalls a brief loss of consciousness and being somewhat rummy afterwards. She apparently assisted some injured people in the vehicle behind her and was then ordered to pull over to the side of the road by the State Patrol. Because of concern with her intense pain another motorist called an ambulance for her. She was taken to a local hospital emergency unit where she was told she had a concussion and a severe whiplash. X-rays of the cervical spine showed no apparent fractures. She was released with a neck brace and pain medications. No scan was done at that time.

An MR scan of the sagittal projections which was done three months after the accident showed a slight bulge of the disc at C5-6. Six months later, a second scan of the sagittal projections showed a definite small bulge of the disc at C5-6, particularly on T1. There was also a soft disc herniation at C5-6. Nothing was mentioned about the brain in the scan report.

The subject was admitted to the study six and half years post-injury. Subject described her problems at this time as inability to connect well, inability to figure things out, forgetting to pay bills quite frequently, getting lost on streets that she knows, and forgetting even important issues such as business appointments and relationships. Other concerns included difficulty in understanding, reading, and loss of track of thought.

The subject had a high school education and about 45 credits of college work. Prior to her injury, the subject had been working as a sales representative selling time clocks and time data apparatus. In 1988 (year of injury) she received a top representative award in 22 states, having achieved 175% of her quota. She was dismissed from this job when her performance dropped dramatically in the two years following the injury. Previous treatment consisted of Prozac 20 mg and Ritalin 10 mg/day in 1994. Current medication consisted of Synthroid 15 mg and Dizapermine 1 tab/day. She had thyroid removal in 1984, and disc surgery to C5 and C6 in 1991.

RAPT data. Data on the RAPT was collected on 5 baseline and 4 outcome trials. Training for this subject commenced with auditory attention (in phases A1 and A2), followed by visual attention (in phases B1 and B2). Numbers of correct responses obtained in individual trials are shown in Tables 7 and 8 for auditory and visual performance, respectively.

Auditory attention. For Auditory Sustained Attention Level I, the mean score for the baseline was 29.6 correct responses compared to 27.75 for outcome. No FPs occurred for outcome. For Auditory Sustained Attention Level II, the baseline mean was 28.8 compared to the outcome mean of 27.75. For Selective Attention Level II, a mean of 26 correct responses was obtained for both baseline and outcome. For Alternating

Attention Level II, the mean was 27.4 for baseline, and 28.75 for outcome. One FP occurred in trial 2 of the baseline, and one switch error occurred in outcome trial 2. Means for Divided Attention Level II were 21.40 and 22.75 correct responses for baseline and outcome, respectively. FPs in each of the five baseline trials were 2, 1, 0, 1, 1, respectively, and one FP occurred in outcome trial 1.

Compared to the baseline, scores in sustained attention showed no increase in the number of correct responses. Some slight improvement was observed in selective attention with more stable performance reflected especially in the last two outcome trials. Although errors remained high for the divided attention task, outcome scores showed more stability and a reduction in the number of FPs compared to baseline scores. In contrast, outcome performance in alternating attention showed an increase in performance, marked by consistent occurrence of 29 correct responses in the last three trials. This finding was suggestive of the possibility of selective effectiveness of the APT training with respect to the different levels of attention, and supported the observation of stability in performance already demonstrated in other tasks.

Table 7. RAPT - Auditory Attention Scores for Subject 02.

Task Level	Date	Baseline					Avg	Outcome				Avg	Norm. Values
		3/6	3/8	3/9	3/10	3/11		4/7	5/5	5/26	6/24		
Sustained: I	Correct	30	29	30	30	29	29.6	28	27	28	28	27.75	M = 30 SD 0.00 FP 0.14 SD 0.38
	Error	0	1	0	0	1		2	3	2	2		
	FP*	0	0	0	0	0		0	0	0	0		
Sustained: II	Correct	28	30	30	27	28	28.6	27	30	27	27	27.75	M = 30 SD 0.00 FP 0.00 SD 0.00
	Error	2	0	0	3	2		3	0	3	3		
	FP*	0	0	0	0	0		0	0	0	0		
Selective: II	Correct	27	29	25	25	24	26	24	26	27	27	26	M = 29.86 SD 0.38 FP 0.14 SD 0.38
	Error	3	1	5	5	6		6	4	3	3		
	FP*	0	0	0	0	0		0	0	0	0		
Alternating: II	Correct	27	27	28	26	29	27.4	28	29	29	29	28.75	M = 26.86 SD 6.72 FP 2.57 SD 5.97
	Error	3	3	2	4	1		2	1	1	1		
	FP*	0	1	0	0	0		0	0	0	0		
	Switch error**	0	0	0	0	0		1	0	0	0		
Divided II	Correct	17	24	26	20	20	21.4	23	23	21	24	22.75	NA
	Error	13	6	4	10	10		7	7	9	6		
	FP*	2	1	0	1	1		1	0	0	0		

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

Visual attention. Individual task scores for visual attention performance are presented in Table 8. RAPT scores for all visual attention tasks showed very little difference in the number of correct responses between baseline and outcome conditions. For Sustained attention the mean number of correct responses was 27.8 for the baseline, compared to 27 for the outcome. The baseline mean for Selective attention was 56.6, compared to the outcome mean of 58. For Alternating attention, the baseline mean was 29.4, compared to the outcome mean of 30.0. The lowest outcome score (25) occurred in

sustained attention, while a score of 30 correct responses was maintained in all alternating attention outcome trials. Except for Sustained attention, outcome scores showed more stability of performance compared to baseline. No FPs occurred in either baseline or outcome for all three tasks. Except for the slight mean increase of 1.4 correct responses in selective attention, there was no evidence of increased performance for this subject in the above mentioned three areas of visual attention.

Scores for the visual component of the Divided Attention task showed an increase in the number of correct responses from baseline (M=18.8) to outcome (M=23.25). Similar to other tasks, the divided attention task also showed more stability in outcome performance compared to baseline. This observation was confirmed by the absence of FPs in the last three outcome trials of this task.

Table 8. RAPT - Visual Attention Scores for Subject 02.

Task Level	Date	Baseline					Avg	Outcome				Ave	Norm. Values
		3/6	3/8	3/9	3/10	3/11		4/7	5/5	5/26	6/24		
Sustained: II	Correct Error FP*	27 3 0	28 2 0	30 0 0	27 3 0	27 3 0	27.8	27 3 0	27 3 0	29 1 0	25 5 0	27	M = 29 SD 1.53 FP 0.00 SD 0.00
Selective: II	Correct Error FP*	55 5 0	57 3 0	57 3 0	56 4 0	58 2 0	56.6	57 3 0	58 2 0	58 2 0	59 1 0	58	M = 58.2 SD 2.13 FP 0.00 SD 0.00
Alternating: II	Correct Error FP* Switch error**	29 1 0 0	30 0 0 0	30 0 0 0	29 1 0 0	29 1 0 0	29.4	30 0 0 0	30 0 0 0	30 0 0 0	30 0 0 0	30	M = 25.14 SD 7.17 FP 2.43 SD 4.15
Divided II	Correct Error FP*	5 25 2	25 5 7	29 11 5	15 5 1	20 10 2	18.8	19 11 1	23 7 0	25 5 0	26 4 0	23.25	NA

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

The baseline mean time score for visual sustained attention was 185.2 s, compared to the outcome mean of 98.25 s, showing a mean reduction of 86.95 s. The baseline mean time score for selective attention was 47.8 s, compared to a mean outcome score of 50 s, showing a slight increase of 2 s in outcome. This loss of time in outcome cancels the 1.4 mean increase in correct responses mentioned earlier. Alternating attention baseline mean was 70.2 s compared to the outcome mean of 42.60 s. The means for divided attention were 183 s and 173 s for baseline and outcome, respectively.

The rate of response scores showed no evidence of increase in visual selective attention. There was evidence of an increase in rate of response for visual sustained, alternating, and divided attention, as shown in Figures 5-8.

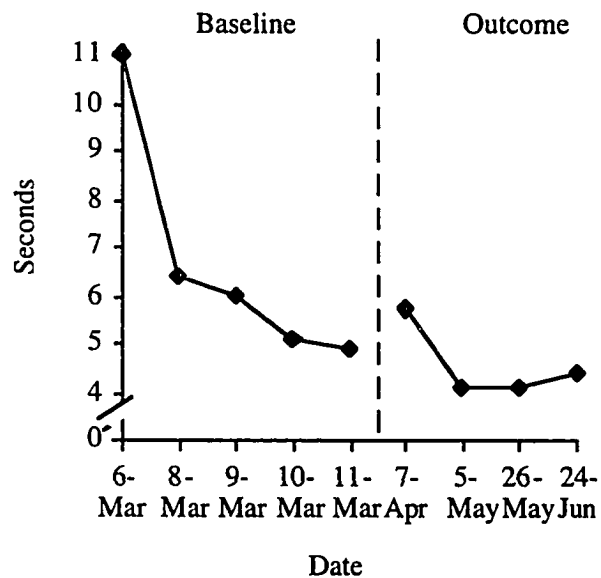


Figure 5. Subject 02 - R APT Visual Sustained Attention Level II, Rate of Response

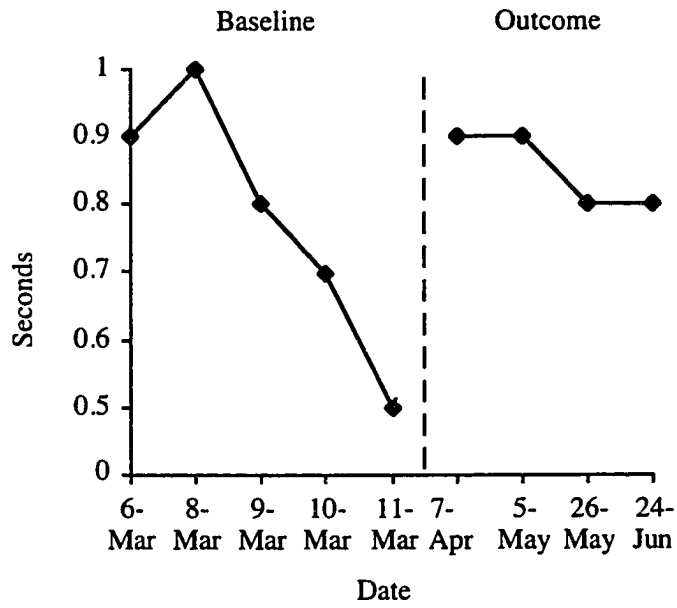


Figure 6. Subject 02 RAPT - Visual Selective Attention Level II, Rate of Response

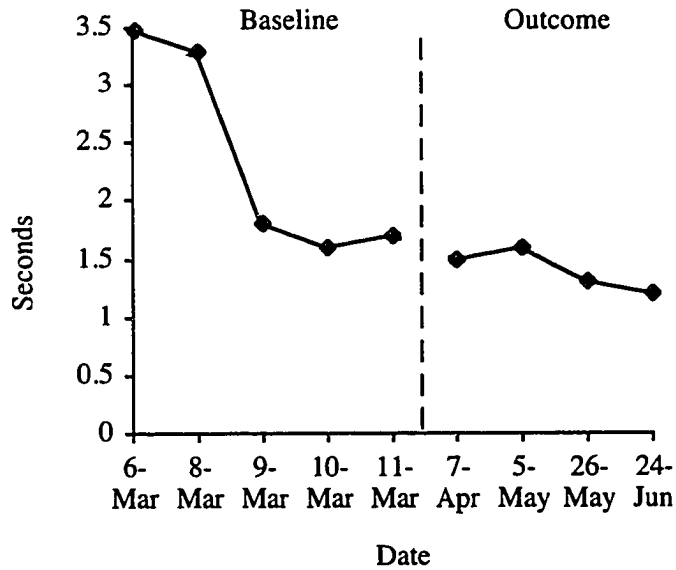


Figure 7. Subject 02 - RAPT Visual Alternating Attention Level II, Rate of Response

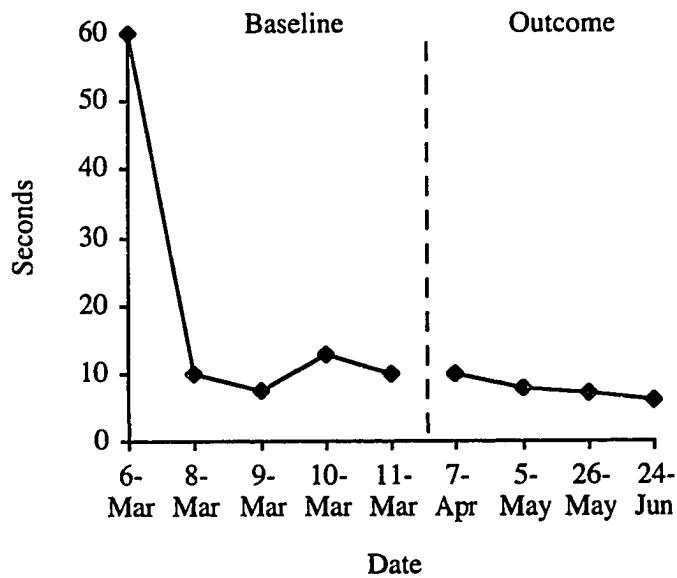


Figure 8. Subject 02 - RAPT Divided Attention Rate of Level II, Rate of Response

Summary. Auditory attention mean scores showed slight increases in alternating and divided attention tasks. No increase occurred in selective attention. Sustained attention performance showed outcome scores that were lower than those of the baseline. Similar to auditory attention, visual sustained attention showed no increase in the mean number of correct responses for the outcome. Slight increases are seen in the mean scores for Selective and Alternating attention tasks. The highest mean increase for visual attention occurred in divided attention. Scores combining the number of correct responses and time showed a general increase in visual attention performance for this subject. The appearance of steadier scores in outcome, accompanied by a reduction of errors in some areas, were suggestive of increased performance attributable to APT. The differences between divided and sustained attention performances may suggest selectivity of the training effect.

Modality specificity. Examination of RAPT data for modality specificity showed no specific effects on outcome for either auditory or visual attention training for subject 02.

Subject 03. History. Medical records for this 38-year-old woman were reportedly lost by the hospital that examined her following the automobile accident. The subject reports having sustained a hairline fracture to her skull and first four cervical vertebrae when her stationary car was hit from behind by another car that was hit by a truck. She suffered a brief loss of consciousness at the time of the impact but recovered soon enough to let herself out before the medical team arrived. The subject reports having undergone medical examination including X-ray checks. However, because of absence of records it was not possible to obtain the details of medical findings pertaining to brain injury for this subject.

Earlier accidents included being dropped by a sister as a baby, and being hit with a baseball bat on the head at a school game. She was admitted to the study 7 years and 10 months post-injury. At this time, she described her problems as: inability to organize ideas, poor understanding of instructions and written material, lack of progress in school resulting from poor memory; lethargy especially in housekeeping which she attributed to depression. She also expressed concern about her inability to focus on a topic in a discussion, frequently drifting into irrelevant issues.

The subject completed an Associate of Arts community college degree after a high school diploma. Her ental inabilities became obvious after she enrolled in a community college program in 1993. She was currently not studying, unemployed, and living alone. Previous medications included Prozac 40 mg/day on and off in the past 5 years, but none at the time of the study. She had no previous formal attention training. In the last 3 weeks

of the study, the subject was on prescribed Meclizine (Diazepam) 12.5 mg, two tablets three times a day, for complaints of dizziness.

RAPT Data. Data collection on RAPT consisted of 4 baseline and 4 outcome trials. Training for this subject commenced with auditory attention (phases A1 and A2), followed by visual attention (phases B1 and B2). The numbers of correct responses obtained in individual trials are shown in Tables 9 and 10 for auditory and visual performance, respectively.

Auditory attention. Individual task scores for auditory attention performance appear in Table 9. For Sustained Attention Level I, a mean of 30 correct responses was obtained for both baseline and outcome. One FP each occurred in trials 2 and 4. No FPs occurred in all of the four outcome trials. For Sustained Attention Level II, the baseline mean was 29.25 correct responses, compared to the outcome mean of 30 correct responses. One FP occurred in trial 4. No FPs occurred in any of the outcome trials. For Selective Attention Level II, the baseline mean was 30 correct responses, compared to an outcome mean of 29.75. No FPs occurred in all baseline and outcome trials. For Alternating Attention Level II, the baseline mean for correct responses was 26 compared to 25.25 correct responses for the outcome. Ten FPs occurred in baseline trial 1; one FP each occurred in trials 1 and 2. Four FPs and one switch error occurred in trial 3. For auditory Divided Attention Level II, the baseline mean for correct responses was 25 compared to the outcome mean of 23.5. In trials 2 and 3 of the baseline, one and two FPs occurred, respectively, and one FP occurred in trial 2 of the outcome.

The complete elimination of the single errors and FPs in outcome trials for the two levels of Sustained Attention suggested some increase in performance in this area. In

contrast, outcome scores for auditory Alternating and Divided attention show mean decreases of .75 and 1.5 correct responses, respectively. Since no errors occurred in all Selective Attention Level-II baseline trials, the occurrence of a single error in outcome trial 1 was thought to be a chance occurrence, not a reflection of ability. Based on the number of correct responses, there was no evidence of increase in performance for all levels of auditory attention for this subject.

Table 9. RAPT - Auditory Attention Scores for Subject 03.

Task Level	Date	Baseline				Avg	Outcome				Avg	Norm. Values
		3/6	3/7	3/8	3/9		4/3	4/26	5/24	6/27		
Sustained: I	Correct	30	30	30	30	30	30	30	30	30	30	M = 30 SD 0.00 FP 0.14 SD 0.38
	Error	0	0	0	0		0	0	0	0		
	FP*	0	1	0	1		0	0	0	0		
Sustained: II	Correct	29	29	30	29	29.25	30	30	30	30	30	M = 30 SD 0.00 FP 0.00 SD 0.00
	Error	1	1	0	1		0	0	0	0		
	FP*	0	0	0	1		0	0	0	0		
Selective: II	Correct	30	30	30	30	30	29	30	30	30	29.75	M = 29.86 SD 0.38 FP 0.14 SD 0.38
	Error	0	0	0	0		0	0	0	0		
	FP*	0	0	0	0		0	0	0	0		
Alternating: II	Correct	15	29	30	30	26	18	28	26	29	25.25	M = 26.86 SD 6.72 FP 2.57 SD 5.97
	Error	15	1	0	0		12	2	4	1		
	FP*	10	0	0	0		0	0	0	0		
	Switch error**	0	0	0	1		0	0	1	0		
Divided II	Correct	21	26	26	28	25	18	22	29	25	23.5	NA
	Error	9	4	2	2		12	7	1	5		
	FP*	0	1	2	0		0	1	0	0		

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

Visual attention. Individual task scores for visual attention performance are presented in Table 10. For subject 03, the baseline mean numbers of correct responses in visual Sustained, Selective, and Alternating attention tasks were 27.75, 58.25, and 29.5, respectively, compared to the outcome means of 28.25, 59.25, and 29.75, respectively. No FPs occurred in both baseline and outcome trials. Except for Selective attention, these scores showed no increase from baseline to outcome. Scores for the Divided Attention task showed an increase in the number of correct responses from baseline (M=12.0) to outcome (M=16.75). Similar to subject 02, a more substantial increase (4.75) in the number of correct responses occurred in the Divided Attention task.

Table 10. RAPT - Visual Attention Scores for Subject 03.

Task Level	Date	Baseline				Avg	Outcome				Avg	Norm. Values
		3/6	3/7	3/8	3/9		4/3	4/26	5/24	6/27		
Sustained: II	Correct Error FP*	27 3 0	28 2 0	27 3 0	29 1 0	27.75	29 1 0	29 1 0	28 2 0	27 3 0	28.25	M = 29 SD 1.53 FP 0.00 SD 0.00
Selective: II	Correct Error FP*	57 3 0	58 2 0	58 2 0	60 0 0	58.25	59 0 0	59 1 0	59 1 0	60 0 0	59.25	M = 58.28 SD 2.13 FP 0.0 SD 0.00
Alternating: II	Correct Error FP* Switch error**	30 0 0 0	29 1 0 0	29 1 0 0	30 0 0 0	29.50	30 0 0 0	29 0 0 1	30 0 0 0	30 0 0 0	29.75	M = 25.14 SD 7.17 FP 2.43 SD 4.15
Divided II	Correct Error FP	2 28 5	14 16 1	19 11 2	20 10 4	12.00	12 18 0	22 8 2	21 9 3	19 11 2	16.75	NA

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

The following mean time scores were recorded for this subject: Sustained attention, baseline mean, 223.50 s, outcome mean, 235.25 s; Selective attention, baseline mean, 63.75 s, outcome mean, 104.75 s; Alternating attention, baseline mean 54.5 s, outcome mean 52.25 s; Divided attention, baseline mean, 184.50 s, outcome mean 178.75 s. There was a reduction in time (11.75 s) for the Sustained attention task, and an increase in time for the Selective attention task, similar to subject 02. Time reductions for Alternating and Divided attention tasks were 2.25 s and 5.75 s, respectively. No FPs occurred in the other areas of visual attention (both baseline and outcome), and the FP mean was reduced from 3 (baseline) to 1.75 outcome.

Mean rate of response for sustained attention was 8.06 s at baseline, compared to an outcome score of 8.32 s. For visual selective attention, the mean score was 1.1 s at baseline compared to 1.77 s for outcome. For alternating attention, the mean rate was 1.83 s compared to 1.88 s for outcome.

Summary. For auditory attention, this subject obtained total or near total scores in baseline trials for Sustained and Selective attention tasks. On the other hand, auditory outcome scores for alternating and divided attention showed a mean decrease of .75 and 1.5 correct responses, respectively, compared to the baseline. For visual attention, outcome scores showed no substantial increase in number of correct responses. Time scores showed that there was a time loss of 11.75 s for sustained attention, 38.75 s for selective attention, and 2.25 s for alternating attention. Figures 9-11 show individual rate of responses for these visual tasks respectively.

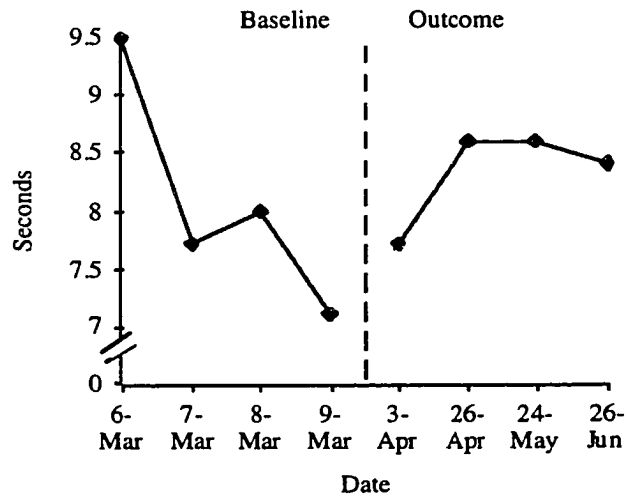


Figure 9. Subject 03 - RAPT Visual Sustained Attention Level II, Rate of Response

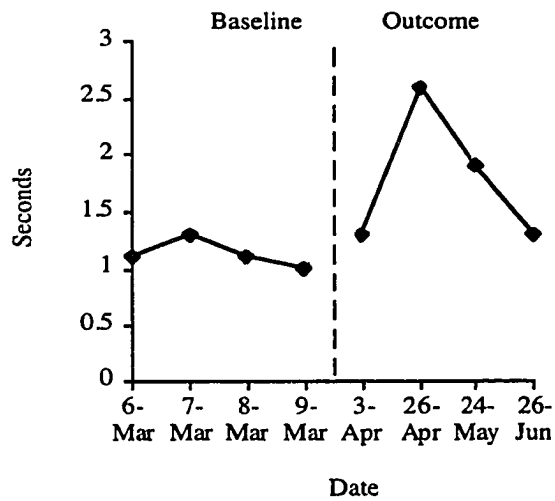


Figure 10. Subject 03 - RAPT Visual Selective Attention Level II, Rate of Response

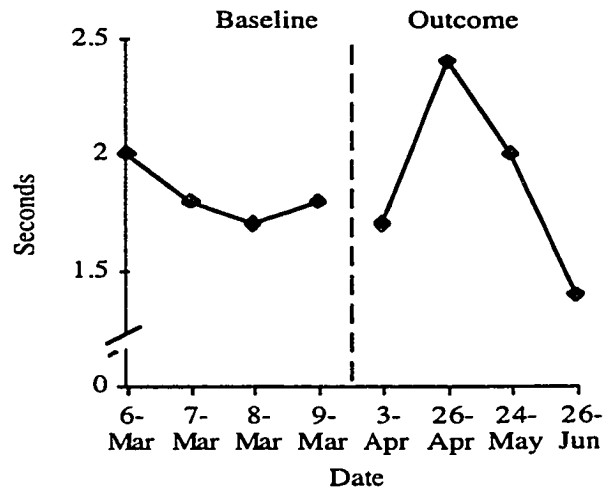


Figure 11. Subject 03 - RAPT Visual Alternating Attention Level II, Rate of Response

The Divided attention mean for time taken to complete the task showed a time gain of 5.75 s. Although individual rate of response scores showed erratic performance (see Figure 12) the mean rate of response for this task was 5.40 s at baseline, compared to 4.51 s for outcome, showing a gain of .89 s.

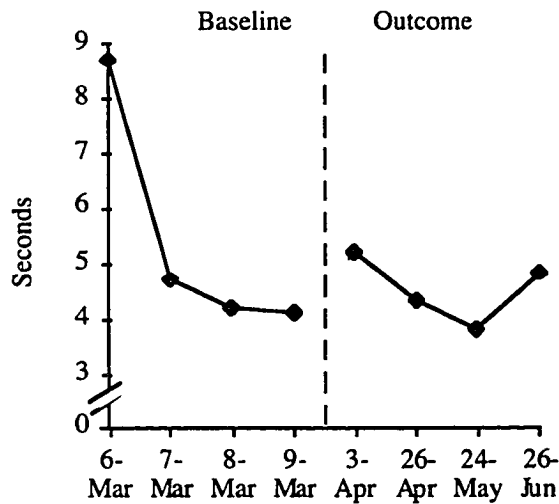


Figure 12. Subject 03 - RAPT Divided Attention Level II, Rate of Response

In summary, no increase occurred in auditory attention for this subject. Increased performance occurred in visual divided attention, as indicated by the rate of response scores. These findings suggest the possibility of selective effects of the APT.

Modality specificity. Comparison of data to assess specificity effects for auditory and visual training showed no evidence of specific effects for either auditory or visual attention training. However, auditory alternating attention scores were higher for this subject following visual attention training.

Subject 04. History. This 27-year-old male diagnosed with TBI was riding a motorcycle traveling at approximately 30 mph and wearing a helmet when he was hit by a car traveling in the opposite direction. He reports that the driver of the car turned left directly in front of him. He tried to bank away, but the front of his motorcycle caught the back of the car and flipped him and the motorcycle over to his left side. He was flung from the motorcycle and hit the pavement, first with his hands, then shoulders, and the side of his head. He was dazed for approximately 30-45 s, and remained in the line of traffic although he realized that was inappropriate. The motorcycle was totaled. Although the police and ambulance came to the scene, he declined hospitalization because he did not think he was seriously injured. He was referred for a neuropsychological evaluation by his naturopathic doctor three months after the accident.

According to the neuropsychologist's report he complained of various cognitive difficulties, including attention, concentration, memory, word-finding, and emotional control. He was found to present with significant cognitive strengths including sustained, alternating, and divided attention processes, visual perception and language skills, basic reading and arithmetic skills. He was able to learn novel information, both verbal and visual, retain this information over time, and recall it accurately. He was able to think abstractly, plan, problem-solve, sequence, and shift mental set. He did, however, present with a relatively severe deficit in selective attention on a task that required him to ignore background distraction. He also had difficulty on a test of reading that required speed. He was found to be severely impaired on a test of working memory that required him to hold information in his mind in the face of distraction. This report pointed out that there was some indication that the tests administered might not have been sensitive enough to detect the difficulties he was experiencing, as he performed many of them using spontaneous compensation strategies, such as verbal mediation, that typically are not necessary but

nonetheless allowed him to perform within normal limits.

On admission to the study (2 years and 3 months post-injury), this subject complained of having a lot of trouble concentrating in the presence of background noise or when his train of thought was interrupted, frequently losing track of what he was saying in a conversation; difficulty coordinating words to express his thoughts and writing his thoughts down; and difficulty falling asleep. He also experienced problems recalling day-to-day things.

Prior to injury the subject had been enrolled in college but he abandoned his program before his degree was completed. He reported having attended the gifted students program in middle school. Currently, he was working as a nursing assistant caring for the elderly and disabled. He was not on any medication presently, and had no previous formal attention training.

RAPT data. RAPT data was collected over three baseline and four outcome trials. Training for this subject commenced with visual attention (phases A1 and A2) followed by auditory attention (phases B1 and B2). The numbers of correct response obtained in individual trials are shown in Tables 11 and 12 for auditory and visual performance, respectively.

Auditory attention. For Auditory Sustained Attention Level I, the mean was 30 correct responses for both baseline and outcome. For Sustained Attention Level-II the baseline mean was 30 correct responses, compared to the outcome mean of 29.25. Two FPs occurred in outcome trial 3. It was noted that the subject became drowsy during this task. Considering that a score of 30 correct responses and no FPs were recorded for all other outcome trials, including baseline, the decreased performance in outcome trial 3 was

assumed to be due to drowsiness rather than the subject's cognitive ability. For auditory Selective Attention, the baseline mean of 30 correct responses was obtained in all trials. The outcome mean was 29.75 correct responses. One FP occurred on each of the outcome trials. All FPs occurred in the latter part of the task, and twice at exactly the same spot on the task sheet.

For auditory Alternating Attention, the baseline mean was 30 correct responses compared to the outcome mean of 26.25. One switch error occurred on outcome trial 3, and one FP occurred on outcome trial 4. Nine targets were lost on trial 4 when, due to fatigue, the subject requested to discontinue the task.

For the Auditory component of the Divided attention task, a baseline mean of 24.3 correct responses was obtained, compared to the outcome mean of 26.5. Two FPs each occurred on trials 1, 2, and 3 of the baseline. Two and one FPs occurred on outcome trials 1 and 3, respectively.

Except for one error in outcome trial 3, auditory Sustained Attention Level-II, both baseline and outcome reflected a persistent score of 30 correct responses, and zero FPs for this subject. Since the decrease in outcome trial 3 was assumed to have been a result of drowsiness on the part of the part of the subject, it was not possible to determine a change for this subject based on this test. Similarly, total absence of errors and FPs in all Alternating Attention baseline trials made it impossible to determine change in this area. The persistent occurrence of one FP in all Selective Attention outcome trials, compared to zero FPs in the baseline condition (though fatigue is thought to have played a role) suggested no increase in performance in this task. In summary, the RAPT data showed no evidence of an increase in auditory attention performance for subject 04.

Table 11. RAPT - Auditory Attention Scores for Subject 04.

Task Level	Date	Baseline			Avg	Outcome				Avg	Norm. Values
		3/17	3/21	3/22		4/11	5/4	6/6	7/3		
Sustained: I	Correct Error FP*	30 0 0	30 0 0	30 0 0	30	30 0 0	30 0 0	30 0 0	30	M = 30.00 SD 0.00 FP 0.00 SD 0.00	
Sustained: II	Correct Error FP*	30 0 0	30 0 0	30 0 0	30	30 0 0	30 0 0	27 0 0	30	29.25 M = 30.00 SD 1.15 FP 0.00 SD 0.00	
Selective: II	Correct Error FP*	30 0 0	30 0 0	30 0 0	30	30 0 0	30 0 0	29 1 1	30	29.75 M = 30.00 SD 0.00 FP 0.00 SD 0.00	
Alternating: II	Correct Error FP* Switch error**	15 15 0 0	29 1 1 0	30 0 0	30	18 12 0 0	28 2 0 0	26 4 0 1	29	26.25 M = 28.67 SD 1.15 FP 1.33 SD 1.15	
Divided: II	Correct Error FP*	20 10 3	28 2 1	25 5 2	24.3	25 5 2	26 4 0	27 3 1	28	26.25 NA	

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

Visual attention. Individual task scores for visual attention performance appear in Table 12. For visual Selective and Alternating attention, a total of 30 correct responses was maintained on both baseline and outcome scores. For Sustained attention, one error each occurred in baseline trial 1, and outcome trials 1 and 2. No FPs occurred in all of the above tasks. Thus, there was essentially no difference in performance between baseline and outcome. Baseline mean time scores for visual Sustained, Selective, and Alternating

attention showed baseline scores of 208, 80, and 46 s, respectively, compared to outcome mean scores of 208, 60, and 39 s, respectively. These findings together suggested no evidence of increased performance for this subject in these areas of attention.

The baseline mean of 18.67 correct responses and the outcome mean of 20.5 for the visual component of Divided Attention showed an average outcome increase of 1.83 correct responses above baseline. Similar to auditory Alternating Attention task, the lowest number of correct responses for this task occurred in outcome trial 4, the task which was discontinued at the subject's request. Outcome scores also showed a steady occurrence of two FPs on each of the outcome trials, as against 5, 3, and 1 FPs, respectively, on baseline trials 1-3. Although practice effect cannot be ruled out, the fact that the two FPs occurred on lines 8 and 16, 9 and 17, 9 and 17, and 11 and 16 of the task sheet on trials 1 to 4, respectively, was considered to suggest signs of steady improvement in attention span for this subject.

Table 12. RAPT - Visual Attention Scores for Subject 04.

Task Level	Date	Baseline			Avg	Outcome				Avg	Norm. Values
		3/17	3/21	3/22		4/11	5/4	6/6	7/3		
Sustained: II	Correct	29	30	30	29.67	29	29	30	30	29.5	M = 28.33 SD 2.08 FP 0.00 SD 0.00
	Error	1	0	0		1	1	0	0		
	FP*	0	0	0		0	0	0	0		
Selective: II	Correct	60	60	60	60	60	60	60	60	60	M = 59.67 SD 0.58 FP 0.00 SD 0.00
	Error	0	0	0		0	0	0	0		
	FP*	0	0	0		0	0	0	0		
Alternating: II	Correct	30	30	30	30	30	30	30	30	30	M = 29.33 SD 0.58 FP 0.00 SD 0.00
	Error	0	0	0		0	0	0	0		
	FP*	0	0	0		0	0	0	0		
	Switch error**	0	0	0		0	0	0	0		
Divided: II	Correct	19	19	18	18.67	21	21	23	17	20.5	N/A
	Error	11	11	12		9	9	7	13		
	FP*	5	2	1		2	2	2	2		

* FP = false positive responses.

** Switch errors occur in alternating attention tasks only, due to incorrect switching or failure to switch.

The baseline mean time for task completion in visual sustained attention was 208 s compared to 242 s for the outcome. For selective attention the baseline mean was 60.0 s compared to 80.0 s for the outcome. The mean time for alternating attention was 39 s compared to the outcome mean of 46 s. The baseline mean time for divided attention was 164.30 s compared to 185 s for the outcome.

The baseline mean rate of response scores for visual sustained, selective, and alternating attention tasks were 7.0, 1.0, and 1.3 s, respectively, compared to 7.8, 1.3, and 1.53 s for outcome, thus showing a loss of time for all three levels. Figures 13-15 show individual rate of response scores for these visual attention levels.

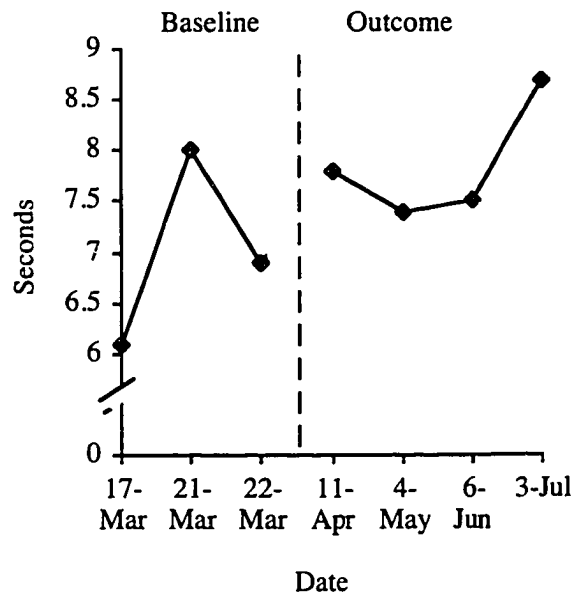


Figure 13. Subject 04 - RAPT Visual Sustained Attention Level II, Rate of Response

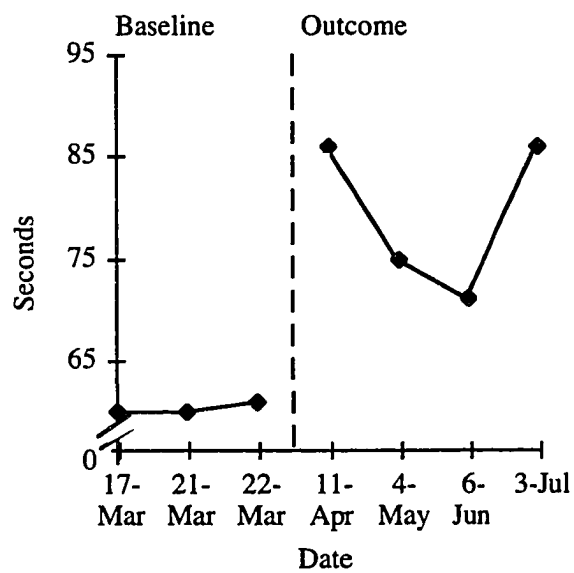


Figure 14. Subject 04 - RAPT Visual Selective Attention Level II, Task Completion Time

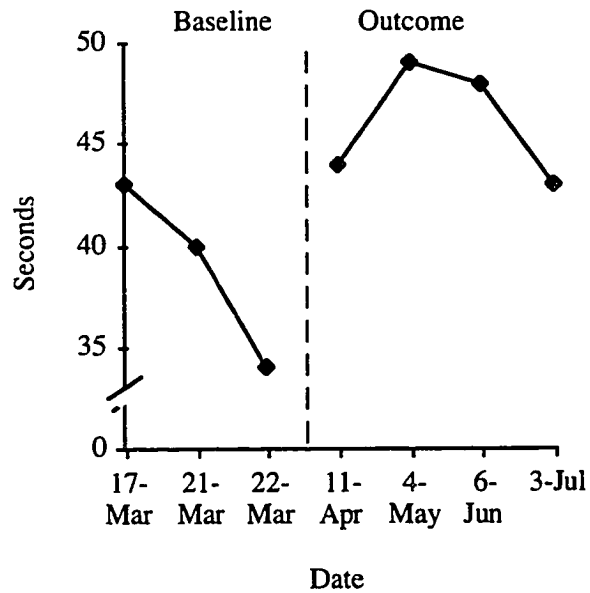


Figure 15. Subject 04 - RAPT Visual Alternating Attention Level II, Task Completion Time

For Divided attention, the baseline mean time taken for task completion was 164.30 s, compared to the outcome mean of 185 s. Although these scores show a mean time loss of 20.7 s on this task, the rate of response scores (baseline, 4.37 s; outcome, 4.19 s) indicated a mean reduction of .18 s per correct response on outcome trials. Figure 16 shows a steady gain in individual rate of response scores over the first three trials.

Based on these considerations, findings on the RAPT suggested an increase only in divided attention for subject 04.

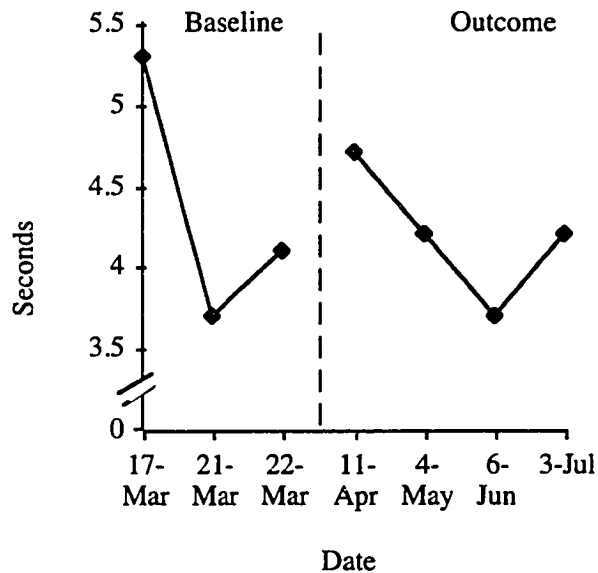


Figure 16. Subject 04 - RAPT Divided Attention Level II, Rate of Response

Modality specificity. Based on this subject's performance, a comparison of data to assess specificity effects for auditory and visual training showed no evidence of specific effects for either auditory or visual attention training.

Summary on RAPT. For auditory Sustained Attention Levels I and II, there was no evidence of increased performance for any of the four subjects. Based on time scores, an increase in visual Sustained Attention Level II is suggested for subjects 02 and 03. Similarly, there was no evidence of increased performance following APT for auditory Selective Attention for all subjects. In the case of subjects 01, 03, and 04, lack of this evidence is mainly due to total scores being obtained in the baseline condition. In the case of subject 02, lack of evidence was due to failure to reduce errors effectively. For visual Selective attention, evidence of increased performance was suggested based on task

completion mean time and rate of responses. Time scores for this task showed loss of time for subjects 02, 03, and 04. Except for subject 02, no evidence of increased attention performance was found in Alternating attention following APT. In the case of subject 02, this increase was observed in visual performance and in the reduction of omission errors on auditory performance. For the remaining subjects, auditory performance was affected by switch errors, rather than omissions, while visual performance was affected by loss of time. The RAPT Divided Attention data based on the rate of response was consistent in suggesting increased performance for all subjects.

Although individual effects were noted, the above findings suggested that RAPT tools used to assess performance in sustained, selective, and alternating attention were not sensitive to the attention deficits experienced by the current sample. The opposite may be said of the divided attention tools with respect to this sample. Finally, no evidence of specificity effects for either modality was found.

The Paced Auditory Serial-Addition Task

To determine an increase in auditory attention performance, three parameters based on the PASAT were considered. These were the total number of correct responses per trial, mean rates of responses per trial, and mean rate of response per paced task. In evaluating outcome scores, any increase in rate of response of at least .10 s above baseline was interpreted to reflect an increase in performance.

Definition of parameters of measurement. The total number of correct responses per trial was the sum total of correct responses obtained in all four PASAT tasks, each with a possible total of 60 correct responses.

The mean rate of responses per trial was the sum of response rates for all four tasks, divided by 4, expressed in seconds, and reflecting the rate per response per trial, where a trial involved all four PASAT tasks.

The mean rate of response per task was the mean, expressed in seconds, reflecting the rate of response per PASAT task, obtained by adding together X number of rates in a specific PASAT task and dividing the sum by X.

Subject 01. Six baseline and two outcome PASAT scores were obtained and analyzed for this subject. Out of a possible total of 240 correct responses per trial, baseline scores were 159, 206, 218, 216, 221, and 227 for trials 1 to 6, respectively. Outcome scores were 229 and 221 for trials 1 and 2, respectively. Comparison of the outcome (M=225) with the baseline (M=208) showed an increase of 17 points in the number of correct responses.

Baseline mean rates of response in s over trials 1 to 6 were 2.68, 2.1, 1.95, 2.0, 1.95, and 1.88, respectively, compared to outcome mean rates of 1.88 s and 1.93 s (see Figure 17). A comparison of scores showed an average increase of .2 s between baseline (M=2.1 s) and outcome (M=1.91 s). Based on the PASAT norm (2.6 s, SD =.25, Spreen & Strauss, 1991) for the study sample, this subject's rate of information processing remained in the 100th percentile at both baseline and outcome assessment times.

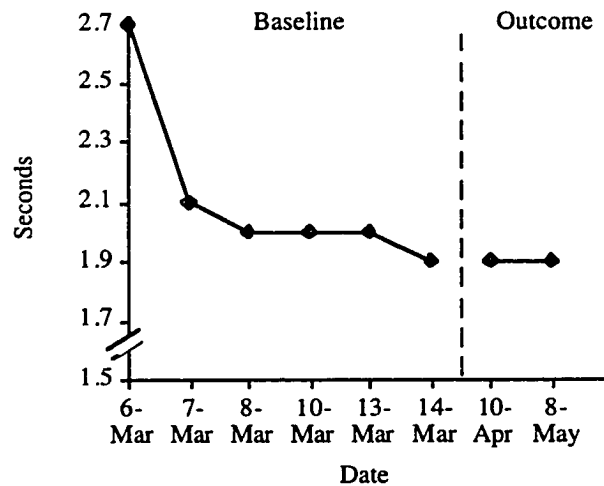


Figure 17. Subject 01 - PASAT Mean Rates of Response, Across Tasks

Baseline mean rate scores per individual task were 2.66, 2.3, 1.72, and 1.56 s, compared to outcome scores of 2.4, 2.05, 1.7, and 1.45 for the 2.4-, 2.0-, 1.6-, and 1.2-s tasks, respectively. Comparison between baseline and outcome showed increased performance in the 2.4-s, 2.0-s, and 1.2-s paced tasks.

In summary, findings on the PASAT suggested evidence of increased performance in auditory attention for this subject following APT.

Modality specificity. Since the subject dropped out of the study after only two outcome trials, it was not possible to determine specificity effects for auditory training on auditory attention performance based on the available data.

Subject 02. Five baseline and four outcome PASAT scores were analyzed for this subject. Out of a possible total of 240 correct responses per trial, baseline scores were

135, 135, 127, 130, and 113 for trials 1 to 5, respectively. Outcome scores were 131, 135, 119, and 134 for trials 1 to 4, respectively. Although none of the outcome scores was higher than the highest baseline score, the mean outcome score (129.75) showed an increase of 1.75 correct responses above baseline ($M=128$).

Baseline rates of response in s over trials 1 to 5 were 3.15, 3.15, 3.48, 3.3, and 3.93, respectively, compared to outcome rates of 3.25, 3.18, 3.63 and 3.23 s, respectively (see Figure 18). A comparison of the baseline ($M=3.4$ s) and outcome ($M= 3.32$ s) showed no evidence of increase in the mean rate of responses across tasks. The rate of responses per individual paced task showed increases in the 2.4-s and the 1.2-s paced tasks.

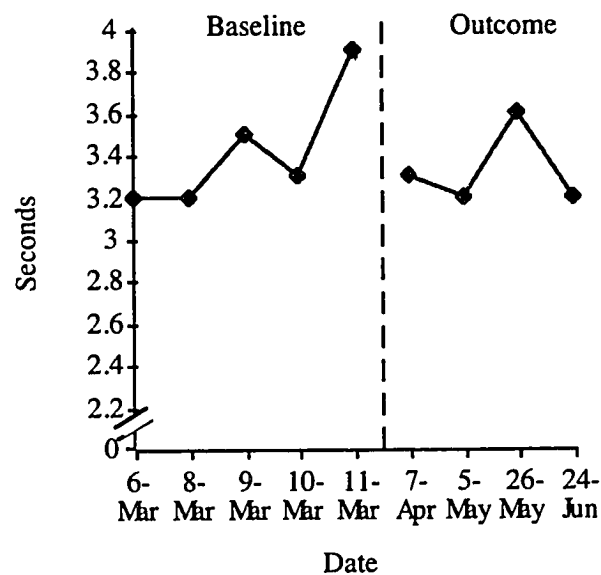


Figure 18. Subject 02 - PASAT Mean Rates of Response, Across Tasks

In summary, findings on the PASAT suggested increases in the total number of correct responses and in two paced tasks, but no evidence of increase in rate of responses

across tasks for this subject following APT.

Modality specificity. Based on the four PASAT outcome trials, there was no evidence of specificity effects for auditory training on auditory attention performance for this subject following APT.

Subject 03. Four baseline and four outcome PASAT scores were obtained and analyzed for this subject. Out of a possible total of 240 correct responses per trial, baseline scores were 118, 131, 149, and 148 for trials 1 to 4, respectively ($M=136.5$). Outcome scores were 123, 168, 140, and 140, respectively ($M=142.75$). These scores showed a mean increase of 6.75 correct responses in outcome, suggesting an increase of performance for subject 03 following APT.

Baseline mean rates of response per trial were 3.63, 3.33, 2.18, and 2.93 s, respectively ($M=3.21$ s). Outcome mean rates were 3.9, 2.56, 3.2, and 3.18 s, respectively ($M=3.21$ s) (see Figure 19). Because of equal baseline and outcome means, the PASAT rate of response scores suggested no increase of performance for this subject.

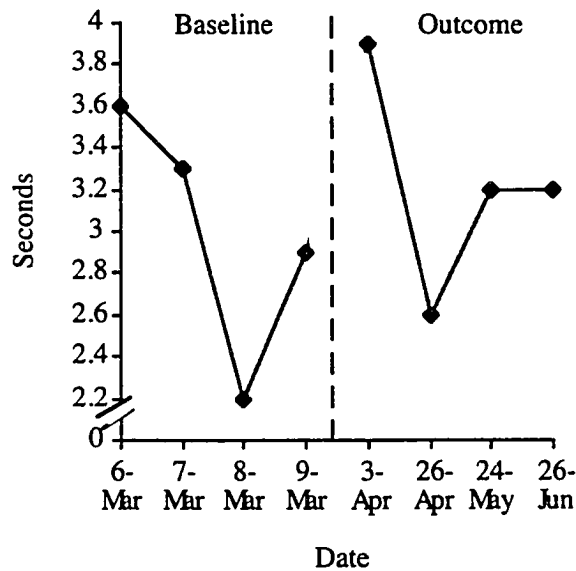


Figure 19. Subject 03 - PASAT Mean Rates of Response, Across Tasks

The baseline mean rates of response per task were 3.25, 3.35, 3.15, and 3.31 s for the 2.4-, 2.0-, 1.6-, and 1.2-s interval tasks, respectively. Outcome scores were 3.43, 2.78, 2.91, and 3.71 s, respectively. A comparison of baseline and outcome rates showed an increase in the 2.0-s and 1.6-s interval tasks.

These findings suggested an increase in the total number of correct responses, the mean rate scores for the 2.0-s and the 1.6-s interval tasks, and no increase in the rate of response scores per trial. Thus, in summary, findings suggest increased auditory attention performance only in selected tasks of the PASAT for subject 03.

Modality specificity. Based on the four PASAT outcome scores, there was no evidence of specificity effects for auditory training on auditory attention performance for this subject following APT.

Subject 04. Three baseline and four outcome PASAT scores were obtained and analyzed for subject 04. Out of a possible total of 240 correct responses per trial, baseline scores were 134, 150, and 159 for trials 1 to 3, respectively. Outcome scores were 191, 174, 181, and 156, respectively. Comparison of outcome scores ($M=175$) with baseline scores ($M=147.7$) showed that three of the four outcome scores remained 15-32 points above the highest baseline score. The lower score in outcome trial 4 appeared to be in line with the subject's performance on other tests on that day. The increase in the PASAT total number of correct responses was suggestive of increased auditory attention performance for this subject.

Baseline mean rates of response over three trials were 3.35, 2.95, and 2.75 s, respectively ($M=3.0$ s). Outcome mean rates were 2.28, 2.48, 2.38, and 2.73 s, respectively ($M=2.47$ s) (see Figure 20). These scores showed an average rate increase of 0.53 s over baseline.

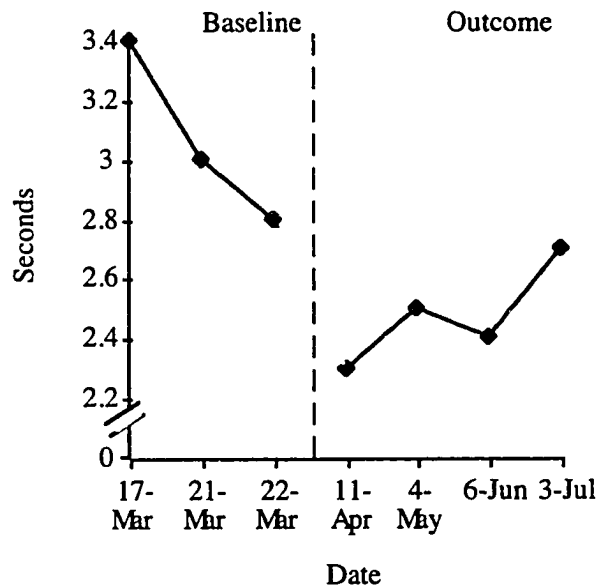


Figure 20. Subject 04 - PASAT Mean Rates of Response, Across Tasks

Baseline means for rate of responses per individual task were 2.86, 3.36, 2.7, and 3.1 s for the 2.4-, 2.0-, 1.6- and 1.2-s tasks, respectively. Outcome scores were 2.7, 2.45, 2.33, and 2.38 s, respectively. These scores showed variable increases above baseline in all four paced tasks, with the highest increase (.91 s) occurring in the 2.0-s task.

For this subject, scores on the PASAT show increased performance on the total number of correct responses per trial, the mean rate of responses per trial, and the mean rate per individual task. In summary, there was evidence of increased performance in auditory attention for subject 04 following APT.

Modality specificity. A comparison of outcome scores to determine specific effects of auditory training on auditory attention suggested no evidence of specific effects. However, there was a tendency for higher scores for this subject following visual training

versus following auditory training. This tendency was observed more in the total number of correct responses than in the mean rate scores.

Summary on PASAT. Findings on the PASAT suggested increases in auditory attention performance for all four subjects in the study. For subject 01 (two outcome trials) and subject 04, increases occurred in all three measures considered for this analysis. For subjects 02 and 03, this increase is reflected in the total number of correct responses and in selected PASAT tasks. There was no evidence of specific effects for auditory attention training on auditory attention performance. However, findings showed higher scores on the PASAT following visual attention for subject 04.

Digit Vigilance Test

Because the DVT was not administered during baseline assessment, only outcome data were available on this test. This situation precluded analysis of data based on comparison of baseline and outcome scores. Measures considered for analysis included total time for task completion and errors of omission. Scores given were based on single page performance.

Subject 01. For this subject, the DVT was administered twice only. Scores for total time to complete task were 109 s and 111 s for trials 1 and 2, respectively. Omission errors were 2 and 8, respectively, in the two trials. Both total time and error scores indicated a decrease in performance on trial 2 compared to trial 1. It was not possible to determine modality specificity for this subject based on only two scores.

Subject 02. The DVT was administered on all four outcome trials for this subject.

Scores for total time to complete task were 176, 176, 131, and 120 s for trials 1 to 4, respectively. Omission errors were 5, 21, 8, and 16 for trials 1 to 4, respectively.

The above scores showed an increase in errors on trial 2 and trial 4. In trial 2, completion time remained the same as for trial 1, but errors increased by more than four times. In trial 4, although time for completion was shorter by 32% compared to trial 1, the number of errors increased 69% above that for trial 1. Scores in trial 3 fell between those of trials 1 and 4. These findings indicated there was no actual increase in performance for this subject.

Subject 03. DVT data were obtained on all four outcome trials for this subject. Scores for total time to complete tasks were 198, 213, 234, and 229 s for trials 1 to 4, respectively. Omission errors at these trials were 8, 0, 5, and 2, respectively.

A comparison of scores between trial 1 and those obtained in the other three trials reflected the following findings: a time increase of 8% in trial 2 with a 100% reduction of 8 errors; a 20% increase in time in trial 3 with a 38% reduction of errors; and a 20% increase in time in trial 4 with a 75% reduction of errors. Findings on this test suggested a progressive increase in visual attention performance for this subject from trials 1 to 4.

Subject 04. DVT data was available on all four outcome trials for this subject. Scores for total time to complete task were 221, 240, 227, and 180 s for trials 1 to 4, respectively. Omission errors at these trials were 2, 5, 0, and 17, respectively.

These scores showed that both time and errors increased at trials 2. Although task completion time decreased at trial 4, a high percentage of errors occurred. A comparison of scores between trial 1 and the other three trials reflected: a time increase of 9% in trial 2 with an error increase of 250%; a time increase of 3% in trial 3 with a 100% reduction of

the two errors; and a time decrease of 19% for trial 4 with an error increase of 850% above trial 1.

Because of increases in completion time and errors in trial 2 and a high number of errors (grossly disproportionate to time reduction) at trial 4, the DVT data suggested no evidence of increased visual attention performance for this subject following APT.

Modality specificity. Comparison of interphase scores to determine specificity effects for visual training showed that for subject 02 many fewer errors occurred in trials following auditory training as opposed to visual training. For subject 03, outcome performance on the DVT was higher both times following visual training, suggesting some specific effect of visual training on visual performance. DVT scores for subject 04 remained substantially higher at both times following visual attention training than they did following both auditory training phases. This finding appeared to suggest specificity effects for visual attention training on visual attention performance for subjects 03 and 04.

Summary on DVT. Because of the absence of baseline scores for the DVT, it was not possible to determine increases on DVT performance that might be attributable to APT. A comparison of scores in outcome trial 1 with scores from subsequent DVT trials showed no evidence of increased visual attention performance, except in the case of subject 03. Analysis of data to determine specific effects of visual attention training on visual attention suggested evidence of specificity in two subjects (03 and 04). No common factor was found between these two subjects to account for the increase. In view of the latter finding, the possibility of visual attention specificity was extended to include subject 01 whose two trials showed higher scores following visual attention. For subject 02, no evidence of modality specificity was suggested.

Multiple Task Visual Attention Test

Like the DVT, the MTVAT was not administered during baseline assessment. To determine the increase in performance, scores obtained in trials subsequent to trial 1 of the MTVAT were each compared with trial 1 scores. To determine the increase in visual attention performance, two parameters of the MTVAT tasks, total time to complete task and number of errors (omissions and FPs), were considered.

Subject 01. This subject participated in two MTVAT trials only. Total times to complete task were 232 and 229 s for trials 1 and 2, respectively. The numbers of errors were 37 and 25, respectively. There was a reduction of 3 s in total time taken and a reduction of 12 errors in trial 2, suggesting an increase in visual attention performance between trial 1 and trial 2 times. Because of limited data, it is not known whether this trend would have continued in subsequent trials.

Subject 02. MTVAT data for this subject was obtained on four trials. Total times to complete task were 465, 338, 348, and 346 s for trials 1 to 4, respectively. Errors recorded were 11, 25, 11, and 18, respectively. Scores at trial 2 showed a reduction of 127 s (27%) from total time taken in trial 1 and an increase of 127.3% in errors. Trial 3 showed a time reduction of 117 s (25%) from total time taken in trial 1, with the same number (11) of errors as in trial 1. Trial 4 showed a time reduction of 119 s (26%) from total time taken in trial 1 and an increase of 64% in errors. Although increased performance was noted in trial 3, in trials 2 and 4 a reduction in time accompanied an increase in errors, indicating the possibility of a trade-off between time and errors, thus suggesting no evidence of an increase in MTVAT performance for this subject following

APT.

Subject 03. This subject participated in all four MTVAT trials. Total times taken to complete the task were 447, 531, 629, and 611 s for trials 1 to 4, respectively. The numbers of errors recorded on trials 1 to 4 were 65, 21, 11, and 14, respectively. Scores at trial 2 showed a time loss of 18.8% and an error reduction of 68% compared to trial 1. Scores at trial 3 showed a time loss of 41% and an error reduction of 83% compared to trial 1. Scores at trial 4 showed a time loss of 37% and an error reduction of 78%. The moderate loss in time accompanied by a disproportionately high percentage of error reduction appeared to suggest an increase in performance level. Time and error scores between trials 3 and 4 balanced each other, rendering performance equal at these two points. Based on these considerations, there was evidence suggesting increased performance on visual attention following APT.

Subject 04. Data for MTVAT was collected in four outcome trials for this subject. Performance scores for total time to complete the task were 404, 414, 376, and 354 s for trials 1 to 4, respectively. Numbers of errors were 25, 22, 25, and 26, respectively. Scores at trial 2 showed a time loss of 3.5%, with a reduction of 12% in errors compared to trial 1. Trial 3 showed a gain of 7% total time with no error reduction compared to trial 1. Trial 4 showed a 12% reduction in time and an error increase of 4% compared to trial 1. Except for trial 2, there was very little difference in the number of errors compared to trial 1. This factor coupled with a progressive reduction in task completion time was suggestive of increase in performance that might be attributed to APT.

Modality specificity. Based on the MTVAT data, there was no evidence of specificity effects for visual attention training on visual attention performance for subjects 02, 03, and 04. Due to the limited number of trials on the MTVAT, it was not possible to determine the specificity effects of visual attention training on visual attention performance for subject 01.

Summary on MTVAT. For two subjects (03 and 04), MTVAT scores showed a progressive increase in visual attention performance which was associated with APT. The possibility of increased performance based on MTVAT scores could not be completely ruled out in the case of subject 01. For subject 02 no evidence of increased performance was found. There was also no evidence suggesting specificity effects for visual attention training on visual attention performance for all subjects.

The California Verbal Learning Test

To answer the question "Does APT increase ability for recall and recognition of verbal material?" pre- and post-training CVLT scores were analyzed for (i) recall ability, (ii) learning characteristics, and (iii) target recognition. To assess recall ability, the following measures were considered: immediate free recall (total trials 1-5); Short-Delay free and cued recall; Long-Delay free and cued recall (20 min); and perseverations. To assess learning characteristics, Semantic Cluster Ratio, Slope, and Consistency of Item Recall from trial to trial were considered. Semantic clustering is a reflection of the extent to which a subject actively organizes verbal material according to shared semantic features. Slope reflects the increment in words recalled per trial over trials 1-5.

To assess recognition ability, Correct Target Recognitions and FPs were considered.

To assess increase in performance, pre- and post-training scores were compared. Analysis was done based on raw scores. Standard score equivalents of raw scores (based on age and sex of the subject) appear in brackets. Ratio scores reflect the position of observed scores in relation to the expected.

Subject 02. Recall measures. Out of a possible total of 90, total raw scores for immediate free recall (trials 1-5) were 49(32) and 39(17) on pre- and post-training assessments, respectively, indicating a decrease of 20%. Distal perseverations were 13 and 5, respectively, indicating a reduction of 61.5%. Scores for Short-Delay Free Recall were 10(-1) at both pre- and post-training times. For Short-Delay Cued Recall, scores were 11(-1) and 10(-1), respectively. Long-Delay Free Recall scores for both pre- training and post-training trials were 11(-1), and those for Long-Delay Cued Recall were 12(-1) and 13(-1), respectively.

Except for a decrease in perseverations, data on recall measures showed no evidence of an increase in performance. Since distal perseverations are a feature of attention or amnesic deficits (Delis et al., 1987; Lezak, 1995) the reduction observed in the post-training trial was interpreted to suggest a decrease in the degree of forgetting which might be associated with APT.

Learning characteristics. The pre-training Semantic Cluster Ratio was 3.1(+1), compared to 1.8(-1) post-training. Slope was +1.1(0) at both pre- and post-training trials. Consistency of item recall across trials 1-5 was 86% (0) and 76% (-1), respectively.

Except for the Slope, both Semantic Cluster Ratio and Consistency of Recall showed decline of performance from normal to below normal. The decline in Semantic Cluster Ratio was an indicator of the subject's use of less effective learning strategies at

the post-training trial. The decline in consistency recall suggests disorganized styles of learning, thus indicating the subject had difficulty formulating or maintaining an effective learning plan. Maintenance of Slope at +1.1, on the other hand, indicated the subject was capable of sizable increases in word recall from trial to trial at both times.

Target recognition. Low scores on Target Recognition observed at both pre- and post-training trials, 13(-2) and 12(-3), respectively, suggested poor encoding of verbal material. Absence of FPs in either trial suggested an ability by the subject to discriminate target from distractor items. In summary, although findings on the selected CVLT measures reflected no evidence of increased performance, the 61.5% reduction in distal perseverations suggested some increased performance in memory function for this subject following APT.

Subject 03. Recall measures. Total raw scores for this subject on immediate recall (trials 1-5) were 59(46) and 62(50) on pre- and post-training, respectively, showing an increase of 5.3%. Perseverations (all distal) increased from 1 at pre-training to 8 at post-training. Scores for Short-Delay Free Recall were 13(0) and 14(+1), respectively. Short-Delay Cued Recall scores were 15(+1) and 14(0), respectively. For Long-Delay Free Recall and Long-Delay Cued Recall, scores were 14(0) at both pre- and post-training trials.

Data on these measures suggested an increase of performance in Immediate Recall and Short-Delay Free Recall. Performance in Short-Delay Cued Recall decreased, but remained on a par with that of normal individuals. No changes were observed in Long-Delay Free Recall and Long-Delay Cued Recall, both of which ranked normal at the pre-training trial. The eightfold increase in the number of perseverations at the post-training

trial could not be accounted for.

Learning characteristics. The pre-training Semantic Cluster Ratio was 3.4(+1) compared to 3.1(+1) post-training. Slope was +1.2 (0) pre-training and +.9 (-1) post-training. Consistency of Item Recall across trials 1-5 remained at 85% (0) at both times.

These scores showed that the Semantic Cluster Ratio and Consistency of Item Recall remained the same on both pre- and post-training trials, suggesting no change in the reorganization of target words into categorical groups or in the formulation of an effective learning plan. However, it was noted that these performances ranked normal at the pre-training trial, suggesting that the subject could have reached her ceiling of learning these skills before training was commenced.

Target recognition. The score for target recognition increased from 14(+1) pre-training to 16(+1) post-training, suggesting an increase in verbal information encoding ability. FPs decreased by 1 from 2(+1) to 1(0). The two findings thus indicated an increase in discrimination of targets from distractor items.

In summary, although distal perseverations increased dramatically at the post-training trial, there was evidence of increased memory performance in Immediate Recall, Short-Delay Free Recall, recognition of target items and reduction of FPs for this subject. No change was observed in both Long-Delay Free Recall and Long-Delay Cued Recall. Also, no change was observed in strategies of learning (Semantic Clustering and Slope), which were at normal levels prior to and after training.

Subject 04. Recall measures. Out of a possible total of 90, total raw scores for immediate recall (trials 1-5) were 59(51) and 63(57) on pre- and post-training trials,

respectively, indicating an increase of 6.7%. Perseverations (distal) were reduced from 5 to 2, a reduction of 40%. Scores for Short-Delay Free Recall were 9(-2) and 8(-3), respectively. Short-Delay Cued Recall scores were 11(-2) and 10(-2), respectively. Long-Delay Free Recall scores were 10(-2) and 9(-2), respectively, while those for Long-Delay Cued Recall remained at 9(-3) at both pre- and post-training trials.

These data suggested increased performance in immediate recall and a reduction in perseverations. The reduction in distal perseverations suggested a decrease in forgetting that might be associated with APT. None of the Short-Delay or Long-Delay Recall scores showed evidence of increase.

Learning characteristics. Semantic Cluster Ratio at pre-training assessment was 2.1(0) compared to 1.8(-1) post-training. Slope scores were +1.4(0) and +1.6(0), respectively, suggesting no sizable increment in target words from trial to trial. Consistency of item recall across trials 1-5 was 84% (0) pre-training, compared to 92%(+1) post-training.

Scores for Consistency of Item Recall show an increase from average to above average performance, suggesting an increase in utilization of an organized style of learning or ability to formulate or maintain an effective learning plan. Slope scores remained the same on pre- and post-training trials, suggesting the subject's quick arrival at a learning plateau at both trials. The decrease in Semantic Clustering is suggestive of an inability of the subject to organize target items into categorical groups at post-training time.

Target recognition. Recognition hits were 13(-4) and 12(-5) for this subject at pre-training and post-training trials, respectively, indicating poor and declining ability for encoding verbal information. FPs remained the same 3(+1) at both pre-training and post-

training times, reflecting maintenance of a deficit in discriminating target from distractor items.

In summary, findings on the CVLT data showed no evidence of increase in both types of Short-Delay and Long-Delay Recall for this subject. However, an increase was suggested in Immediate Recall. Decrease was also indicated in perseveration, suggesting an increase in memory performance. Although there was evidence of a decrease in Semantic Clustering, suggesting inability to organize verbal material into semantic categories, increase in Consistency of Item Recall was observed, suggesting improvement in formulation and maintenance of an effective learning plan. Decrease in target recognition and the non-reduction of FPs suggested failure to increase ability to discriminate. Finally, maintenance of the zero value in slope indicated that the trial-to-trial increment did not increase. Thus, memory performance for this subject increased only in three areas, viz., Immediate Recall, perseveration reduction, and Consistency of Item Recall.

Subject 01. For subject 01, only the pre-training scores were available on this test. Although these data do not qualify for determining the effect of APT on memory deficits, they were included to give an indication of memory status for the subject prior to attention training.

Recall measures. The total raw score for immediate recall was 64(50). There were 7 perseverations. The score for the Short-Delay Free recall was 14(0) and that for the Short-Delay Cued Recall was 15(0). Long-Delay Free Recall and Long-Delay Cued Recall both scored 15(0). Except for perseverations, other recall measures indicated normal performance.

Learning characteristics. The pre-training Semantic Cluster Ratio for this subject was 1.8(-1). Slope was +1.3(0) and Consistency of Item Recall across trials 1-5 was 88% (0). The low score in Semantic Clustering suggest poor reorganization of target items into higher-order semantic units. Consistency of target item recall suggested average ability in formulation of an effective learning plan. Slope score indicated average ability for trial-to-trial increment in words recalled over trials 1-5.

Target recognition. This subject scored 16 hits on target recognition, indicating average efficiency in encoding verbal information. No FPs occurred. Except for Semantic Clustering and perseverations, all pre-training scores on the selected CVLT measures showed normal performance for this subject.

Summary on CVLT. Following APT, data on selected CVLT measures showed evidence of an increase in immediate memory recall for subjects 03 and 04. There was a reduction in the occurrence of perseverations for subjects 02 and 04. In addition, subject 03 showed increased performance in short-delay free recall, recognition of target items, and a reduction of FPs. There was also evidence of increased consistency in recall of target words for subject 04. No evidence of increased performance was observed with respect to Short-Delay Cued Recall, Long-Delay Free Recall, Long-Delay Cued Recall, Semantic Clustering Ratio, and Slope.

The Complex Figure Test

Figure reproduction. To answer the question "Does APT increase visual memory?" performance scores on the Rey CFT (Rey, 1941; Osterrieth, 1944) and the Taylor CFT (Taylor, 1979) were analyzed for accuracy in recall of visually presented

material. The Rey CFT was administered once prior to commencement of attention training and once after attention training was completed.

The Taylor Figure was administered post-training only, a day ahead of the Rey Figure, as a distractor task. Parameters considered for analysis were: accuracy in reproducing the figures by (1) copying, (2) immediate recall, and (3) delayed recall; time taken to complete the figure at each of the three trials; and organizational strategies in drawing the figures. The possible accuracy score for each figure was 36. Raw together with percentile scores (in parentheses) are given.

Subject 02. Pre-training accuracy scores for copying, immediate recall, and delayed recall on the Rey Figure were 34(75), 23(58), and 21(40), respectively, and post-training scores were 36(100), 23(58), and 24(60), respectively. Pre-training completion times were 172, 141, and 120 s for copying, immediate recall, and delayed recall, respectively. Post-training times were 215, 180, and 220 s, respectively. Accuracy scores thus reflected increased performance on copying and delayed recall abilities, with loss of time on all three tasks. For the Taylor Figure, accuracy scores were 36(100), 27(80), and 27(80), respectively, for the three tasks, and completion times were 115, 191, and 158 s, respectively.

Subject 03. Pre-training accuracy scores for copying, immediate recall, and delayed recall on the Rey Figure were 35(90), 28(90), and 30(97), respectively. Post-training scores, in turn, were 35(90), 32(100), and 32(100), respectively. Pre-training task completion times were 230, 112, and 104 s, respectively, for copying, immediate recall, and delayed recall, compared to post-training times of 230, 141, and 61 s, respectively. While there was no evidence of increased copying ability, immediate and delayed recall

ability increased, with time gained on delayed recall and lost on immediate recall. Accuracy scores for the Taylor Figure were 36(100), 34(100), and 34(100), respectively, for the three tasks. Completion times were 261, 261, and 158 s respectively.

Subject 04. Pre-training accuracy scores for copying, immediate recall, and delayed recall on the Rey Figure were 35(90), 27(80), and 24(60), respectively. Post-training scores were 35(90), 27(80), and 26(70), respectively. Pre-training task completion times were 224, 92, and 138 s, respectively, for copying, immediate recall, and delayed recall. Post-training completion times were 169, 152, and 135 s, respectively. Therefore, increased accuracy occurred only in delayed recall, while completion time reduced substantially on copying and slightly on delayed recall, with loss on immediate recall. Accuracy scores for the Taylor Figure were 35(90), 21(40), and 22(50), respectively for the reproduced figures. Completion times were 180, 167, and 178 s, respectively. This was consistent with observations made in previous research (Duly et al., 1993; Kuehn & Snow, 1992) where recall scores on the Taylor Figure were higher than for the Rey.

Subject 01. Pre-training accuracy scores for copying, immediate recall, and delayed recall on the Rey Figure were 34(70), 10(5), and 10(5), respectively. Pre-training task completion times were 277, 264, and 327 s, respectively, for the same tasks.

Summary on figure reproduction. Analysis of scores on reproducing the Rey Figure suggested evidence of increased accuracy in one or more tasks for individual subjects. Increase in delayed recall was observed in all three subjects who participated in the two trials. Completion time was reduced in selected tasks for two subjects (indicating

increase in speed), but was increased in all tasks for subject 02.

Organizational ability. Rey Figure organizational quality scores were analyzed to determine increase in visual organization ability. Three subjects (02, 03, and 04) participated in both pre- and post-APT testing. The Taylor Figure scores are included for purposes of comparison in consideration of observations by Hamby et al. (1993) that because of its simpler structure, it is easier to make a well organized copy of the Taylor Figure than of the Rey.

Subject 02. The pre-training visual organization score on the Rey Figure for this subject based on the Hamby et al. (1993) Likert scale was 1, indicating very poor organization. The post-training score on this figure was 2, indicating poor organization. A score of 1 was also obtained on the Taylor Figure, indicating very poor organization.

Subject 03. For this subject, the pre-training score on the Rey Figure was 2, indicating poor organization, compared to the post training score of 3, indicating fair organization. The score on the Taylor Figure was also 3.

Subject 04. For this subject, the pre-training score was 2, compared to a score of 3 post-training, suggesting an increase in organization from poor to fair. The score on the Taylor Figure was 1, indicating very poor organization.

Subject 01. Pre-training testing for this subject yielded a score of 2, indicating poor performance.

Summary on organizational ability. Data on the Rey Figure organizational quality scores (Hamby et al., 1993) suggested an increase in visual organizational ability for all three subjects following APT. Contrary to expectations, for two subjects, scores on the Taylor Figure were lower than those of the Rey Figure.

Prospective Memory Screening Test

To answer the question "Does attention training increase prospective memory?" PROMS (Solhberg & Mateer, 1986) scores were analyzed for prospective memory performance. PROMS was administered once prior to commencement of attention training and once after attention training was completed. To determine increase in performance, Pre- and post-training scores, based on the subjects correctly carrying out assigned tasks, were compared. Three subjects (02, 03, and 04) participated in both trials. Because previously subjects had shown no difficulty executing the 2-min task with time cue, the 1-min task with associative cue was excluded in post-training testing. Scores were allocated out of a possible total of 18. Total scores obtained are shown in parentheses.

Subject 02. Data at the pre-training assessment (score 13) showed this subject had no difficulty performing all three (2 min, 10 min, and 20 min) time-cued tasks. The 10-min task with associative cue was correctly carried out. In the 20-min task with associative cue, the subject ignored the boat picture when shown until verbally reminded, indicating a memory lapse. At post-training testing (score 10), time limits were exceeded by 56 s in the 2-min task and by 2 min in the 10-min task. The 20-min time-cue task was correctly carried out. Both the 10-min and 20-min associative cue tasks were successful. The pre-training 24-hr task (mailing the postcard) failed, as the card was mailed three days later after a reminder. Because of illegibility of the postmark, it was not possible to

determine the date on which the card was mailed at the post-training trial. For this reason this data could not be used to determine change in memory performance.

Data showed improved performance in the 20-min task with associative cue and failure in the 2-min and 10-min time-cued tasks. Since previously the subject had no difficulty performing time-cued tasks and because the premature responses had been self-initiated, miscalculation of time as a possible cause of the failure in these two tasks could not be ruled out. However, the subject was penalized for these inaccuracies. For this subject, an increase in prospective memory performance was suggested in the 20-min task with associative cue.

Subject 03. At pre-training (score=15.5), all prospective memory tasks except for the 2-min time-cue task were successfully completed. This task was executed .5 min sooner than the target time. Post-training (score=14.5), both associative cue tasks were successful. Time-cue tasks, however, were executed 3 s, 7 s, and 2 min before target time, respectively, for the 2-min, 10-min, and 20-min tasks. In addition, a wrong target item (pen instead of a paper clip) was picked in the 10-min task.

For this subject, task failures occurred in relation to time-cue tasks. While picking the wrong target item was possibly a memory-related error, the same could not be said of the sooner-than-target time errors shown by this subject. These errors, however, appeared to be miscalculations, rather than memory errors. Both 24-hr tasks were successfully carried out. Based on the total score, findings on this test suggested no increase in prospective memory performance for this subject between the two trials.

Subject 04. For this subject, pre-training data (score=9) showed the two tasks (10 min and 20 min) with associative cue were correctly carried out. In the case of time-

cued tasks, only the 2-min task was correctly executed. The 10- and 20-min time-cued tasks were carried out only after the subject was reminded about the pending tasks, indicating a memory lapse. Reminders were made 2 min, 41 s, and 10 min after the target time had elapsed. Post-training data (score=4.5) showed that for the 10-min task the subject recognized the associative cue but was unable to recall the expected response. The 20-min associative cue task was, however, correctly carried out. None of the three time-cue tasks was correctly carried out. In the 2-min task, the subject was reminded about the pending task 3 min and 43 s after the target time. The 10-min task was remembered 2 min and 18 s after the target time. During the 20-min time-cued task, the subject fell asleep and was awakened 5 min after the target time had elapsed. At which point he could not remember the target behavior. Both 24-hr tasks were not correctly carried out.

Subject 01. For this subject, only the pre-training data (score=18) was available on the PROMS. Both associative cue and time cue tasks, including the 24-hr task, were correctly carried out.

Summary on PROMS. Based on total scores, there was no evidence of increase in any area of prospective memory. However, examination of individual items showed an increase in the 20-min task with associative cue for subject 02. The lack of increase in associative cued tasks was largely due to the fact that for two subjects (03 and 04) no deficits were manifested during pre-training evaluation. No increase was suggested in any area of prospective memory. For two subjects (02 and 03) pre-training success in time-cued tasks was not maintained in post-training performance. This appeared to be due to errors of calculation rather than memory. Pre-training errors in time-cued tasks for subject 04 were maintained in post-training assessment, thus suggesting no evidence of increase in

this area of prospective memory. For this study, there was no evidence suggesting an increase in time-cued tasks or the 24-hr task.

Generalization

To answer the question "Do attention behaviors acquired through APT transfer to naturalistic settings?" data from the following sources was analyzed: APT-II Attention Questionnaire (Sohlberg, Johnson, et al., 1993) reflecting perceived degree of attention impairments in daily functioning; and recordings in the APT-II Attention Lapse and Success Logs (Sohlberg, Johnson, et al., 1993), reflecting experienced attention problems and strategies used to overcome them. Individual probes were set to supplement these tools. A probe is an assessment of behavior targeted for observation on selected occasions when no contingencies are in effect for that behavior (Kazdin, 1982).

Probes in this study included performance on the math problems and frequency in completing the success section of the APT-II log. Math exercises, administered to all subjects, served two purposes; first, as a distractor in PROMS testing and second, to assess attention performance. Parameters for evaluating performance on math problems included the total number of problems attempted, percentage correct, and errors made. Completion of the attention-success section of the APT-II Log was assigned the probe status when it was observed that despite persuasion one subject consistently ignored completing this section.

Completed Questionnaires were scheduled for submission once prior to commencing training and periodically after each phase of training. Attention logs were scheduled for weekly submission. Participation by SOs varied from subject to subject, depending on availability and cooperation. To determine improvement, specific measures over time were compared.

Subject 02. APT-II Questionnaire. In addition to the subject, two SO's completed the APT-II Questionnaire. The second SO was signed on later in the study when contact between subject and the first SO became limited. The subject and the first SO each completed five Questionnaires. Three Questionnaires were submitted by the second SO. To get a single score for each data point, available scores were averaged, yielding the following scores: 36, 29, 25.3, 27.6, and 20.6 for this subject. This finding suggested a progressive reduction in the severity of perceived impairments which can be attributed to APT.

The most frequent and frustrating attention breakdowns identified for this patient were: inability to ignore noise and easily irritated by any kind of noise or more than one activity going on around her; inability to plan more than one step at a time, thus refusing to plan in advance, even when it was necessary; overwhelmed by multiple pieces of information, tasks, and instructions; poor handling of budget issues; difficulty making decisions, therefore unable to complete challenging tasks; inability to draw on information at hand, therefore failure to figure out an alternative route around familiar neighborhoods; hard time being punctual; and severe forgetfulness.

APT-II Attention Lapse/Success Log. Log recordings by both the subject and SO's indicated improvement in advance planning, taking on tasks involving decisions, successfully working out an alternate route, and being punctual. The latter was corroborated by the researcher's observations of the subject's punctual arrival for training sessions in the last three weeks of the study. There were reflections of positive attitudinal changes, such as being comfortable with acknowledging limitations and not taking unrealistic responsibilities; appearing more happy: "seems to realize planning something

is fun not a chore;" and being more involved with her children than prior to training, "have consistently kept the kids involved in checking on the flower bulbs they planted. This is a big change for me - normally I would have dropped the ball." Although forgetfulness did not appear to have decreased, the subject developed more frequent use of her pager system. There was no evidence of increased tolerance for noise and multiple activity.

Math exercise. Pre-training performance showed a total of 248 problems were attempted, 235 (95%) were correct, and there were 13 errors. Post-training scores showed a total of 263 problems were attempted, 256 (97%) were correct, and there were 7 errors. Comparison of Pre- and post-training scores showed increased attention performance by this subject in this exercise.

Individual probes. Entries on the success section of the APT-II Log were given probe status when it was observed that despite encouragement, the subject completely ignored this section of the tool in the first three logs submitted. It was assumed this failure was due to a type of attention deficit. Improvement in compliance was observed in all but one future submissions. In the next seven logs submitted, three had one success entry each, and four had two successes each entered. The last three logs each had five, zero, and two successes entered. This finding, irrespective of the cause for the initial failure, suggested that the subject had gained some control over the problem associated with completing the success section of the APT-II Log.

Subject 03. APT-II Questionnaire. For this subject, none of the four approached SOs complied with the request to complete the APT-II Questionnaire. For this reason, only the subject's own entries were analyzed. Five Questionnaires were

submitted. Scores on perceived attention difficulty over the entire period of the study were 26, 21, 16, 14, and 12. This finding suggested progressive reduction in the severity of perceived impairments.

The most frequent and frustrating attention breakdowns identified for this patient were: being distracted by erratic noises such as some chewing crunches; difficulty with interpretation of instructions and losing track of thought during conversation and drifting into irrelevant issues; difficulty in switching her thought from one thing to another; absentmindedness especially when cooking, frequently burning food; neglect of household chores like house cleaning and washing dishes; if interrupted when doing chores, often losing track of what she was doing, then starting something new; unable to determine the date without counting on her fingers; and frequently forgetting her shopping list and/or items to buy.

APT-II Attention Lapse/Success Log. Examination of Log recordings showed an increase in the number of outings undertaken by the subject. Compared to one shopping trip per four weeks in the first eight weeks after commencement of training, one or two outings per week were undertaken in the next five weeks of the study. These included self-initiated walks and visits to street fairs and recreational facilities. Five weeks after commencement of training, the subject started working on establishing a head-injury support group in her neighborhood. This was after she had stopped going to one more than a year previous. Improvement was also recorded in completion of house chores. Compared to one success reported in the first eight weeks after commencement of training, five successes were reported in the following five weeks of the study. No report on chores was made during the last two weeks of the study, during which the subject was sick.

Successes were reported also in cooking and being attentive to environmental cues. With respect to the latter, it was observed that, by the sixth week of training, the subject had stopped accidentally disturbing the other subject's training sessions. This previously had occurred frequently, when the subject would miss the "do not disturb" sign, and open the door or continue a loud discussion while someone else's training was in session.

Math exercise. Pre-training performance showed a total of 159 problems were attempted, 142 (89%) were correct, and there were 17 errors. Post-training scores showed a total of 276 problems were attempted, 260 (94%) were correct, and there were 16 errors. Comparison of pre- and post-training scores in this exercise showed increased attention performance by this subject.

A change in attitude was reflected in the following statement by the subject: "Did lawn work for 6 hours - enjoyment of being outdoors overcame my depression." There was no evidence of a decrease in difficulty with interpreting instructions, losing track of her thought during a conversation, difficulty in switching her thought from one thing to another, or inability to determine the date without counting on her fingers.

Individual probes. A recall of shopping items on two visits to the store, arranged by the researcher, showed a reduction in the number of forgotten items. On the first visit (8 weeks into training), 7 of 19 items were forgotten and four items not on the list were picked up. On the second visit (11 weeks into training), 2 of 19 items were forgotten and no irrelevant items were picked up.

Subject 04. APT-II Questionnaire data. Three APT-II Questionnaires were completed by the subject and four by the SO. The subject did not submit the second and

last of the scheduled five questionnaires, and the SO failed to submit the last one. To get a single score for each data point, pairs of scores were averaged, yielding the following scores: 39, 34, 39, and 36.5 for this subject. The erratic pattern of performance and the missing data made it impossible to determine any change on perceived difficulty of attention problems for this subject.

The most frequent and frustrating attention breakdowns identified for this patient were: difficulty in dealing with multiple tasks; difficulty coordinating words to express thoughts; difficulty switching his thought from one thing to another; loss of track of thought in a discussion; inability to plan and prioritize, thus never got around to doing things in time; panic under stress; failure to concentrate in the presence of noise; and missing appointments and tasks even with a list.

Only three APT-II Logs (3rd to 5th week of training) were submitted by this subject in the entire period of the study. Part of the first of these was tape-recorded in an effort to make it easier for the subject to comply. Despite encouragement, no entries were made on the success section of the Log. Because of situations in the subject's social life, attempts to set individual probes failed. Based on the available data, there was no evidence of attention problems reduction in daily performance for this subject.

However, some statements made by the subject suggested some compensatory skills developed. The effectiveness of these in dealing with attention-related problems is illustrated in the following statements by the subject: "Completely removing myself from the situation for a time, though not an option, may well have solved the problem" and "I ended up picking up the two most important items and letting the rest slide, even if there was time for them."

Math exercise. Pre-training performance showed a total of 146 problems were

attempted, 127 (87%) were correct, and there were 19 errors. Post-training scores showed a total of 233 problems were attempted, 228 (98%) were correct, and there were 5 errors. Comparison of pre- and post-training scores in this exercise showed increased attention performance by this subject.

Subject 01. APT-II Questionnaire. This subject completed two APT-II Questionnaires, one prior to commencing attention training, and the other following the first training phase. The SO submitted three in consecutive order. With the first two sets of scores being averaged, final scores were 28, 18.5, and 15. Since the third score was from a single contribution, its use in determining performance increase was limited. Thus, it was not possible to determine a change in perceived difficulty of attention problems for this subject.

APT-II Attention Lapse/Success. The most frequent and frustrating attention breakdowns listed for this patient were: having a hard time getting things together when going out for the day; difficulty resuming tasks at work following an interruption; difficulty cooking while listening to a conversation or when the kitchen is cluttered; extreme difficulty pulling up words to match thoughts in a discussion or when writing; distracted by peripheral noises; inability to figure out direction in new environments; frequently missing the latter part of what is being said in a conversation; difficulty recalling details; and leaving the stove on frequently after cooking.

Seven APT-II logs were completed by the subject during the eight weeks of training. Data recorded showed that within the first week of study, some improvement was noticed in: handling of more than one task at a time, cooking without forgetting ingredients, asking for instructions to be repeated, and keeping appointments. Successes

recorded on these aspects in five days ranged from two to five, with zero lapses. Improved recall (phone numbers, shopping list) was reflected in the fourth week after training started. No evidence of improvement was suggested in other listed problems. For this subject no individual probes were set, since there appeared to be efficiency on the part of the subject in handling data recording.

Math exercise. Pre-training performance for this subject showed a total of 303 problems were attempted, 280 (92%) were correct, and there were 23 errors. Since the subject abandoned the study, this measure was not obtained for post-training assessment. Therefore, for this subject it was not possible to determine generalization in performance based on this measure.

Summary on generalization. Findings on measures used to assess generalization of attention skills following APT suggested the following: A reduction in the degree of perceived difficulty of various attention problems in two subjects (02 and 03). For the remaining two subjects, a conclusion was not possible due to limited data. Findings on APT-II Lapse and Success Log reports suggested success in reducing the frequency of some identified attention problems for three subjects (01, 02, and 03). Two of these subjects reported successes over four problems and one had successes over three problems. The remaining subject registered no successes. In addition, data showed attitudinal changes were developed by two subjects (02 and 03) during the course of the study. Also, two subjects (02 and 04) developed or increased the use of effective compensatory skills.

Findings on the math exercise suggested that, at the end of attention training, three subjects were able to handle an increased number of math problems at a time, with an

increase in the number of correct responses compared to before training. Due to missing data, this assessment was not done in the case of subject 01. Findings on individualized probes suggested improved performance for both subjects. Based on these findings, there was evidence that some skills learned in APT were transferred successfully to other and naturalistic situations in the subjects' daily lives.

Table 13. Summary of Outcome on Attention Performance.

Evaluation Measure	Subject			
	01	02	03	04
Revised Attention Process Test				
Auditory - mean number correct responses				
Sustained I	0*	-	0*	0*
Sustained II	0*	-	0*	0*
Selective II	0*	0	0*	0*
Alternating II	0*	+	0*	0*
Visual - mean rate of response				
Sustained II	+	+	-	-
Selective II	+	-	-	-
Alternating	-	+	-	-
Divided - mean rate of responses				
	+	+	+	+
Paced Auditory Serial-Addition Test				
Mean total correct responses	+	0	+	+
Mean rate of responses across tasks	+	-	-	+
Mean rate of responses (No. of paced tasks improved)	+++	++	++	++++
Digit Vigilance Test				
Rate of response	?	+	-	0
Multiple Task Visual Assessment Test				
Rate of response	?	+	-	+

Legend: + = Change in desired direction 0 = No change
 - = Change in undesired direction * = No change but normal performance
 ? = Data incomplete

Table 14. Summary of Attention Performance.

Evaluation Measure	Subject			
	01	02	03	04
Modality Specificity				
RAPT				
Auditory	?	0	0	0
Visual	?	0	0	0
PASAT	?	0	0	0
DVT	?	-	+	+
MTVAT	?	-	-	-

Legend: + = Change in desired direction
 - = Change in undesired direction
 0 = No change
 0* = No change but normal performance
 ? = Data incomplete

Table 15. Summary of Outcome on Memory Performance.

Evaluation Measure	Subject			
	01	02	03	04
California Verbal Learning Test				
Recall:	N/A			
List A Trials 1-5 immediate recall		-	+	+
Short-delay free recall		0	+	0
Short-delay cued recall		0	-	0
Long-delay free recall		0	0*	0
Long-delay cued recall		0	0*	0
Perseverations		+	-	+
Learning characteristics				
Semantic cluster ratio		-	0*	-
Slope		0*	-	0*
Consistency of item recall		-	0*	+
Target Recognition				
False positive		0	+	0
		0*	+	0*
Rey Complex Figure Test (task/time)				
Copying		+/-	0*/0	0*/+
Immediate recall		0/-	+/-	0*/-
Delayed recall		+/-	+/+	+/+
Organizational ability		+	+	+
Prospective memory screening				
Associative cued				
10 cued		+	+	-
20 cued		+	+	0*
Time-cued				
2 min task		-	-	-
10 min task		-	-	0
20 min task		+	-	0
24 hr task		-	+	0

Legend: + = Change in desired direction 0 = No change
 - = Change in undesired direction 0 = No change but normal performance
 N/A = Not applicable

Table 16. Summary of Outcome on Generalization

Evaluation Measure	Subject			
	01	02	03	04
APT-II Questionnaire	?	+	+	?
APT-II Attention Lapse/Success Log				
Reduced problems	+	+	+	0
Reported successes	+	+	+	0
Math exercise	?	+	+	+
Individual probes	N/A	+	+	N/A

Legend: + = Change in desired direction
 - = Change in undesired direction
 0 = No change
 0* = No change but normal performance
 ? = Data incomplete
 N/A = Not Applicable

CHAPTER FIVE

DISCUSSION OF FINDINGS

The purpose of this investigation was to examine the efficacy of process-specific attention training techniques, the APT, in remediating attention and memory deficits following mild TBI. The study was a single-case, multiple baseline design, with a sample of four subjects. This chapter is a presentation of the discussion, summary, and recommendations based on the results of the study. Content is subdivided into findings, conceptual methodological issues, summary, limitations of the study, contributions to knowledge of nursing science, and suggestions for future investigations.

The discussion section addresses the results of the hypotheses testing and implications associated with those results. Discussion of results is subdivided into three major areas of investigation, namely, attention performance, memory performance, and generalization of learned skills. The discussion of attention performance is presented to answer two questions. The first question is a general one addressing the issue of whether there was an increase in attention performance following attention training. This question, although not directly addressed, is embedded in hypotheses 1 and 2. The second question addresses the issue of specific effects with respect to the modality of attention training. This question is contained in hypotheses 1 and 2. Investigation of modality specificity provides answers to the question of whether or not attention training on a specific modality selectively influences attention performance of the same type as the modality; for example, does auditory attention training selectively influence auditory attention performance? Data on this aspect of the investigation were obtained from the evaluation

of attention performance scores on the following tests: RAPT, PASAT, DVT, and MTVAT. The discussion on the RAPT addresses separately each of the five levels of attention suggested by the Clinical Model of Attention (Sohlberg & Mateer, 1987). Discussion of memory and generalization performance is presented in the respective subdivisions.

Attention Process Training Outcomes

Performance on the Revised Attention Process Test

Findings on this test are presented in Table 13. Observations on the RAPT data showed that increase of performance in attention associated with the APT varied from subject to subject, and from test measure to test measure, thus implying the possibility of selective effectiveness. Specific findings on the RAPT-associated results and the implications of the outcomes are presented below.

Data provided by the RAPT scores on divided attention suggested evidence of increased performance for all subjects following APT. This conclusion was based on evidence of increased mean rates of response and a reduction in the number of FPs. Since perseverations are an important feature of certain brain lesions (for example, frontal lobe damage [Lezak, 1995]), the reduction in the number of FPs was considered clinically significant. Reduction in FPs was not a consideration in the case of one subject whose performance did not reflect any FPs. The rate of response scores were computed based on the total number of correct responses in both auditory and visual attention tasks, FPs, and the total time taken to complete the tasks. The formula for this computation was provided

in the Methods section.

The underlying rationale for the divided attention task is the assumption that attentional demands are additive (Kahneman, 1973; Norman & Bobrow, 1975). This assumption proposes that as long as the joint attentional demands of the two tasks do not exceed attentional capacity, the two tasks can be executed together with no decrement in performance. The decrement in performance or absence thereof provides a measure for the extent to which the available attentional capacity is exceeded.

Based on total number of correct responses, no evidence of increased performance was found in auditory and visual attention for all subjects in alternating attention. This situation was a result of the subjects having obtained total or near total scores in the baseline condition for this task. The fact that this occurred suggested that the RAPT instrument might not have been sensitive to the attention deficits in these levels of performance for this particular sample. There was, however, a decrease in the mean time performance on the visual task for two subjects, implying increased performance on this section of the test. Except for one subject, no FPs occurred in both baseline and outcome conditions of the alternating attention task. The one subject with 10 FPs in baseline trial 1 (auditory task) showed four FPs in outcome trial 4, thus indicating increased control of alternating attention generally. It is noted that this subject's performance was generally poor on all tasks on this trial.

Alternating attention requires the subject to shift attention from one stimulus to another, thus increasing the demand on attention capacity. The increased demand on attention resources imposed by alternating attention tasks can be explained on the basis of

observations that patient populations in brain injury show a reduction in the ability to shift attention efficiently from one stimulus to another (Sohlberg & Mateer, 1989, p. 119).

Data on selective attention showed no evidence of increased performance in both auditory and visual tasks for all four subjects. For auditory attention, this evidence was based on the total number of correct responses obtained. For visual attention, the rate of response showed loss of time between baseline and outcome conditions. In the auditory component of this level, three subjects obtained total or near total scores in the baseline condition. In contrast, one subject had errors occurring in both baseline and outcome conditions, and for both auditory and visual attention tasks. Since all subjects had reported inability to function in any noise situation and had been observed to be easily distracted by noise, the incongruence between performance on this task and real life situations suggests that the RAPT selective attention instrument was insensitive to selective attention deficits in this sample. The visual attention task, however, appeared to show efficiency in this respect. It is assumed that unlike auditory attention tasks (which feature a single parameter), the time-monitored visual attention tasks are more demanding on attention capacity, and therefore do better at targeting the deficits. As pointed out by Sohlberg and Mateer (1989), in brain injury slowness of elementary psychological operations is particularly significant when time pressure is involved and subjects are forced to summon more effort to complete a task.

Except for one subject, no FPs occurred in either auditory or visual attention selective levels of the RAPT. For the one subject, despite complete absence of FPs in the baseline condition one FP occurred persistently in each visual attention outcome trial.

Since these FPs occurred in the latter part of the task, it was assumed they were fatigue related. In the outcome condition, the administration of the RAPT test was preceded by three other tests, compared to the baseline condition, where it was administered after only one test. While prompted by the need to create an instrument comprehensive enough to provide a clear indication of the subject's cognitive disorder, the various tests administered could have been tiring to the subject, thus increasing chance of errors (Wilson, 1987).

Data on auditory sustained attention showed no evidence of an increase in performance for all four subjects. The baseline condition scores showed that three subjects obtained total or near total scores, allowing no room for improvement in outcome scores. In contrast, there were errors in both baseline and outcome conditions for one subject. However, the means for the correct number of responses in both baseline and outcome conditions were equal, thus reflecting no actual increase in performance. For visual sustained attention, the mean time scores for task completion and the rates of response showed an increase in performance for two subjects. Scores for the remaining two subjects showed loss of time at outcome. Compared to its auditory counterpart, the visual sustained attention performance testing tool appeared to have been more sensitive to the attention deficits for this sample.

Based on these findings of the RAPT, three possibilities were suggested. First was the possibility that the auditory aspect of this test was generally insensitive to the attention deficits of the three subjects in the study. The second possibility was that the three subjects who got total or near total scores in auditory attention might not have had attention deficits in auditory attention. Since all subjects had shown poor performance in one or

more levels of visual attention, the third possibility concerned whether attention deficits could be confined to one modality only, in this case visual, leaving the other (auditory) modality intact.

Another question arising from the findings is one relating to the proposal of a hierarchy within the levels of attention as suggested by the Clinical Model of Attention (Sohlberg & Mateer, 1987). The term hierarchy is suggestive of a standing sequential order from one level to the next. Since there was evidence of increased performance for all subjects in divided attention (which is considered the highest of the five levels of attention), and in auditory alternating attention and visual selective attention for one subject, but none in visual sustained attention for two subjects, the proposed hierarchy order comes into question. Presumably, inability to function at the divided attention level implied ability to function efficiently at the "lower" three levels, namely, alternating, selective, and sustained attention. This, however, appeared not to be the case in these findings.

In summary, following APT there was evidence of increased performance in divided attention for all subjects. Increased performance was also evidenced in visual sustained attention for two subjects, and for one subject each in visual selective and visual alternating attention. Due to absence of errors in auditory attention baseline performance, findings on the RAPT showed no evidence of an increase in performance for all but subject 02. For this subject more stability of performance was observed in the outcome condition, as indicated by fewer errors and a reduction in FPs compared to the erratic performance in the baseline condition. Although errors were not completely eliminated,

this outcome was considered clinically significant taking into account that in cognitive rehabilitation, it is far more effective to build on the person's strengths in order to bypass the weaknesses themselves. Also, tests for cognitive performance should focus on the individual's needs, rather than assessing how subjects meet the general population standards (Wilson, 1987). It is interesting to note that, generally speaking, subject 02 showed increased performance in more areas than the rest of the subjects. This finding seems to suggest that APT effects are better demonstrated in individuals with more obvious attention deficits. This feature does not appear to have been investigated yet.

On the other hand, since three subjects performed at a high level on the three auditory attention tasks before they underwent attention training, it is reasonable to assume that the APT auditory attention tasks were not complex enough to create a competitive effect proposed in Luria's (1981) hypothesis that following brain injury repeated taxing of a specific neurological system facilitates and guides the reorganization of function in that system, improving the rate and level of recovery. Also, in consideration of the capacity theory of information processing (Kahneman, 1973), it appears the RAPT auditory attention tasks were not complex enough to make extra demands on attentional resources for three of the subjects. It needs to be mentioned at this point that for the most part subjects' performance scores tended to be above the normal RAPT performance for non-brain injured individuals. This was particularly true of subject 01 in auditory assessment tasks. Variable increases in visual attention performances that occurred even within the same individual appeared to suggest selective effectiveness of the APT, probably determined by the extent of attention deficit in different individuals, with possible

association to the brain lesion.

Performance in the Paced Auditory Serial-Addition Test

Findings on this test are presented in Table 13. This auditory test assessed the speed of information processing. Overall, findings on the PASAT suggested evidence of variable increases in all three parameters for the four subjects following APT. The parameters considered were: (1) the correct number of responses out of a total of 240; (2) the mean rates of response across trials, one trial comprising all four paced tasks; and (3) the mean rates of response in each individual paced task, for example, the 2.4 s paced task. For subjects 01 and 04, increased performance was shown in all three parameters. For subject 01, the mean rates of response for paced tasks showed increases in the 2.4-s, 2.0-s, and 1.2-s intervals. For subject 04, increases in the mean rates of responses for paced tasks were shown in all four intervals. Subject 03 showed increases in the mean for total correct responses and mean rates of responses for the 2.0-s and 1.6-s paced tasks. There was no evidence of increased performance for this subject in the mean rate of response across tasks. For subject 02, increases in performance occurred only in the mean rates of response for the paced (2.4-s and 1.2-s) tasks. No increases of performance occurred in the mean for total correct responses and the mean rates of responses across tasks. Since slowness in elementary psychological operations is a significant feature of attention deficits (Sohlberg & Mateer, 1989), evidence of increased performance in one or more individual tasks of the PASAT was considered a significant finding, implying the efficacy of APT in ameliorating attention deficits.

Performance on the Digit Vigilance Test

Findings on this test are presented in Table 13. The DVT was administered in the outcome condition only. Being a well-established, standardized test on visual attention, the DVT was added to the battery of attention tests to increase the validity of the study. Using additional attention tests of cognitive assessment satisfied the need to create an instrument comprehensive enough to provide a clear diagnosis of the subject's attention deficits (Wilson, 1987). The rate of response scores showed an increase of performance from trial 1 to trial 4 for subject 02. None of the other subjects showed any increase in the rate of response for this test. However, since no baseline measures were available for this test, the effect of APT on this function could not be totally confirmed.

Performance on the Multiple Task Visual Attention Test

Findings on this test are presented in Table 13. Like the DVT, the MTVAT was administered in the outcome condition only. In addition to increasing the study validity, the inclusion of the MTVAT with its multiple concurrent mental activities also served to increase the vigor of testing. This was in recognition of the proposal that when more than one item of information is concurrently processed more mental effort is required (Kahneman, 1973). An increase in the rate of responses from trial 1 to trial 4 was shown for subjects 02 and 04 in the outcome condition. No increase in performance was shown for subject 03. This measure could not be determined in the case of subject 01, who did not complete the study.

Generally, it would appear that compared to auditory attention tasks, visual

attention tasks were more sensitive to attention deficits found in the current study sample. This observation is particularly salient in the case of the RAPT. However, this argument does not hold in the case of the auditory attention, speed testing PASAT. This consideration, along with the earlier suggestion that visual tasks tended to be more sensitive to attention deficits in this group of subjects, seems to identify time limit as a capable factor in detecting attention deficits in mild TBI. This suggestion is supported by the observation that the speed at which the brain-injured respond is decreased in direct proportion to the amount of information to be processed (Gronwall & Wrightson, 1974). It is argued here that the added element of the time constraint that was required for the visual attention tasks and the PASAT placed more demands on attention than did the single-activity auditory tasks of the RAPT.

Modality Specificity

Table 14 shows findings on modality specificity. The modality specificity hypothesis was supported with respect to visual attention training in the case of the DVT only. Findings on this test showed that for two subjects performance was higher following each visual attention training phase compared to following auditory attention training, suggesting that visual attention training selectively reduces visual attention deficits. Findings on the visual RAPT and the MTVAT did not support this hypothesis. There was also no evidence of modality specificity in the case of auditory attention training.

Attention Process Training and Memory

The secondary purpose of this study was addressed in hypotheses 3-6 investigating the efficacy of APT in (1) increasing the ability for recall and recognition of verbal material, (2) increasing visual memory, (3) increasing prospective memory, and (4) increasing the ability to organize information in memory. The choice of more than one assessment instrument and the decision to assess four different attributes of memory recognized the submission that "it is naive to expect a single or simple test to determine cognitive dysfunction" (Wilson, 1987, p. 38).

Verbal Recall and Recognition

Findings on the CVLT regarding performance in recall, learning characteristics, encoding, ability to discriminate, and perseveration tendency varied substantially from subject to subject (see Table 15). There was evidence of increased immediate recall for subjects 03 and 04, short-delay free recall for subject 03, and reduction in perseveration for subjects 02 and 04. Although there was no evidence of increased performance in both long-delay free and cued recall for all subjects, performance for subject 03 was found to be at normal levels on both these tasks. Findings on learning characteristics showed an increase on consistency of item recall for subject 04. There was evidence of increased performance on target recognition and reduction of FPs for subject 03. In summary, CVLT findings indicated increases in four areas for subject 03, three areas for subject 04, and one area for subject 02, suggesting a possible selectiveness of APT influence.

Since all three subjects showed an increase in the above memory functions, albeit

to varying degrees, the proposition that regardless of time post injury, cognitive rehabilitation facilitates functional reorganization of brain ability (Gronwall, 1977; Guentz, 1988; Sohlberg & Mateer, 1987) appeared to hold true. The fact that both short-term and long-term performances showed no increase in any of the subjects following APT could not be explained theoretically. Two factors appear accountable for this lack of explanation. In the first, the exact mechanism of APT functioning has not yet been defined. Secondly, none of the studies reporting increases in memory function consequent to attention training identifies the type of memory in which these increases are said to have occurred. Because long-term memory is directly dependent on short-term memory storage (Squire, 1987), it is assumed that the reason long-term memory did not increase was a consequence of short-term memory failure.

Visual Memory

The hypothesis that APT increases visual memory was supported by findings on some aspects of the Rey CFT (see Table 15). Accuracy in delayed recall of the Rey Figure was increased for all three subjects. This finding was consistent with observations made on mild brain injury patients within the first 21 months post-injury (Leininger, Gramling, Farrell, et al., 1990). Accuracy in copying the figure increased for subject 02 and the normal performance for subjects 03 and 04 remained unaltered. Performance for these two subjects was found to be within the 90th percentile of the normal sample, suggesting the possibility of these subjects having reached the learning ceiling in this area prior to commencing training. Increase of accuracy in immediate recall was evidenced in subject 03

only. There was a substantial reduction in task completion time for subject 04 in copying and delayed-recall tasks. Subject 03 also showed a reduction in time for the delayed-recall task. Except for one subject, accuracy scores for the Taylor Figure (Taylor, 1979) were higher than those obtained on the Rey Figure on all levels of recall. Because practice effects were unlikely in the case of the Taylor Figure test, the observation that compared to the Rey Figure, the Taylor Figure was easier to copy (Hamby, Wilkins, and Barry, 1993) was corroborated.

Organization of Information in Memory

Of the two measures used to determine increase in ability to organize information in memory, only the findings on the Rey Figure were supportive of the aim addressed in hypothesis 6. There was evidence of increased ability in the organization of visual information for all three subjects. However, no evidence of increase was found in the ability to organize verbal information based on the semantic clustering ratio of the CVLT.

Organizational ability or ability to conceptualize requires input by the executive system. By comparison, lack of increase in performance associated with the auditory RAPT task was due to subjects obtaining total or almost total scores in the baseline conditions, leading to findings that showed slight or no difference in outcome performance. In contrast, findings on the CVLT semantic clustering task, a function thought to be served by the central executive system, showed a decline in the level of scores for all subjects. This is consistent with observations suggesting poor organizational ability following brain injury (Lezak, 1993). Further, since the CVLT was administered in

conjunction with the Taylor CFT and the PASAT at post-training time, it is suggested that additional demands on attention might have limited the central executive system capacity, contributing to a decline in performance at this time (Baddeley, 1989; Lezak, 1995). The effect of fatigue on attention performance when subjects are presented with several tasks in an effort to achieve adequate assessment is acknowledged by Wilson (1987).

Prospective Memory

Prospective memory requires a particular action at a specific time in the future, based on a self-initiated and internally generated plan of action (Sohlberg, Mateer, & Stuss, 1993). Winograd (1988, p. 348) submits that "There can hardly be a more practical aspect of memory than remembering to do things at the appropriate time." Further, being dependent on the ability of the person to remember to remember, prospective memory demands the greater degree of self-initiation (Craik, 1986). Based on these considerations, the PROMS was included in the battery of tests to achieve a more comprehensive assessment of memory functioning for this study. Findings on prospective memory are shown in Table 15.

Although total scores for the PROMS showed poor performance for all subjects, individual analysis of items showed increased performance in the 10-min and 20-min associative-cue tasks for subjects 02 and 03. This finding was consistent with findings on normal subjects in the study by Sohlberg and Mateer (1986). For the time-cued tasks, increased performance was indicated in the 20-min task for subject 02 and in the 24-hr task for subject 03. The poor performance in time-cued tasks was a result of failure to

self-initiate as demonstrated by the need for one subject to be reminded about the pending task more than once in one trial. There were also miscalculations of target time as illustrated by repeated premature execution of target tasks by another subject. On the other hand, failure due to memory lapse was also observed, as in the case of a subject who executed tasks several minutes after the target time.

Finally, fatigue was also implicated, as demonstrated by the subject who despite the distractor exercise fell asleep in the process of the carrying out the 20-min time-cued task. A point of concern is that generally there was poor performance for all subjects at outcome condition compared to baseline. This is thought to be a result of non-study related pressures in the subjects' social lives. Records showed that, at the time of the trial, one subject was a day away from surgery. Another was on a prescription tranquilizer that made her "dopey." A third subject was in the midst of a civil law case. This situation typifies the difficulty of coping with several attentional demands and the effect of excessive arousal experienced by patients with mild brain injury when they return to normal life.

Observations show that in high arousal attention tends to be concentrated on the dominant and most obvious aspects of the environment (Cimprich, 1992). Because arousal affects the policy by which attention is allocated to different activities, over-aroused subjects are prone to poor performance (Kahneman, 1973). Although the extent of this negative influence on performance was not investigated, considering that memory is dependent on attention, it is reasonable to assume the poor prospective memory performance observed at post-training time, was a result of among other things high

arousal.

Generalization

Table 16 represents the findings on generalization ability following APT. Learning underlies the structured, process-specific attention retraining design of the APT technique. The primary aim of learning is development of behaviors that are adapted to an ever-changing environment (Carlson, 1991), thus rendering learned behaviors generalizable across situations. Generalization of skills or behaviors acquired in a specific clinical or educational setting to other environments in which a client functions is of concern to all types of service providers (Sohlberg, Johnson, Paule, Raskin, & Mateer, 1993). Based on these principles, transference of attention behaviors acquired through APT to naturalistic settings was investigated. The following findings were supportive of the aim in hypothesis 7.

Findings on the APT-II Questionnaire showed a reduction in the degree of perceived difficulty of attentional problems for subjects 02 and 03. The APT-II Questionnaire data for subjects 01 and 04 were incomplete. Except for subject 04, findings on the APT-II Attention Lapse Log entries reflected a reduction in the frequency of some previously identified attentional problems in three subjects. This was also true of the findings based on the attention success data. There was evidence of a positive change in attitude in the three subjects as reported by themselves or their SOs. Such changes included more involvement in family activities, willingness to go out on recreational trips, and being more realistic about limitations caused by attentional deficits. Further reports

suggested development of more tolerance of the subject's attentional limitations by family members. It is however important to note that the close similarity between the depression-like manifestations of attention deficits and manifestations of pure depression that could occur as a result of prolonged stress present a limitation in this particular group of findings. Further investigation is therefore warranted to clear the uncertainty. All three subjects who remained on the study were able to perform more math tasks at outcome compared to baseline, suggesting increased control of focused attention. The apparent development of new habits that were previously lacking is thought to be suggestive of APT-acquired skills successfully transferred to naturalistic settings.

Summary of Results

Following is a summary of the findings presented in the order of the hypotheses:

1. Overall findings suggested variable increases in selected levels of attention performance following APT. These increases were observed more in visual attention performance than in auditory attention. Auditory attention performance increases were observed in the PASAT in contrast to the RAPT performance. Except for one subject, the RAPT auditory measure appeared not to be sensitive enough to detect attentional deficits experienced by subjects in this study.

2. Evidence of modality specificity was demonstrated in the findings of one visual attention test, the DVT. In general, more higher scores occurred following visual training than was the case with auditory training. Examination of auditory attention data at the end of the two auditory attention training phases did not show any specific effects of auditory

attention training on auditory attention performance. Since all forms of learning have some effect on the learner, it is assumed that auditory attention training might have had general rather than specific effects on attention.

3. CVLT data showed varied outcome responses. Performance suggested evidence of increased verbal recall in immediate memory for two subjects only. There was evidence of increased performance for one subject only in each of the following: short delay free recall, recognition of target items, and consistency of target recall. Evidence of reduction in perseverations and FPs was shown in two and one subjects, respectively. There was no evidence of increased performance with respect to short-delay cued recall, long-delay free recall, long-delay cued recall, semantic cluster ratio, and slope.

4. Following APT, accuracy in reproducing the Rey Figure showed evidence of an increase in delayed recall for all three subjects. There was evidence of a reduction in completion time for two subjects, indicating a gain in speed. Accuracy in reproducing the Taylor Figure showed higher scores than was the case with the Rey Figure.

5. There was an increase in visual organizational ability for all three subjects following APT, as evidenced by the Rey Figure scores. Organizational ability on the Taylor Figure showed poor performance. Poor semantic clustering was observed in the CVLT for all subjects, suggesting poor organizational skills of verbal material and use of poor learning strategies.

6. Findings on the PROMS suggested evidence of increased performance in the 10-min and 20-min associative-cue tasks for two subjects. There was evidence of increased performance for one subject each in the 20-min time-cued and the 24-hr tasks.

The poor performance in the time-cued tasks was a result of errors in the outcome condition that had not previously occurred in the baseline condition. These were errors in calculation of time as well as memory lapses.

7. Following APT there was some evidence of generalization of APT learned behaviors to variable degrees for all subjects. Such behaviors included reduction in the degree of perceived difficulty of attention problems, reduction in the frequency of attention lapses, development of positive changes of attitude regarding handling of attentional handicaps, and evidence of a longer span of sustained attention in the math exercise.

Limitations of the Study

Inadequate Assessment Instruments

Studies attempting to measure attention are still handicapped by the difficulties associated with understanding the concept of attention itself. Despite the long-standing recognition of the influence of attention on human behavior, attempts to define attention have been characterized by controversy (Sohlberg & Mateer, 1989). The problem is compounded by the fact that not many studies have been undertaken in the area of rehabilitation for attention deficits, thus resulting in limited availability of well-developed investigative tools.

Only two of the assessment tools (the PASAT and the DVT) used to investigate attention performance in this study were standardized and well-established tests. Of the remaining two, one (RAPT) was still in its experimental stage and the other (MTVAT)

was being piloted. Because of their newness, caution is required in interpreting findings based on these tests. A similar situation is the case with the PROMS, used to test prospective memory. Although intended for use as a screening measure, the test was used in this study for lack of an alternative.

On the other hand, the fact that subjects with identified attention deficits did well on the RAPT suggested that this instrument was not sensitive enough to the attention deficits of people with mild TBI. Sight must not be lost, however, of the fact that these tests were used in combination with other well-established alternative tests, thus reducing their weight in the findings.

The existing APT tools for both training and assessment of attention performance are handicapped by cross-cultural limitations. First, the content is heavily biased toward the American settings and culture, thus limiting their use universally. Secondly, because of their heavy reliance on the ability to decipher written material, these tools cannot be used in illiterate communities, thus limiting their usefulness universally. Thirdly, by their nature the tools confine their use to laboratory settings and sedentary activity, two factors that tend to demotivate participants, especially considering the length of time required for effective training. This latter factor is thought to have contributed to the attrition of one subject in this study. This subject felt that since she had no serious problems with numbers, letters, and word stimuli, the training she received did not cater to her individual needs as she had expected. Her preference would have been for tasks related to reading and music rhythms, which were areas of her central interest. One is inclined to think that generally tasks that allow more variety of activities and movement may be more stimulating and

motivating without jeopardizing the intended effect.

Lack of Criteria on Measurement of Behavior Changes

The controversy regarding the definition of attention has in turn led to a relative lack of studies in attention, especially in the area of brain injury (Sohlberg & Mateer, 1989). Problems associated with the lack of studies in attention extend beyond the limits of definition to handicap the very process of interpreting study outcomes. Currently, there is no clear directive on the criteria of what constitutes increased performance in the area of attention. This is more evident in parameters that involve rates of response. In this study, since increase of performance in visual attention could not be measured based on the number of correct responses only, the lack of definite criteria for determining what constituted increased performance was a crucial issue. A related concern was the apparent oversight in not providing for people with education higher than the general majority. In this study, despite her attention disabilities one subject was able at baseline to perform far above the given normal values in almost all tests. It was assumed that her level of education gave her an advantage over the other subjects. Since the assessment tools appeared insensitive to the deficits in this particular subject, a concern is raised regarding the potential risk of excluding such persons from training in the case where any of these instruments are used to screen subjects.

Generalization

The question of generalization of findings was affected by several issues in this

study. The limited sample made necessary by the study design was one major limitation. Four subjects were recruited to the study. Of these, three completed the study and one subject dropped out halfway through it. However, part of the data from this subject was sufficient enough to be useful in determining some aspects of the outcome. Thus, the limited sample findings from this study are not sufficient to generalize to a wider population. Another generalization problem related to the sample was the female bias. Three female subjects and only one male participated in the study. All participants were Caucasian, thus creating a race bias with limiting effects on generalization. The recruitment market was another concern for generalizability of the results. The fact that the sample in this study came only from the local head injury support groups pool has a potential influence on the outcome of the study. It is difficult to predict how a sample from another source would have responded to the intervention. The economic status of the participants is another issue for consideration. The lower socioeconomic status of the participants in this study might have had a profound influence on the outcome of the study.

Study Duration

Learning is a slow and long process, sometimes involving a lifetime. Since changes due to learning do not generally occur in a short time, and since when they do occur they take time to be established, the period of training in this study appeared relatively short for the intended changes to take root. This is more of a concern when one considers that APT aims at changing cognitive behavior. Compared to some previous studies, however, the duration of this pilot study was considerably longer. Individualizing the intervention also ensured maximum benefit from training procedures.

Transference of Learned Behavior

Despite the recognition that the aim of any rehabilitation program is to provide subjects with skills that fit within their life situations, the study provided no training for generalization of learned behavior. The need to train participants in a cognitive rehabilitation program on generalization skills has been indicated in previous studies (Raskin & Gordon, 1992; Sohlberg & Mateer, 1987). Limitations in the use of subjective data provided by participants cannot be overlooked. However, it is the investigator's opinion that the inability of subjects in this study to report more accurately the frequencies of their attention lapses and successes deprived the study of valuable data. Training subjects in generalization skills would ensure adequate use of instruments in obtaining subjective but quantifiable data. To achieve this goal there should be closer supervision and guidance of participants in real life situations. Learners need reinforcement of learned skills in order to persist in exhibiting the learned behavior. In the absence of this

reinforcement learned behavior usually falters.

Practice Effects

The basic principle of the technique of APT is provided by Luria (1981). This neuropsychologist hypothesized that repeated stimulation of the targeted neurobiological system facilitates its recovery and reorganization of functioning. This principle calls for repeated practice of targeted behaviors, thus laying individuals open to the effects of automatization. Findings on performance from these studies may be misleading. To reduce this effect the current study provided alternate versions of training tasks and made use of several tests to evaluate each of the outcome variables.

Lack of Follow-up

The lack of long-term follow-up on the subjects to investigate persistence of learned behavior is a significant limitation for this study. Due to time constraints and limited resources, this important exercise was omitted. It is not known, therefore, how long the desired behaviors persisted in these subjects after training was discontinued. The study did, however, provide continued, periodic, short-term evaluation of learned behavior during the progress of the study.

Contribution to Knowledge of Nursing Science

Like all other health care concerns, cognitive performance is a concern of nursing. This study created an awareness of the need for cognitive rehabilitation in persons with mild TBI. The study also provided preliminary evidence of the possibility for specific effects of attention training modality on attention performance. It has also raised the possibility that visual attention training may have a higher response than auditory attention training. That findings further support the general effect of attention training on the reduction of attention deficits is of significance to nurses in patient teaching situations. Creating both physical and biological environments suitable for patient learning is of paramount importance. Perhaps the most significant finding was the confirmation that attention training confined to the laboratory setting does not provide adequately for the attention needs of persons with mild TBI. There is an indication that inclusion of more real life training opportunities in cognitive rehabilitation is needed. This fact brings into awareness the limitations of Luria's hypothesis on targeting of the neurocognitive system as a basic principle in cognitive rehabilitation.

Suggestions for Future Research

Since cognitive assessment is a complex process requiring accuracy and involving multiple factors, it is recommended that future studies be directed to the broadening of the evaluation instruments used in order to increase their effectiveness in the assessment of mild TBI. Such instruments will need to take into consideration the need to provide for more wider use, in the form of cultural diversity, differences in interest, and peoples'

varied preferences with respect to activities that stimulate attention and enthusiasm. It is not unreasonable to suggest that things that provide for the immediate needs of people stimulate more interest than things that do not. This flexibility is essential when one considers the amount of time individuals have to spend on a cognitive rehabilitation program. To meet the need for more useful attention assessment tools, future research is needed to develop tools that will cater to wider populations of brain damage, cultural diversity, educational differences, and illiteracy.

Since there seems to have been no research done on how educational level influences the sensitivity of attention assessment instruments, a need is indicated for research to determine this factor. Findings on this study appeared to identify the rate of response as a better and more sensitive indicator of attention deficits. There is a need, therefore, to further investigate this finding. Another area to investigate is the question of whether auditory and visual attention deficits always occur in association with each other or not. The possibility was raised in this study that perhaps the subjects' high scores in auditory attention tasks prior to attention training, in contrast to visual attention tasks, could have been an indication of absence of auditory attention deficits despite the apparent deficits in visual attention. There is a need for future studies to investigate this possibility.

The predominantly female and Caucasian sample in the current study calls for future studies that will extend the sample to include more male subjects and individuals from other racial and ethnic groups. A diversified study sample will dilute the biases inherent in the current study sample and thereby give a better indication of the effectiveness of the APT. To facilitate generalization, it is desirable that future studies be

conducted on a larger and randomized sample.

The relatively short duration of this study presents a limitation in consideration of the fact that learning is a slow process. It is recommended that future studies be conducted over a period of time longer than the 16-week period that was allowed for the current study. This increase in time should take into consideration the need for follow-up on the subjects to determine stability of the learned skills and their generalization. A major hindrance in this recommendation would be cost of a longer study.

Finally, the need for cognitive training in both laboratory and non-laboratory situations was indicated in the current study and others before it. There appears to be a need for a theory that will accommodate this approach to cognitive rehabilitation. Such a move will require research oriented towards modifying the emphasis on mental activity generated by Luria's hypothesis.

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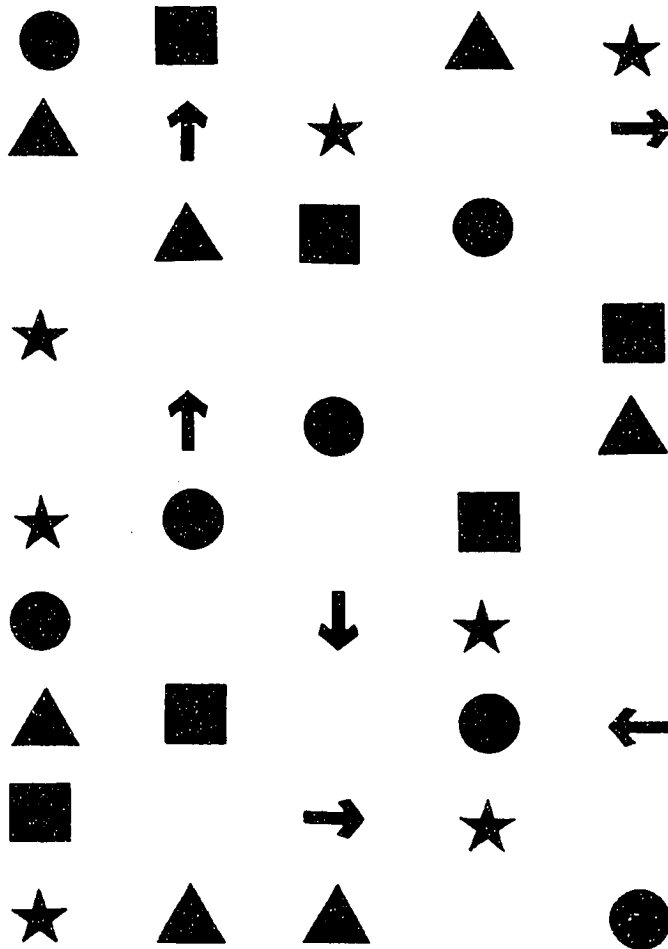
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APPENDIX A. ATTENTION PROCESS TRAINING MATERIALS

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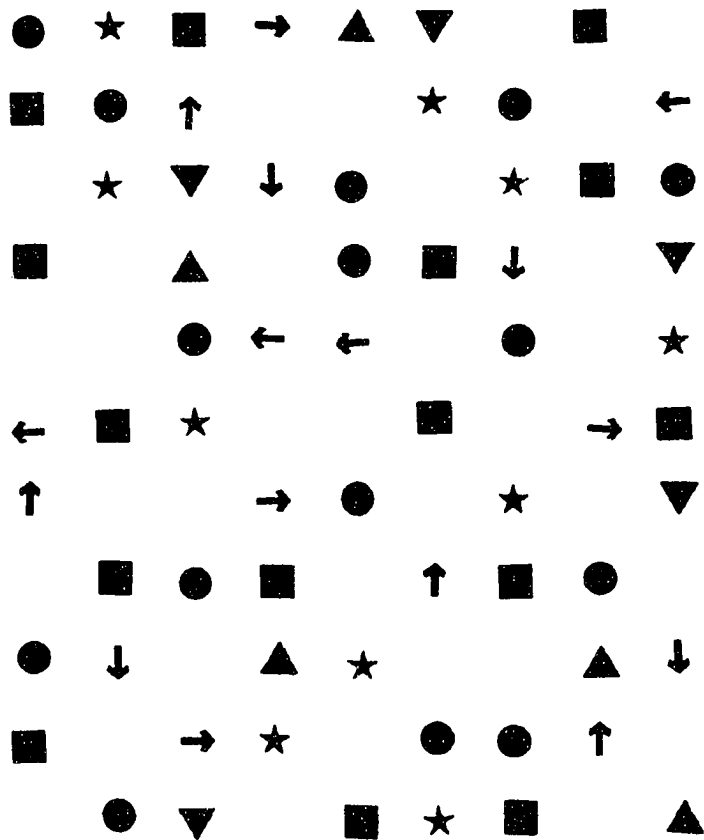
STIMULUS SHEET #1



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STIMULUS SHEET #2

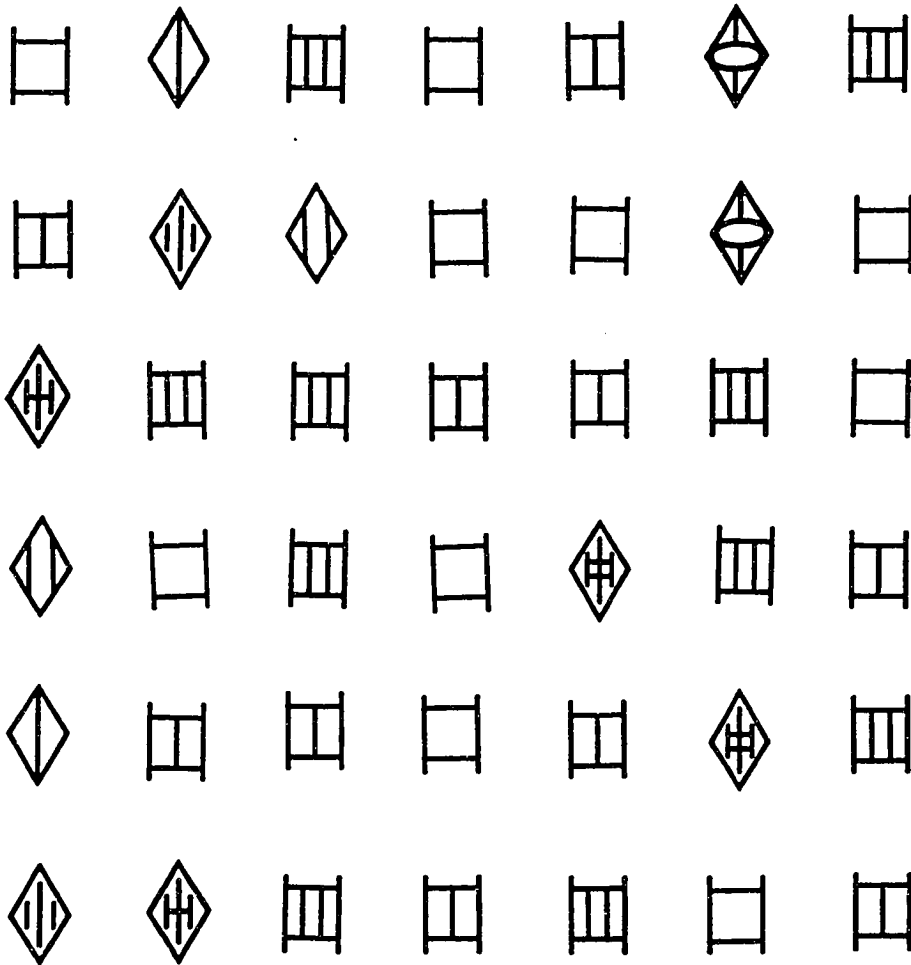


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STIMULUS SHEET #3A

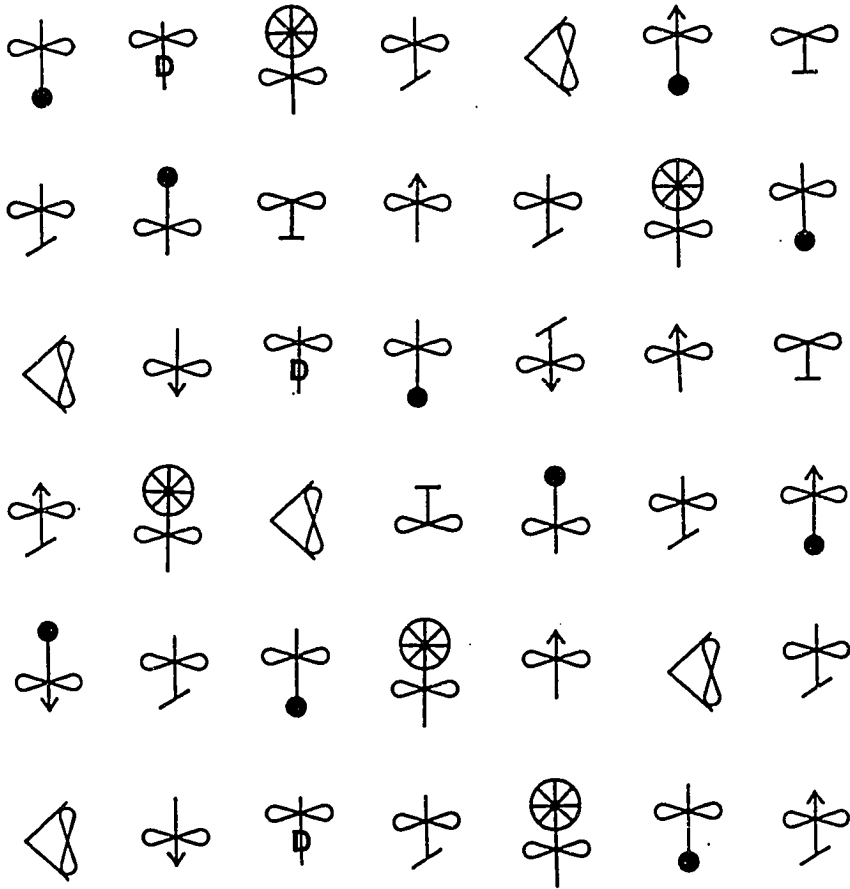


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STIMULUS SHEET #3B



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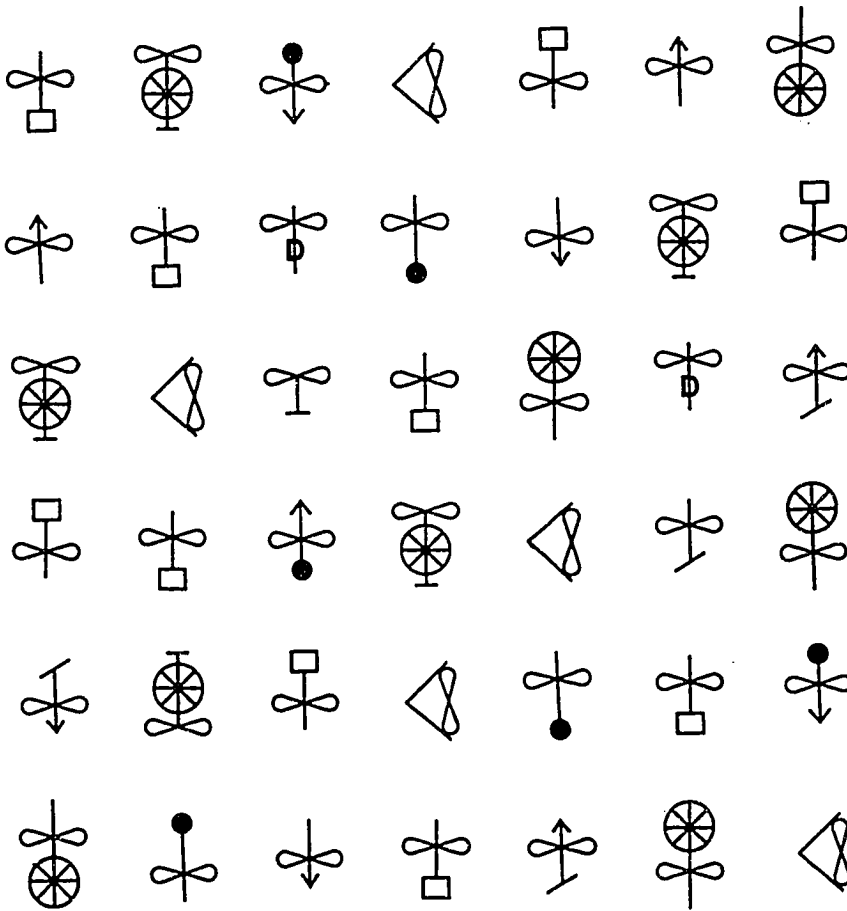
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STIMULUS SHEET #3C



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STIMULUS SHEET #4

4	6	3	8	6	4	3
3	3	4	3	8	6	4
4	3	8	6	5	7	6
2	6	3	5	6	3	5
3	4	3	2	1	3	4
4	4	3	6	4	3	4
7	6	5	3	6	6	2
6	5	4	4	3	2	0
4	4	6	3	6	2	6
8	6	3	2	6	1	5
4	3	6	4	8	4	4
3	6	5	3	7	6	4

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STIMULUS SHEET #5

3	4	9	6	5	4	3	1	9	8	7	2	2
2	5	7	6	4	2	8	9	3	4	0	1	4
3	1	4	2	0	5	7	6	6	0	3	5	9
5	4	2	0	0	9	1	7	3	4	6	8	5
9	3	1	1	3	6	9	8	7	3	8	5	6
8	4	3	4	2	3	5	0	8	4	2	6	4
9	9	7	3	8	7	4	0	6	6	1	7	2
0	6	6	1	9	8	2	1	4	5	6	0	1
2	5	4	4	4	0	1	4	0	0	9	4	0
3	4	1	2	1	9	7	7	4	9	0	5	4
6	2	8	0	0	3	9	4	2	5	3	4	5
9	1	4	8	0	4	6	3	2	7	4	5	1
8	0	3	2	8	5	4	4	0	7	4	7	9
7	5	9	5	1	6	3	6	6	7	3	1	6
2	2	0	6	7	5	7	8	7	9	2	0	7
9	3	6	0	3	2	1	8	5	0	8	5	9

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STIMULUS SHEET # 8

98	5	66	1	29	65	37	68	83	37	67	31	24	42	23	71	42	64	82
36	67	6	21	9	38	69	41	96	97	4	25	43	38	96	39	66	8	95
72	7	82	7	56	55	8	42	70	98	85	3	54	41	26	2	20	81	44
46	11	10	76	8	9	86	97	39	43	84	32	84	19	98	40	44	65	23
39	96	29	40	56	9	75	41	10	69	43	99	1	85	70	27	48	7	45
83	12	36	22	36	20	55	10	66	11	18	86	89	28	77	49	6	45	24
11	58	97	13	23	57	35	87	52	80	29	12	25	58	80	53	25	5	59
46	84	89	35	14	34	19	24	17	87	64	30	13	78	2	26	4	92	46
59	12	15	98	88	63	85	40	39	23	28	16	27	14	31	47	92	80	93
13	26	90	99	1	79	3	18	33	50	47	29	21	62	15	51	32	48	54
60	16	78	17	37	27	34	18	88	17	71	22	16	30	48	91	31	16	72
77	28	37	62	25	38	24	36	19	20	52	86	32	49	50	53	56	17	60
53	96	42	7	4	89	11	47	32	22	59	67	47	12	95	14	87	66	43

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APT-II
SEMANTIC CATEGORIES—Set A

Name _____

Circle the word in each group that does not belong

APPLE	PEAR	PAPAYA	PANTS	GRAPE
ROSE	TULIP	PANSY	HOUSE	DAISY
DESK	BED	COUCH	TABLE	MAIL
STRAW	MAN	WOMAN	CHILD	GIRL
SCHOOL	FRIEND	LIBRARY	STORE	BANK
CIRCUS	MOVIE	STREET	CONCERT	PLAY
SAD	HAPPY	GIFT	BORED	CURIOUS
FORK	HAND	SPOON	KNIFE	SPATULA
PAPER	PEN	STAPLER	SHIRT	PENCIL
HAND	PLANT	LEG	HEAD	ARM
BLUE	GREEN	BLACK	RED	CLOUD
CAR	TRUCK	BLENDER	BUS	TRAIN
RAIN	SNOW	SUN	PHONE	HAIL
HOUSE	TENNIS	JOGGING	SOCCER	TRACK
KITTY	DOG	DOLL	BIRD	RABBIT
CAKE	COOKIE	CANDY	ICE CREAM	CORN
SPELLING	MATH	READING	EAT	SCIENCE
TEACHER	CLERK	FRIEND	WAITER	DOCTOR
WOOD	SAW	METAL	PLASTIC	CEMENT

HUNGRY	RAINY	STORMY	SUNNY	SNOWY
MONDAY	TUESDAY	APRIL	SUNDAY	SATURDAY
PACK	SUITCASE	TICKET	PLANE	COOK
CRAYON	PEN	PENCIL	MARKER	LIGHT
OAK	PINE	MAPLE	GRASS	REDWOOD
NEEDLE	PIN	KNIFE	SCISSORS	SPOON
SEW	SWIM	KNIT	CROCHET	WEAVE
PARK	PLAYGROUND	ZOO	MOVIE	BALLFIELD
HEART	STOMACH	LIVER	LUNG	HAIR
GIFT	BALLOON	SAND	CANDLES	CAKE
WATCH	PICTURE	CLOCK	ALARM	TIMER
PILLOW	BLANKET	RUG	SHEET	COVERS
ORANGE	YELLOW	BLUE	GREEN	PAINT
BATHE	SCUBA DIVE	DRIVE	WADE	SWIM
RADIO	COMPACT DISK	TAPE	STEREO	BOOK
SWEEP	DUST	WASH	READ	MOP
BOTTLE	DIAPER	BOAT	PACIFIER	POWDER
SUN	EARTH	PLUTO	JUPITER	CITY
MAN	WOMAN	FAN	CAN	TAN
FALL	VACATION	WINTER	SPRING	SUMMER

APT-II
SEMANTIC CATEGORIES—Set B

Name _____

Circle the word in each group that does not belong

RUN	WALK	CRAWL	JUMP	SLEEP
FIRE	EARTHQUAKE	FLOOD	TORNADO	JUNGLE
TRACTOR	TIGER	PIGS	COW	BARN
JUICE	WATER	APPLE	MILK	SODA
ROUND	SQUARE	CIRCLE	ROOM	OVAL
ONE	SEVEN	THREE	MANY	FIVE
SEE	HELP	HEAR	TOUCH	TASTE
FRANCE	NEW YORK	MEXICO	U.S.	CANADA
LAMP	FIRE	RADIO	LIGHT	CANDLE
MILK	BREAKFAST	LUNCH	DINNER	SNACK
COLD	FROZEN	HOT	SNOW	WARM
VEAL	CHICKEN	TURKEY	SOUP	BEEF
DATE	PRUNE	RAISIN	FIG	TOMATO
FURNACE	WINDOW	HEATER	BOILER	PUMP
BED	MORNING	NIGHT	DAY	EVENING
TEEN	CHILD	ADULT	GROW	BABY
BOOK	PARAGRAPH	WORD	LETTER	SENTENCE
FIGHT	ARGUE	SHOUT	PERSON	YELL

HAPPY	GLAD	BORED	CHEERY	EXCITED
HAT	SWIMSUIT	SCARF	MITTENS	COAT
UNCLE	LOG	GRANDPARENT	AUNT	COUSIN
SKI	SLEIGH	SLED	SNOW	BOAT
T.V.	MAGAZINE	BOOK	CATALOG	PAPERBACK
DOLL	BALL	TRIKE	KNIFE	BLOCKS
MIX	HAT	FAT	CAT	SAT
ROOF	DOOR	CAR	WINDOW	WALL
FINGER	SHOULDER	ARM	ELBOW	HAT
DRESSER	WINDOW	BED	CHAIR	TABLE
CAT	HAMSTER	SPOT	DOG	PARAKEET
FISH	MONKEY	WHALE	SHARK	SEAL
QUARTER	WALLET	PENNY	DIME	NICKEL
WAX	HARDWOOD	CARPET	TILE	LINOLEUM
MARY	HARRY	LARRY	BOB	JIM
HAPPY	JOYFUL	UPSET	MERRY	BLISSFUL
BUFFALO	CATTLE	TURTLE	HORSES	MULES
FORK	KNIFE	SPOON	PLATE	HOUSE
BLANKET	BEDROOM	QUILT	SHEET	BEDSPREAD
SUNSHINE	CHANDELIER	LAMP	SPOTLIGHT	HEADLIGHT

APT-II
SEMANTIC CATEGORIES—Set C

Name _____

Circle the word in each group that does not belong

CABINET	DRAWER	SHELF	CUPBOARD	CHAIR
GLUE	SYRUP	TAPE	TAR	METAL
RING	NECKLACE	BRACELET	NAIL	EARRING
FAIR	CIRCUS	SLEEP	PARADE	PICNIC
GOLD	PLASTIC	EMERALD	DIAMOND	SILVER
PLANE	SWIM	BOAT	TRAIN	BUS
MOP	SWEEP	HOP	TOP	POP
TEN	TWO	THREE	TWELVE	SIX
CARROT	CANDY	CELERY	BROCCOLI	BEANS
VACUUM	HAMMER	SAW	DRILL	PLIERS
EYES	NOSE	LEG	MOUTH	EARS
TEACHER	STUDENT	HOME	CLASSROOM	DESK
SINK	DESK	FRIDGE	OVEN	STOVE
DAISY	PANSY	DAFFODIL	WEED	TULIP
VALLEY	MOUNTAIN	CAR	HILL	FIELD
MOUSE	HAMSTER	BUNNY	LION	RAT
WHEAT	BASKET	RICE	BARLEY	OAT
MUSIC	SIREN	SCREECH	ALARM	HONK

BLUE	RED	BLOOD	GREEN	ORANGE
UP	DOWN	TOWN	ACROSS	THROUGH
BEGIN	COMPLETE	FINISH	STOP	DONE
BRICK	WOOD	PLASTER	STEEL	BUILDING
RUN	SKIP	GALLOP	TROT	EAT
SUN	SIT	MAT	SIX	SET
DREAM	COOK	SNORE	SLEEPWALK	SLUMBER
TUESDAY	CHRISTMAS	NEW YEARS	EASTER	JULY 4TH
MONDAY	NIGHTTIME	SUNDAY	WEDNESDAY	SATURDAY
DOCTOR	ENGINEER	BANKER	SECRETARY	WEEKEND
GOAT	COW	SHEEP	CHICKEN	MONKEY
HAIR	BROWN	RED	BLACK	BLOND
HONDA	FORD	BICYCLE	JEEP	TOYOTA
TIE	SUIT	SLACKS	COAT	BLANKET
LAKE	FIELD	POOL	OCEAN	RIVER
TABLE	BED	CHAIR	SOFA	WHEEL
RAKE	REST	MOW	PRUNE	WEED
CHILD	INFANT	BABY	TODDLER	PUPPY
PARK	STREET	BOULEVARD	FREEWAY	ROAD
TRAFFIC	SIGNAL	CROSSWALK	INTERSECTION	KITCHEN
IN	OUT	GIVE	UNDER	ON
WEDDING	DOG	BRIDE	GROOM	RING

APT-II
ARTICLE #5

Directions: Read article. After you have finished reading, you will be asked to answer several questions, but you will not be able to look back at the article. While you are reading, cross out all of the ____s ("and" or "the" words or "ed" word endings). Then count the total number that you crossed out when you are done reading.

Economists often seem to be searching for a quick cure to economic problems. Many economists think they have found it in the gold standard. The gold standard is one of the oldest economic ideas, and one that many people thought was no longer relevant. Only recently, with world economies troubled by markets that rapidly go up and down, high interest rates, and rising deficit the idea of the gold standard has been revived.

Under the gold standard, all countries once valued their moneys in gold, making paper money convertible into gold and setting currency exchange rates on the basis of that convertibility. Many decades back, this country had a "pure" gold standard under which any citizen could turn in paper money for gold. This was abolished in the early 1930's for a "modified" gold standard, under which paper currency was tied to gold at \$35.00 an ounce, and other currencies were tied to the value of the dollar. This standard was eliminated in the early 1970's.

Some people believe that going back to the gold standard would cure some of the world economic problems given that all people understand the value of gold. They say it would force the U.S. and its trading partners to do some automatic adjustments in their monies. They also argue that it would keep our government honest.

There are other people who think that a gold standard would send us back to the financial dark ages. They recall the inflexibility of the gold standard. They further argue that it could destabilize economies. One never knows, however; if our economic situation does not improve, there are those who believe we will be hearing more about the gold standard. Others say do not hold your breath waiting for this to happen as they feel it is very unlikely.

Answer the following questions based on the article you have been reading:

Q.1

What is the gold standard?

Q.2

When was the gold standard abolished?

Q.3

Give 2 reasons in support of the gold standard

Q.4

Give 2 reasons some people think the gold standard will belongs to the dark ages

Q.5

Give three factors contributing to the recent revival of the gold standard

APT-II
ARTICLE #6

Directions: Read article. After you have finished reading, you will be asked to answer several questions, but you will not be able to look back at the article. While you are reading, cross out all of the ____s ("the" words; "ed" or "ing" word endings). Then count the total number that you crossed out when you are done reading.

Imagine that you leave your car parked all day in the sun with the windows rolled up. When you return, the interior of your car will be much hotter than the air outside. The reason is because the window glass lets the sunlight through but captures the heat. A similar principle exists with the gas that we breathe out, carbon dioxide. Carbon dioxide lets sunlight through, but captures heat.

Our earth does need carbon dioxide to help provide insulation, but we need it in a certain proportion--about .03 percent of the total atmosphere. In the past 100 years, however, the amount of carbon dioxide in our atmosphere has increased about 15 percent. Most of this increase is due to the burning of coal, oil, and gas. Another cause has been the logging of trees, where there has been clearing of large planting areas. Plants are needed to help turn carbon dioxide into oxygen and carbohydrates.

The more carbon dioxide we have in our atmosphere, the hotter we get. There is much controversy over how worried we should be about the possibility of a trend in "global warming" or a heating up in the atmosphere. Some scientists are concerned that a rise in temperature will melt ice caps at the North and South Poles. They say this melting might cause seas to rise which will flood coastal cities; make strange weather patterns, triggering droughts and floods; and alter the ocean currents reducing the fish supply.

Other scientists are more optimistic. They think a warming trend might keep us from having another ice age. They further argue that an increase in carbon dioxide might increase the amount of plant growth.

Global warming is an environmental issue receiving a lot of attention. There has been a major effort to cut down in burning the fossil fuels like coal that produce carbon dioxide. Scientists are taking a more careful look at what we need to do to preserve our earth.

Answer the following questions based on the information you have just been reading:

Q1.

The earth needs carbon dioxide to

Q2.

The amount of carbon dioxide needed is of the total atmosphere.

Q3.

In the past years the amount of carbon dioxide has increased by

Q4.

What are the two factors that have contributed significantly to the increase of carbon dioxide in the atmosphere?

Q5.

Global warming due to excess of carbon dioxide may cause:

1)

2)

3)

Q6.

Plants control global warming by:

.....

.....

APT-II

ARTICLE #8

Directions: Read article. After you have finished reading, you will be asked to answer several questions, but you will not be able to look back at the article. While you are reading, cross out all of the ____s ("the" words; or "ed" or "ing" word endings). Then count the total number that you crossed out when you are done reading.

During the Renaissance period in Italy, a number of important art techniques were developed and refined, shaping the direction of the art world.

One such technique is "chiaroscuro". Chiaroscuro is the name of an Italian art technique. The word "chiaroscuro" means "bright-dark" in Italian. It is a technique used in painting or drawing, of making three-dimensional figures by contrasting areas of light and dark. Leonardo da Vinci was among one of the first artists to use chiaroscuro. The painter, Rembrandt, is probably the most well known master of this technique. Prior to his using chiaroscuro, the art tradition was to draw or paint flat, one-dimensional outlining of figures. Hence, the chiaroscuro technique represented a major advance in artistic techniques. It developed during the Renaissance period and is considered one of that time period's most major achievements.

A second interesting art technique is "fresco". This is an ancient method for painting indoor murals. It involves brushing water-based paints onto fresh, moist lime plaster, so that the paint is absorbed by the plaster as it dries and becomes part of the wall. The word fresco means "fresh" in Italian. Like "chiaroscuro", "fresco" reached its peak during the Renaissance period. Two of the most famous frescoes are one by Michelangelo in the Sistine Chapel and one by Raphael in the Stanza della Segnatura.

Yet a third artistic technique is "pentimento". This is the term used for a method of how an artist covered a mistake or changed his mind regarding what he wanted to paint. The technique is simply to paint over the area that is to be modified. Pentimento comes from the Italian word for repentance. An interesting thing has happened in some of the paintings where pentimento was used. Over many years the top layer of paint becomes transparent, so that the original portion of the picture that was painted over shows through. The most famous example is in a painting by Rembrandt where there is a double hat brim on the lady in the portrait, *Flora*, because the original one now shows through the paint.

ARTICLE #8 - QUESTIONS

239

Q1.

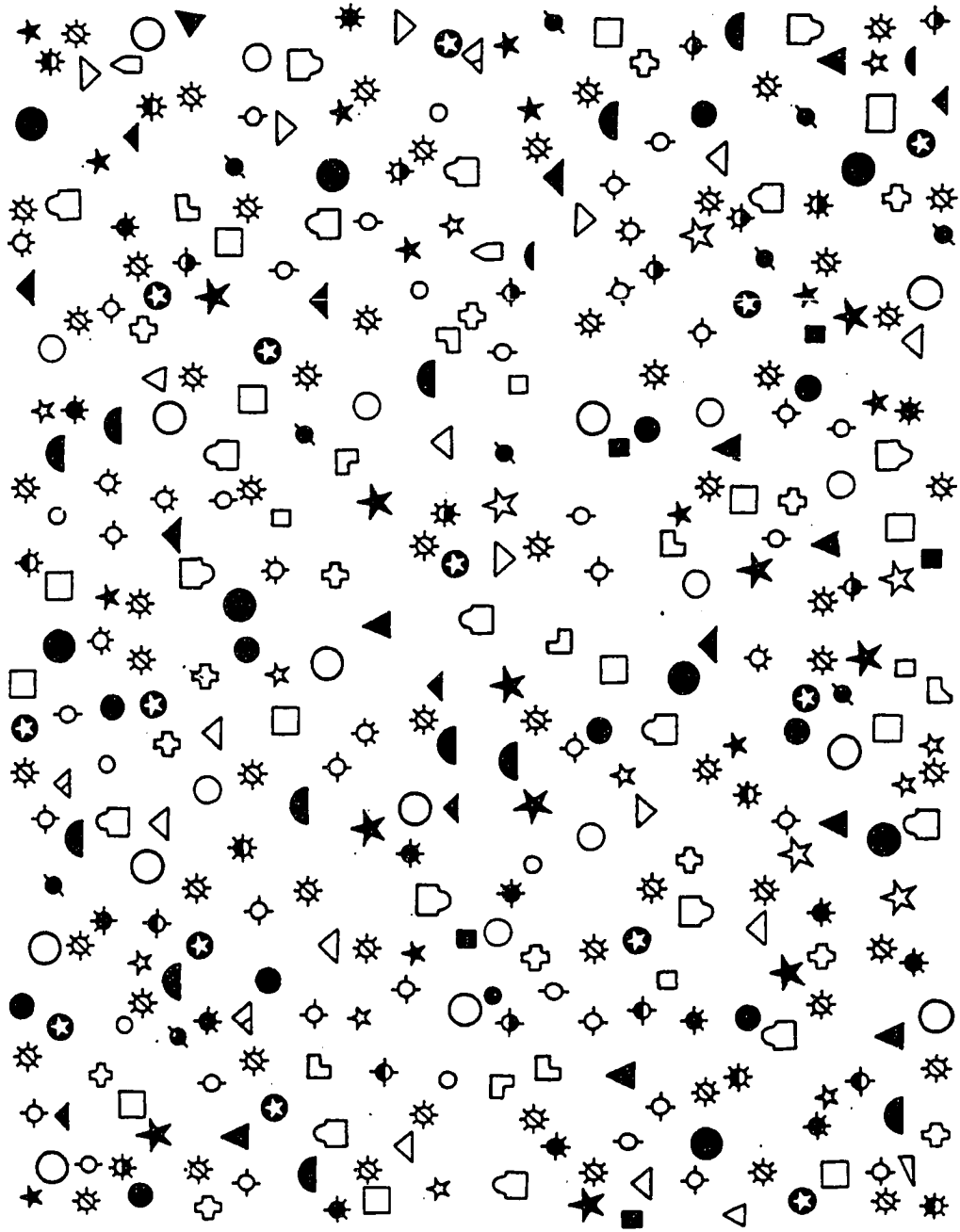
Give this article a suitable title.

Q2.

Describe specific characteristics/features of the 3 art techniques outlined in this article.

**APPENDIX B. VERBAL AND NONVERBAL CANCELLATION TASK
STIMULUS SHEETS**

N E A P W B V A Q H C R Y A G
 X Z R U A T I L S N K O X M Z L A O D
 F R G A V K Y D U P A A Z T F S J A L B R C
 Q I O B L P K A E I J O L Z H V X Q A F W U A
 B A S F M V K A W C P J S E U D P V R A I B X H
 T J A S Z A W A W A Y A C W I G A K L
 F N Z X E B A L T Y G N P F A C W I G A K L
 I A Q D M W G E F A V L R S B X M I Q U R A H N
 U A K C H U T I G F S J O A S R D P H N R G O A E V
 O K C H U T I G F S J O A S R D P H N R G O A E V
 Y D A H R I G F S J O A S R D P H N R G O A E V
 E W L A A T M V I A K U A A F P
 T A P Y N K A S B W L U I B J A L D Q A T S Y I
 H P B K A S B W L U I B J A L D Q A T S Y I
 J S I A L G C A P R R P W U L D Q A T S Y I
 D A I N F A J R E K A I M D H V A O G T B A
 C Q T B A O S J R E K A I M D H V A O G T B A
 A L I D W A F P Z V O R U E J Y A U I D A
 S E G A B W F G A H T T K A Q Y A R C A U I M R Y



APPENDIX C. INDIVIDUALIZED TRAINING PROGRAMS

Subject 01.....	244
Subject 02.....	251
Subject 03.....	269
Subject 04.....	273

PHASE A, VISUAL ATTENTION:

3/17/95

Sustained

Stimulus sheet #1

Circle all red objects except those found to the left of yellow objects. Add them to the total number of star.*

Stimulus sheet #2

Circle all black objects except those found to the left of yellow objects. Add them to the number of red objects that are not stars.*

Stimulus sheet #3A

Circle all beds with 2 lines and cross out every 3rd one-line bed.*

Stimulus sheet #3B

Count all arrows and add them to dots and diagonal lines.*

Stimulus sheet #3C

Circle all objects with arrows, shade in squares, and check diagonal lines.*

Stimulus sheet #4

Cross out all 3's and every 3rd 4, in this sheet of paper.

Stimulus sheet #5

Cross out all 9's and 2's.

Stimuli sheet #6

Cross out all 6's and 9's

Stimulus Sheet #7

Count down from a given number. (All series).

Divided

Read and scan - Article #1

3/20/95

Sustained

Stimulus sheet #4 - Circle all 6's and cross out every 3rd 4's.

Stimulus sheet #5 - Cross out all 9's and alternate 2's.

Stimulus sheet #6 - Cross out all 9's and 1's

Cross out all A's and I's.

Cross out all sun's with eight rays.

Cross out all round objects and triangles.

Divided Read and scan - Article #1

3/22/95

Sustained

Stimulus Sheet #4 - Circle all 6's and cross out every 3rd 4's.

Stimulus Sheet # 5 - Cross out all 9's and alternate 2's.

Stimulus Sheet #6 - Cross out all 9's and 1's.

Cross out all A's and I's*

Cross all suns with eight rays.*

Cross out all round objects and triangles.*

Stimulus Sheet #8 - Cross out every other odd number.

Divided Read and scan - Article #1

3/24/95

Sustained

Stimulus Sheet #5 - Cross out all 9's and alternate 2's.

Stimulus Sheet #6 - Cross out all 6's and 1's.

Stimulus Sheet #5 - Circle any number in a row that is 1 less or 1 more than the one above it.

Stimulus Sheet #8 - Cross out every other odd number.

Cross out all round objects and triangles.*

Cross out all suns with 8 rays.*

Cross out all A's and I's.*

Divided Read and scan - Article #2

3/29/95

Sustained

Stimulus Sheet #5 - Cross out all 9's and alternate 3's

Stimulus Sheet #8 - Cross out all alternate odd numbers

Cross out all suns with 8 rays.*

Cross out all A's and S's.*

Cross out all round objects and triangles.*

Divided Read and scan - Articles #3 and #4

246

*These tasks were modified from Mesulam Spatial Relations Test sheets.

3/31/95

Selective

Stimulus sheet #4 - Cross out all 3's and every 3rd 4, (Overlay C)

Stimulus sheet #5 - Cross out all 9's and 2's, (Overlay A)

Stimulus sheet #6 - Cross out all 9's and 1's, (Overlay B)

Alternate

Stimulus sheet #4 - Cross out 3's and 6's, then 4's and 6's, (10 sec. intervals)

Stimulus sheet #5 - Cross out 5's then 9's, then 2's. Repeat order at switch command.

Stimulus sheet #6 - Cross out 9's and 1's, reverse order at switch command, etc.

Stimulus sheet #8 - Circle first odd numbers, then even numbers at switch command. Keep on alternating.

Sustained Stimulus sheet #6 - Cross out 9's and 2's (Intensive)

Divided Read and scan - Article #5 (with questions prepared).

4/3/95

Sustained Cross out 9's and 0's (Intensive).

Divided Read and scan - Article #6.

Selective

Stimulus sheet #6 - Cross out 1's and 6's, (Overlay B).

Reading: Article #5 with Overlay A.

Alternate

Stimulus sheet #5 - Cross out 2, then 9, then 5 at switch commands. Change order to 9, 2, 5, at end of cycle. Alternate the cycles accordingly. (10 sec. intervals).

Stimulus sheet #6 - Cross out 1's and 9's, then 1's and 6's at switch command. (10 sec. intervals).

stimulus sheet #8 - Going down two columns, first cross out even numbers, then odd numbers, at the switch command.

Stimulus sheet #10 - Set Dependent Activity.

2/5/95

247

Sustained Stimulus Sheet #6 - Cross out all 9's and 0's

Alternating

Stimulus Sheet #8

Going down two columns at a time, first, cross out even numbers. At the switch command cross out odd numbers. Alternate these at the switch command.

Stimulus Sheet #5

Going row by row from left to right, cross-out first 2, then 9, then 5, at the switch command. Change the order to 9, 2, and 5 at the end of the cycle. Alternate these cycles accordingly at the switch command (10 sec. intervals).

Stimulus Sheet #10 - Set Dependent Activity.

Stimulus Sheet #11 - Set Dependent Activity

Serial Numbers - 3 Step / Series 1

Divided Read and scan - Article #7

4/7/95

Alternating

Stimulus Sheet #8

Going down two rows at a time, and starting from the right, cross out even numbers. At the switch command cross out odd numbers. Alternate these at every switch command.

APT -II Alternating Alphabet Stimuli

Divided

Read and scan - Article #8 (with made-up questions).

Card sort - (1)Sort by suite and card name (T);

(2)Sort by color and card name (N).

Mental Control

3-Step Serial Numbers - (-5 +1 -3)

Number Mental Control Stimuli - 4 Numbers/0-100

(Ascending, Descending, Reverse, Every other).

END PHASE (A) ASSESSMENT (01) 4/10/95

Paced Auditory Serial-Addition Test

Revised Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test - Cross out every other odd number, and all numbers divisible by 4.

PHASE (B₁) - AUDITORY ATTENTION TRAINING (01)

248

4/12/95

Tapes- IA, IIA, IIIA,

Semantic Categories - Set A

APT-II Sentence Stimuli - 4 Word:

Alphabetize 1-10

Reverse 11-20

Progressive 21-30

4/17/95

Tapes - IIA, IVA, IB (slow and fast condition)

*This session cut short at the subject's request - time constraints

4/19/95

Tapes - IVA slow, IB (slow), IIB (slow & fast), IIIB (slow & fast), IVB (slow & fast)

APT -II Sentence Stimuli - 4 Word:

Alphabetize and Reverse simult. 31-40

- 5 Word:

Alphabetize 1-10

Reverse 17-26

Progressive 11-20

Semantic Categories Set - A & B

4/21/95

Tapes - IVA (slow), IIB (slow & fast), IIIB (slow & fast), IVB (slow & fast)

APT -II Sentence Stimuli - 4 Word:

Alphabetize/Reverse 42-51

-5 Word:

Alphabetize 11-20 (score discarded due to error in item #18)

Reverse 1-10

Semantic Categories -Set B

4/24/95

Tapes - IVB (Slow & fast), IC (slow & fast), IIC (slow & fast)

APT -II Sentence Stimuli - 4 Word:

Alphabetize and Reverse simult. 21-30

-5 Word:

Alphabetize 22-31

Reverse 32-41

Progressive 42-51**Semantic Categories -Set C**

4/26/95

Tapes - IVB (slow & fast), IIIC (slow & fast), IVC (slow & fast)**Sentence Stimuli -4 Word:**

Alphabetize & Reverse simult. 51-60

5 Word:

Alphabetize 31-40

Reverse 41-50

Progressive 21-30

Semantic Categories -Set B**Semantic Categories -Set C**

4/28/95

**Tapes - IVB (slow & fast), IIIC (slow & fast),
(IVC not done, subject reluctant)****APT -II Paragraph Listening -Side A****Sentence Stimuli -6 Word:**

Alphabetize 1-10

Reverse 11-20

Progressive 21-30

5/1/95

Tapes - IVC (slow & fast), IF (slow & fast),**APT -II Paragraph Listening -Side B****Sentence Stimuli -5 Word:**

Alphabetize and Reverse 52-61

-6 Word:

Alphabetize 21-30

5/3/95

Tapes - IIIE (slow & fast), Paragraph Listening -Side C;**Sentence Stimuli -6 Word:**

Alphabetize 11-20

Reverse 21-30

Progressive 1-10

APT -II Paragraph Listening -Side B

Paced Auditory Serial-Addition Test

Revised Attention Proces Test

Lafayette Digit Vigilance Test

Multiple Tusk Visual Attention Test - Cross out every other odd number, and all numbers divisible by 4.

PHASE A, AUDITORY TRAINING:

3/15/95

Tapes: IA (slow and fast), IIA (slow only)

Sentence Stimuli 4-Word: Task discontinued during explanation, at the request of subject.

Semantic Categories -Set A

3/20/95

Tapes: IA (slow and fast), IIA (slow and fast);

Sentence Stimuli 4-Word: Alphabetize 1-10

Reverse 11-20

Semantic Categories -Set A

3/22/95

Tapes: IA (Fast condition only), IIA (slow and fast conditions);

Sentence Stimuli 4-Word: Alphabetize 21-30

Reverse 11-20

Semantic Categories - Set B

3/24/95

Tapes: IIA (slow and fast conditions), IIIA (slow and fast conditions)

Sentence Stimuli 4-Word : Alphabetize 31-40

Alphabetize 41-50

Reverse 21-30

Alphabetize and Reverse simultaneously 41-50

Semantic Categories - Set A

3/25/95

Tapes: IVA (slow and fast conditions), IB (slow condition only);

Sentence Stimuli 4-Word: Alphabetize 51-60

Reverse 61-70

Alphabetize/ Reverse simultaneously 67-76

Progressive 1-10

Semantic Categories -Set B

3/27/95

Tapes: IA (Fast condition), IVA (slow and fast conditions), IB (slow and fast conditions);

Sentence Stimuli 4-Word: Alphabetize 1-8 (time monitored 1 min.)
 Alphabetize 41-47 (time monitored 1 min.)
 Reverse 51-60 (time monitored 1 min.)

Semantic Categories -Set B

3/29/95

Tapes: IA (fast condition), IVA (slow and fast conditions), IB (slow and fast condition);

Sentence Stimuli 4- Word: Alphabetize 67-76
 Reverse 40-49

Semantic Categories -Set B

3/31/95

Tapes: IB (slow and fast condition), IIB (slow and fast conditions),

Training abandoned at subject's request*

4/5/95

Tapes: IA (fast condition), IVA (fast), IB (slow and fast condition), IIB (slow and fast condition);

Sentence Stimuli 4 -Word: Alphabetize and progressive order simultaneously 12-21
Semantic Categories -Set C

END PHASE A, EVALUATION (02) 4/7/95

Paced Auditory Serial-Addition Test

Revises Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test

4/10/95

Sustained

Stimulus sheet #3A - Circle all beds with 2 lines and cross out every 3rd one-line bed.

Stimulus sheet #3B - Count all arrows and add them to the dots and diagonal lines.

Stimulus sheet #3C - Circle all objects with arrows, shade in squares, and check diagonal lines.

Stimulus sheet #4 - Cross out all 3's and every 3rd 4, in this sheet of paper.

Stimulus sheet #5 - Cross out all 9's and 2's.

Stimuli sheet #6 - Cross out all 6's and 9's

Stimulus Sheet #7 - Counting down from a given number. (All serials).

Cross out all A's and I's

Divided Read and scan - Article #1 and answer questions

4/14/95

Sustained

Circle all red objects except those to the left of yellow objects. Add them to the total number of stars.

Circle all black objects, except those to the left of yellow objects. Add them to the number of red objects that are not stars.

Stimulus sheet #4 - Cross out all 3's and every 3rd 4.

Stimulus sheet #5 - Cross out all 9's and 2's.

Stimulus sheet #6 - Cross out all 9's and 1's

Cross out all A's and I's.

Cross out all sun's with eight rays.

Cross out all round objects and triangles.

Divided Read and scan - Article #1 and answer questions (repeat)

4/17/95

Sustained

Stimulus Sheet #8 - Cross out every other odd number

Stimulus Sheet #5 - Going from row to row, cross out any number that is 1 less or 1 more

than the one above it.

Stimulus Sheet #4 - Cross out all 6's and every other 3.

Stimulus Sheet # 5 - Cross out all 9's and 2's.

Stimulus Sheet #6 - Cross out all 9's and 6's.

Cross out all A's and G's

Cross all suns with eight rays.

Cross out all round objects and triangles.

Divided Read and scan: Article #2, and answer questions

4/19/95

Sustained

Stimulus sheet #4 - Cross out all 6's and every 3rd 4.

Stimulus Sheet #5 - Cross out all 9's and 2's.

Stimulus Sheet #5 - Going from row to row, cross out any number that is 1 less or 1 more than the one above it.

Stimulus Sheet #6 - Cross out all 6's and 9's.

Stimulus Sheet #8 - Cross out every other odd number.

Cross out all round objects and triangles.

Cross out all suns with 8 rays.

Cross out all A's and I's.

Divided Reading: Article #3, and answer questions.

4/21/95

Sustained

Stimulus sheet #4 - Cross out all 3's and every 3rd 4.

Stimulus Sheet #5 - Cross out all 6's and 2's.

Stimulus Sheet #5 - Going from row to row, cross out any number that is 1 less or 1 more than the one above it.

Stimulus sheet #6 - Cross out all 9's and 1's.

Stimulus sheet #8 - Cross out every other odd number.

Cross out all round objects and triangles.

Cross out all suns with 8 rays.

Cross out all A's and I's.

Divided Read and scan: Article #4 and answer questions.

4/24/95

Sustained

Cross out all round objects and triangles.

Stimulus sheet #6 - Starting from the bottom, working upwards, cross out all 9's and 1's.

Stimulus Sheet #5 - Starting from the bottom, cross out any number that is 1 less or 1²⁵⁵ more than the one above it.

Stimulus sheet #8 - Cross out every other odd number.

Working from the botom up, cross out all A's and I's.

Stimulus sheet #4 - Cross out all 3's and every 3rd 4.

Stimulus Sheet #5 - Cross out all 6's and 2's.

Stimulus sheet #8 - Cross out every other odd number.

Divided Read and scan: Article #4 and answer questions.

4/26/95

Sustained

Read and scan: Article #5 and answer questions.

Stimulus Sheet #5 - Starting from the bottom, cross out any number that is 1 less or 1 more than the one above it.

Working from the botom up, cross out all A's and I's.

Stimulus sheet #6 - Starting from the bottom, working upwards, cross out all 9's and 1's.

Cross out all round objects and triangles.

Stimulus sheet #5 - Cross out all 6's and 2's

Stimulus sheet #4 - Cross out all 3's and every 3rd 4.

Cross out all stars with 8 rays.

Stimulus sheet #8 - Cross out every other odd number.

4/28/95

Sustained

Read and scan: Article #5 and answer questions (repeat).

Stimulus sheet #6 - Starting from the bottom, working upwards, cross out all 9's and 1's.

Cross out all stars with 8 rays.

Stimulus sheet #8 - Cross out every other odd number.

Stimulus sheet #4 - Cross out all 6's and every other 3.

Working from the bottom up, cross out all A's and I's.

Stimulus Sheet #5 - Starting from the bottom, cross out any number that is 1 less or 1 more than the one above it.

Cross out all round objects and triangles.

Stimulus sheet #5 - Cross out all 9's and 6's.

5/3/95

Sustained

Read and scan: Article #6 and prepared questions.

Stimulus sheet #6 - Starting from the bottom, working upwards, cross out all 9's and 6's.

Working form the bottom up, cross out all stars with 8 rays.

Stimulus sheet #8 - Cross out every other odd number.

Stimulus sheet #4 - Cross out all 6's and every other 3.

Working from the bottom up, cross out all A's and G's.

Cross out all round objects and triangles.

Stimulus Sheet #5 - Starting from the bottom, cross out any number that is 1 less or 1 more than the one above it.

Stimulus sheet #5 - Cross out all 9's and 6's

END PHASE (B₁) EVALUATION (02) 5/5/95

Paced Auditory Serial-Addition Test

Revises Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test

PHASE A₂ - AUDITORY TRAINING TASKS (02)

257

5/6/95

Tapes: IB (slow and fast); IIB (slow & fast); IVA (slow & fast)

Sentence Stimuli 4-Word: Progressive 1-10

5/8/95

Tapes: IIB (slow and fast); IIIB (slow and fast); IVB (slow & fast)

Sentence Stimuli 4-Word: Progressive 11-20

5/10/95

Tapes: IVA , IIB, IIIB (slow and fast conditions);

5/13/95

Tapes: IVA, IIIB, IC, (slow and fast conditions); IVB (slow condition only)

Sentence Stimuli 4-Word : Progressive 21-30

5/15/95

Tapes: IIIB, IC, (slow and fast conditions), IVB, IIC (slow condition only);

Sentence Stimuli 4-Word: Progressive 31-40

5/17/95

Tapes: IIIB, IC (slow and fast conditions), IVB (slow condition only);

Sentence Stimuli 4-Word:

5/19/95

Tapes:IIIB, IC, (slow and fast conditions), IVB (slow condition only);

Sentence Stimuli 4- Word: Progressive 51-60

5/22/95

Tapes:IIIB, IC, (slow and fast conditions), IVB (slow condition only);

Sentence Stimuli 4- Word: Progressive 61-70

Alphabetize/Reverse 11-20

5/24/95

Tapes:IIIB, IVB,IC, IIC, (slow and fast conditions),

Sentence Stimuli 4- Word: Progressive 67-76

Alphabetize/Reverse 21-30

END PHASE (A₂) EVALUATION (02) 5/26/95

Paced Auditory Sesial-Addition Test

Revised Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test

5/27/95

Sustained

Read and scan: Article #6 and answer questions

Stimulus Sheet #4 - Cross out all 6's and every other 3.

Stimulus Sheet #5 - Cross out all 6's and 9's

Stimulus Sheet #5 - Starting from the bottom, cross out any number that is 1 less or 1 more than the one above it.

Stimulus sheet #6 - Cross out all 6's and 9's.

Stimulus sheet #8 - Cross out every other odd number.

Working from the top, left to right, cross out all A's and G's.*

Working from the bottom up, cross out all suns with 8 rays*

Cross out all circles and triangles*

5/29/95

Sustained

Read and scan: Article #7 and answer questions

Working from left to right, cross out all suns with 8 rays*

Stimulus Sheet #4 - Cross out all 6's and every other 3.

Stimulus sheet #8 - Cross out every other odd number.

Stimulus Sheet #5 - Cross out all 6's and 9's

Cross out all circles and triangles*

Stimulus Sheet #5 - Working from left to right, cross out any number that is 1 less or 1 more than the one above it.

Working from the top, left to right, cross out all A's and G's.*

Stimulus sheet #6 - Cross out all 6's and 9's.

Stimulus Sheet #7 - Counting down from a given number. (All serials).

5/31/95

Sustained

1. Read and scan: Article #7 and answer questions

2. Stimulus Sheet #4 - Cross out all 6's and every other 3.

3. Cross out all circles and triangles*

4. Stimulus Sheet #5 - Cross out all 6's and 2's

5. Stimulus sheet #8 - Cross out every other odd number.

6. Stimulus sheet #6 - Cross out all 9's and 1's. 2.

8. Working from the top, left to right, cross out all A's and S's.*

Number Mental Control Stimuli -4 Numbers/0-100

Ascending 1-10

Reverse 1-10

6/2/95

259

Sustained

Cross out all circles and triangles*

Stimulus sheet #6 - Cross out all 9's and 1's.

Stimulus Sheet #5 - Cross out all 6's and 2's

Stimulus sheet #8 - Cross out every other even number.

Starting from the bottom, working upwards, cross out all A's and S's.*

Stimulus Sheet #4 - Cross out all 6's and every other 3.

Selective Stimulus Sheet #4 - Cross out all 6's and every other 3 -(Overlay C)

Divided Read and scan: Article #8 (prepared questions)

Number Mental Control Stimuli -4 Numbers/0-100

Ascending 11-20

Reverse 11-20

6/5/95

Sustained

Stimulus sheet #8 - Cross out every other even number.

Starting from the bottom, working upwards, cross out all A's and S's.*

Stimulus Sheet #5 - Cross out all 6's and 2's

Stimulus sheet #6 - Cross out all 9's and 1's

Stimulus Sheet #4 - Cross out all 4's and every other 3.

Cross out all circles and triangles*

Selective Stimulus Sheet #4 - Cross out all 4's and every other 3 -(Overlay C)

Divided Read and scan: Article #8 (answer questions)

Number Mental Control Stimuli -4 Numbers/0-100

Ascending 21-30

Descending 1-10

6/7/95

Sustained

Stimulus sheet #8 - Cross out every other even number.

Cross out all circles and triangles*

Cross out all A's and S's.*

Stimulus Sheet #4 - Cross out all 4's and every other 3

Stimulus sheet #6 - Cross out all 9's and 1's

Stimulus Sheet #5 - Cross out all 9's and 6's

Selective Stimulus Sheet #4 - Cross out all 4's and every other 3 -(Overlay C)

Number Mental Control Stimuli -4 Numbers/0-100
Ascending 31-40
Reverse 21-30

260

6/14/95

Sustained

- Stimulus Sheet #5 - Cross out all 9's and 3's
- Stimulus sheet #8 - Cross out every other even number.
- Stimulus Sheet #4 - Cross out all 6's and every other 4
Cross out all circles and triangles*
- Stimulus sheet #6 - Cross out all 9's and 0's (intensive)
- Stimulus sheet #6 - Cross out all 1's and 6's

Selective Stimulus Sheet #4 - Cross out all 6's and every other 4's -(Overlay A)

Number Mental Control Stimuli -4 Numbers/0-100
Descending 11-20
Reverse 31-40

6/16/95

Sustained

- Cross out all circles and triangles*
- Stimulus sheet #6 - Cross out all 9's and 0's (intensive)
- Stimulus Sheet #5 - Cross out all 9's and 3's
- Stimulus sheet #8 - Cross out every other even number.
- Stimulus sheet #6 - Cross out all 9's and 6's
- Stimulus Sheet #4 - Cross out all 6's and every other 4

Selective Stimulus Sheet #4 - Cross out all 6's and every other 4's -(Overlay A)

Number Mental Control Stimuli -4 Numbers/0-100
Descending 21-30
Every Other 1-10

6/19/95

Sustained

- Stimulus Sheet #5 - Cross out all 6's and 3's
- Cross out all circles and triangles*
- Stimulus sheet #8 - Cross out every other odd number
- Stimulus sheet #6 - Cross out all 6's and 9's
- Stimulus sheet #6 - Cross out all 9's and 2's (intensive)
- Stimulus Sheet #4 - Cross out all 3's and every other 4
- Stimulus Sheet #7 - Counting down from a given number. (All serials).

Selective Stimulus sheet #4 - Cross out all 6's and every other 4, (Overlay A).

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Number Mental Control Stimuli -4 Numbers/0-100
Descending 31-40
Every Other 11-20

END PHASE B₂ EVALUATION

6/21/95 - PROMS, Math problems

6/23/95 - CVLT, Taylor Complex Figure

6/24/95 - PASAT, RAPT, Lafayette Digit Vigilance Test,
- MTVAT

PHASE A, AUDITORY ATTENTION:

3/13/95

Tapes: IA (slow condition)

3/15/95

Tapes: IA, IIA, (slow and fast conditions)

Semantic Categories - Set A

3/17/95

Tapes: IIA (slow), IIIA (slow and fast conditions)

Sentence Stimuli - 4 word: Alphabetize 1-10

Alphabetize and Reverse together 11-20

Semantic Categories - Set A

3/20/95

Tapes: IIA (slow conditions); Tapes: IIIA (slow and fast conditions)

Semantic categories - Set A

Sentence Stimuli - 4 Word: Alphabetize 31-40

Reverse 31-40

3/22/95

Tapes: IIIA (slow and fast conditions), IVA (slow and fast conditions)

Sentence Stimuli - 4 Word: Alphabetize 41-50

Reverse 41-50

Semantic Categories - Set B

3/24/95

Tapes: IIIA (slow and fast conditions), IVA (slow and fast conditions)

Sentence Stimuli - 4 Word: Alphabetize 21-30

Reverse 51-60

Semantic Categories - Set A

3/27/95

Tapes: IIIA, IVA, IB (slow and fast conditions)

Sentence Stimuli - 4 Word: Alphabetize 31-35 (timed for 1 min.)

Reverse 61-65 (timed for 1 min.)

Alphabetize and Reverse together 67-76

Semantic Categories - Set A and Set B

3/29/95

Tapes: IIIA, IVA, IB (slow and fast conditions)

Sentence Stimuli - 4 Word: Alphabetize 11-20
 Alphabetize 50-60
 Reverse 40-49

Semantic Categories -Set A and Set B

3/31/95

Tapes: IIIA, IIB, IIIB (slow and fat conditions)

Sentence Stimuli - 4Word: Alphabetize 61-70
 Progressive 61-70

Semantic Categories Set C

END PHASE A₁ EVALUATION 4/3/95

Paced Auditory Serial-Addition Test

Revised Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test

PHASE B₁ VISUAL ATTENTION

4/5/95

Sustained

Stimulus sheet #3A

Circle all beds with 2 lines and cross out every 3rd one-line bed.

Stimulus sheet #3B - Count all arrows and add them to the dots and diagonal lines.

Stimulus sheet #3C

Circle all objects with arrows, shade in squares, and check diagonal lines.

Stimulus sheet #4 - Cross out all 3's and every 3rd 4, in this sheet of paper.

Stimulus sheet #5 -Cross out all 9's and 2's.

Stimulus sheet #6 - Cross out all 6's and 9's

Stimulus Sheet #7 - Counting down from a given number. (serials 1's -4's).

Task #8 - Cross out all A's and I's

4/7/95

264

Sustained

Stimulus sheet #4 - Circle all 6's and cross out every 3rd 4's.

Stimulus sheet #5 - Cross out all 9's and alternate 2's.

Stimulus sheet #6 - Cross out all 9's and 1's

Stimulus Sheet #8 - Cross out every other odd number

Cross out all A's and I's.

Cross out all sun's with eight rays.

Cross out all round objects and triangles.

Divided Read and scan - Article #1 and answer questions

4/10/95

Sustained

Circle all red objects except those to the left of yellow objects. Add them to the total number of red objects that are not stars.

Circle all black objects, except those to the left of yellow objects. Add them to the number of red objects that are not stars.

Stimulus Sheet #4 - Cross out all 3's and every 3rd 4

Stimulus Sheet #5 - Cross out all 9's and 2's

Stimulus Sheet #6 - Cross out all 1's and 6's

Stimulus Sheet #8 - Cross out every other odd number

Cross out all A's and S's

Cross out all suns with 8 rays

Divided Read and scan - Article 1 and answer questions

4/12/95

Sustained

Cross all suns with eight rays.

Stimulus Sheet # 5 - Cross out all 9's and 2's.

Stimulus Sheet #4 - Cross all 4's and every other 3

Stimulus Sheet #8 - Cross out every other odd number

Stimulus Sheet #6 - Cross out all 9's and 1's.

Cross out all A's and I's

Cross out all rounds and triangles

Divided Read and scan - Article #2

4/14/95

Sustained

Stimulus Sheet #4 - Cross out all 3's and every 3rd 4

Cross out all suns with 8 rays

Stimulus Sheet #5 - Cross out all 9's and 1's

Cross out all A's and I's

Stimulus Sheet #8 - Cross out every odd number

Cross out all circles and triangles

Stimulus Sheet #6 - Cross out every 1 and 6

Divided

Read and scan - Article #2 and answer questions

4/17/95

Sustained

Stimulus sheet #4 - Cross out all 6's and every other 3.

Stimulus Sheet #5 - Working from row to row, cross out any number that is 1 less, or 1 more than the one above it.

Stimulus Sheet #6 - Cross out all 9's and 6's.

Stimulus Sheet #8 - Cross out every other odd number.

Cross out all round/circular objects and triangles.

Cross out all suns with 8 rays.

Cross out all A's and G's.

Divided

Read and scan: Article #3, and answer questions.

Selective

Stimulus Sheet #5 (Overlay B) - Cross out 1 and 6

Stimulus Sheet #4 (Overlay C) - Cross out 6 and every other 3.

4/19/95

Sustained

Stimuli sheet #6 - Cross out all 9's and 6's.

Stimuli sheet #5 - In any row, cross out any number that is 1 less or 1 more than the one above it

Cross out all A's and G's

Stimuli sheet #8 - Cross out every other odd number.

Stimuli sheet #4 - Cross out all 6's and every other 3

Cross out all round objects and triangles.

Selective

Stimulus sheet #4 - Cross out all 6's and every other 3 (Overlay C)

Stimulus sheet #5 - Cross out all 1's and 6's (Overlay A)

Divided Reading: Article #3 and answer questions.

4/21/95

Sustained

Working from bottom up, cross out all A's and I's

Stimuli sheet #6 - Working from the bottom up, cross out all 1's and 9's

Starting from the bottom, cross out all suns with 8 rays

Stimuli sheet #5 - Working from the bottom up, cross out any number that is 1 less, or 1 more than the one above it

Stimuli sheet #8 - Cross out every other odd number

Cross out all circles/round objects and triangles

Selective

Stimulus sheet #4 - Cross out all 3's and every third 4, (Overlay C).

Stimulus sheet #5 - Cross out all 9's and 2's, (Overlay B).

Divided Read and scan - Article #4, and answer questions

4/24/95

Sustained

Stimuli sheet #8 - Cross out every other odd number

Stimuli sheet #5 - Working from the bottom up, cross out any number that is 1 less, or 1 more than the one above it

Cross out all circles/round objects and triangles

Stimuli sheet #6 - Working from the bottom up, cross out all 1's and 9's

Working from the bottom up, cross out all A's and I's

Working from the bottom up, cross out all suns with 8 rays

Stimulus sheet #6 - Cross out all 9's and 6's, (Overlay C).

Alternate

Stimulus sheet #4 - Cross out 3's and 6's, then 4's and 6's, (15 sec. intervals)

Stimulus sheet #5 - Cross out 5's then 9's, then 2's. Repeat order at switch command.

Divided Read and scan - Article #5, and answer questions (modified)

END PHASE (B₁) ASSESSMENT (Code-03) 4/26/95

Paced Auditory Serial-Addition Test

Revised Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test

PHASE (A₂) AUDITORY ATTENTION (03)

267

5/1/95

Tapes IIIA, IVA, IIB, IIIB; (Slow /Fast)

Semantic Categories - Set B

Sentence Stimuli- 4 Word:

Alphabetize 67-76

Reverse 51-60; Progressive 41-50

5/3/95

Tapes IIIA, IVA (Slow /fast); IIB, IIIB,(slow /fast).

Semantic Categories - Set B

Sentence Stimuli - 4 Word:

Alphabetize 41-50

Reverse 31-40; Progressive 21-30

5/5/95

Tapes IIB, IIIB, IVB, (slow /fast).

Semantic Categories - Set B

5/8/95

Tapes IIB, IVB, IC, (slow /fast).

Sentence Stimuli - 4 Word:

Alphabetize 51-60

Reverse 61-70; Progressive 41-50

Semantic Categories - Set C

5/12/95

Tapes IIA, IIB, IVB, (slow /fast).

Sentence Stimuli - 4 Word:

Alphabetize & Reverse sim. 41-50

Progressive 51-60

Semantic Categories - Set C

5/15/95

Tapes IIA, IIIB, IVB, (slow /fast).

Sentence Stimuli - 4 Word:

Progressive 67-76

5/19/95

Tapes IC, IIC, IIIC, (slow /fast).

Sentence Stimuli - 4 Word:

Alphabetize & Reverse sim. 51-60

Progressive 61-70

5/20/95

Tapes IC, IIC, IIIC, (slow /fast).

Sentence Stimuli - 4 Word:

Alphabetize & Reverse sim. 61-70

Progressive 67-76

5/22/95

Tapes IC, IIC, IIIC, (slow /fast).

Sentence Stimuli - 4 Word:

Alphabetize & Reverse sim. 51-60

Progressive 67-76

END PHASEA, EVALUATION (03) 5/24/95

Paced Auditory Serial-Addition Test

Revised Attention Process Test

Lafayette Digit Vigilance Test

Multiple Task Visual Attention Test

5/26/95

Sustained

Stimulus Sheet #6 - Cross out all 1's and 9's

Stimulus Sheet #4 - Cross out all 6's and every other 3

Stimulus Sheet #5 - Cross out all 9's and 2's

Stimulus Sheet #5 - Cross out every number that is 1 more, or one less, than the one above it.

Stimulus Sheet #8 - Cross out every other odd number

Cross out all rounds and triangles*

Stimulus Sheet #6 (Intensive) - Cross out all 9's and 0's.

Stimulus Sheet #7 - Counting down from a given number. (serials 1's -6's).

Divided Read and scan- Article #5 (prepared questions).

5/29/95

Sustained

Read and scan -Article #6 (modified questions)

Cross out all rounds and triangles*

Stimulus Sheet #8 - Cross out every other odd number

Stimulus Sheet #6 (Intensive - Cross out all 9's and 2's

Selective Stimulus sheet #6 (Overlay B) - Cross out 1's and 9's.

Alternating

Stimulus sheet #4 - Start by crossing out 6, then 3, in that order at the switch command. Then change the order to 6, and 4. Repeat these cycles to the end of the sheet with subsequent switch commands. (10 sec. intervals).

Stimulus sheet #5 - Start by crossing out 9, then 2, and then 5, in that at the switch command. Then change the order to 2, 9, and 5. Repeat these cycles to the end of the sheet with subsequent switch commands. (10 sec. intervals).

Stimulus Sheet #7 - Counting down from a given number. (serial 7's, subtract 6 and add 1).

5/31/95

Sustained

Read and scan -Article #7

Cross out all rounds and triangles*

Stimulus Sheet #6 (Intensive - Cross out all 9's and 2's

Stimulus Sheet #8 - Cross out every other odd number

Alternating

Stimulus sheet #4 - Start by crossing out 6, then 4, in that order at the switch command. Then change the order to 6, and 3. Repeat these cycles to the end of the sheet with subsequent switch commands. (10 sec. intervals).

Stimulus sheet #5 - Start by crossing out 2, then 9, and then 5, in that at the switch command. Then change the order to 9, 2, and 5. Repeat these cycles to the end of the sheet with subsequent switch commands. (10 sec. intervals).

Stimulus Sheet #8 - Working from left to right, cross out first even numbers. Change to odd numbers, at the switch command. Alternate between even and odd numbers to completion.

Number Mental Control Stimuli -4 Numbers/0-100

Ascending 1-10

Reverse 1-10

6/2/95

Sustained

Cross out all rounds and triangles*

Stimulus Sheet #6 (Intensive - Cross out all 9's and 2's

Stimulus Sheet #8 - Cross out every other odd number

Alternating

Stimulus Sheet #8 - Working from left to right, cross out first odd numbers. Change to even numbers, at the switch command. Alternate between odd and even numbers to completion.

APT -II Alternating Alphabet Stimuli -After/Before (15 sec.)

Number Mental Control Stimuli -4 Numbers/0-100

Ascending 11-20

Reverse 11-20

Divided

Read and scan -Article #8 (modified questions)

Card sort (T)

6/5/95

Sustained

Stimulus Sheet #8 - Cross out every other odd number

Stimulus Sheet #6 (Intensive - Cross out all 9's and 2's

Cross out all rounds and triangles*

Alternating

APT -II Alternating Alphabet Stimuli -Before/After (15 sec.)

Stimulus Sheet #8 - Going down two columns, and starting from left to right, cross out even numbers. Change to odd numbers, at the switch command. Alternate between even and odd numbers accordingly.

Divided Read and scan -Article #8
 Card sort (N)
 Number Mental Control Stimuli -4 Numbers/0-100
 Ascending 21-30
 Descending 21-30

6/14/95

Sustained
 Cross out all rounds and triangles*
 Stimulus Sheet #8 - Cross out every other odd number

Alternating
 APT -II Alternating Alphabet Stimuli - Before/ After (15 sec.)
 Stimulus Sheet #8 - Going down two columns, and starting from left to right, cross out odd numbers. Change to even numbers, at the switch command. Alternate between even and odd numbers to completion.
 APT Dependent Activity I (10 sec.)

Divided Card sort (I)
 Number Mental Control Stimuli -4 Numbers/0-100
 Ascending 31-40
 Reverse 21-30

6/16/95

Sustained
 Stimulus Sheet #8 - Cross out every other odd number
 Cross out all rounds and triangles*

Alternating
 APT -II Alternating Alphabet Stimuli - Before/ After (15 sec.)
 Stimulus Sheet #8 - Going down two columns, and starting from left to right, cross out odd numbers. Change to even numbers, at the switch command. Alternate between even and odd numbers to completion.
 APT Dependent Activity I (10 sec.)

Divided Card sort (E)
 Number Mental Control Stimuli -4 Numbers/0-100
 Descending 1-10
 Every other 1-10

PHASE A(1)**VISUAL ATTENTION:**

3/23/95

Sustained

Stimulus sheet #3A: Circle all beds with 2 lines and cross out every 3rd one-line bed.

Stimulus sheet #3B: Count all arrows and add them to the dots and diagonal lines.

Stimulus sheet #3C: Circle all objects with arrows, shade in squares, and check diagonal lines.

Stimulus Sheet #8: Circle alternate odd numbers and cross out all those divisible by 4.

Stimulus sheet #4 - Cross out all 3's and every 3rd 4, in this sheet of paper.

Stimulus sheet #5 - Cross out all 9's and 2's.

Stimuli sheet #6 - Cross out all 6's and 9's

Stimulus Sheet #7 - Number count down (items 1-7). Time 1

3/24/95

Sustained

Stimulus sheet #4 - Circle all 6's and cross out every 3rd 4's.

Stimulus sheet #5 - Cross out all 9's and alternate 2's.

Stimulus sheet #6 - Cross out all 9's and 1's

Cross out all A's and I's.*

Cross out all sun's with eight rays.*

Cross out all round objects and triangles.*

Divided

Read and scan - Article #1

3/28/95

Sustained

Stimulus Sheet #4 - Circle all 6's and cross out every 3rd 4's.

Stimulus Sheet # 5 - Cross out all 9's and alternate 2's.

Stimulus Sheet #6 - Cross out all 9's and 1's.

Cross out all A's and I's *

Cross all suns with eight rays.*

Cross out all round objects and triangles.*

Stimulus Sheet #8 - Cross out all alternate odd numbers

Divided

Read and scan - Article #2

**These tasks are designed from the Mesulam Spatial Relation Test sheets*

3/29/95

Sustained

Stimulus sheet #4 - Cross out all 6's and every 3rd 4.

Stimulus Sheet #5 - Cross out all 9's and alternate 2's.

Stimulus Sheet #6 - Cross out all 9's and 2's.

Stimulus Sheet #8 - Cross out all alternate uneven numbers.

Cross out all round objects and triangles.*

Cross out all suns with 8 rays.*

Cross out all A's and I's.*

Divided Read and scan - Article #3 (modified questions).

3/30/95

Sustained

Stimulus sheet #6 - Cross out all 9's and 2's.

Stimulus sheet #8 - Cross out all alternate odd numbers.

Cross out all circles and triangles.*

Divided Read and scan - Article #4 (modified questions).**Selective**

Stimulus sheet #4 - Cross out all 3's and every 3rd 4, (Overlay C)

Stimulus sheet #5 - Cross out all 9's and 2's, (Overlay A)

Stimulus sheet #6 - Cross out all 9's and 1's, (Overlay B)

3/31/95

Sustained

Stimulus sheet #6 - Cross out all 9's and 2's.

Selective

Stimulus sheet #4 - Cross out all 3's and every third 4, (Overlay C).

Stimulus sheet #5 - Cross out all 9's and 2's, (Overlay B).

Stimulus sheet #6 - Cross out all 9's and 6's, (Overlay C).

Alternate

Stimulus sheet #4 - Cross out 3's and 6's, then 4's and 6's, (15 sec. intervals)

Stimulus sheet #5 - Start by crossing out 5's. At switch command cross out 9's, and then 2's. Repeat this cycle at switch command, to the end of the sheet.

Divided Read and scan - Article #5, (answer questions)**These tasks are designed from the Mesulam Spatial Relation Test sheets*

4/4/95

275

Sustained

Cross out all rounds and triangles.

Stimulus sheet #6 - Cross out all 9's and 0's (errors and time).

Divided Read and scan: Article #6 with modified questions.

Selective

Stimulus sheet #4 - Cross out all 3's and every third 4 /Overlay C/ (errors).

Stimulus sheet #5 - Cross out all 9's and 2's /Overlay A/ (time reduction)

Stimulus sheet #6 - Cross out 1's and 6's, /Overlay B/ (time and errors).

Alternate

Stimulus sheet #5 - Cross out 2, then 9, then 5 at switch commands. Change order to 9, 2, 5, at end of cycle. Alternate cycles accordingly. (10 sec. intervals).

Stimulus sheet #6 - Cross out 1's and 9's, then 1's and 6's at switch command. (10 sec. intervals).

4/7/95

Sustained

Circle all red objects except those found on the left of yellow objects. Add them to the total number of stars

Circle all black objects, except those found to the left of yellow objects. Add them to the number of red objects that are not stars

Stimulus sheet #5 - Working from top to bottom, and left to right, cross out any numbers in each row, that is 1 more, or 1 less than the one above it.

Divided Read and scan - Article #7 and comprehension questions.

Alternating

Stimulus sheet #5 - Alternate 2, 9, 5; then 9, 2, 5; every time the command switch is given.

Stimulus Sheet #6 - Cross out 1's and 9's; then 1's and 6's every time the command switch is given (10 seconds interval).

Stimulus Sheet #10 - Set Dependent Activity I. Alternate between reading the words Big/little and calling the type in which they appear (10 sec. interval).

Mental Control:

APT 4-Number Serial 0-100, ascending and descending

APT Serial Numbers - 2 step (Serial 1 +9 -4).

4/10/95

276

Sustained

Cross out all rounds and triangles.*

Stimulus sheet #6 - Cross out all 9's and 0's (errors and time).

Stimulus sheet #8 - Cross out every other odd number.

Divided

Read and scan - Article #7. Answer questions.

Selective

Stimulus sheet #5 - Cross out all 9's and 2's /Overlay A/ (time reduction)

Stimulus sheet #6 - Cross out 1's and 6's, /Overlay B/ (time and errors).

Alternate

Stimulus sheet #6 - Cross out 1's and 9's, then 1's and 6's at switch command. (10 sec. intervals).

Stimulus sheet #8 - Starting from the left, and working in 2-row vertical columns, cross out all odd numbers. At the switch command, change to even numbers. Alternate between odd and even numbers with every switch command.

END OF PHASE A(1) - TESTING

(04)

4/11/95

- 1) Paced Auditory Serial-Addition Test
- 2) Revised Attention Process Test
- 3) Digit Vigilance Test
- 4) Multiple Task Visual Attention Test

PHASE B1:

AUDITORY ATTENTION TRAINING CODE #4

4/13/95

Tape IA - slow and fast conditions

Tape IIA - slow and fast conditions

Tape IIIA - slow and fast conditions

Sentence Stimuli- 4 word: Alphabetize 1-10; Reverse 11-20; Progressive 21-30

Semantic Categories-Set A

4/14/95

Tape IIIA - slow and fast conditions

Tape IVA - slow and fast conditions

Tape IB - slow and fast conditions

Tape IIB - slow condition only

Sentence Stimuli- 4 word: Alphabetize 11-20; Reverse 31-40; Progressive 1-10

Semantic Categories-Set A and Set B

4/17/95

Tape IIA - slow condition only

Tape IVA - slow and fast conditions

Tape IIB - slow and fast conditions

Sentence Stimuli-4 word: Alphabetize 41-50; Reverse 51-60; Progressive 61-70;
Combined Alphabetize and reverse together 21-30. / Semantic Categories-Set B

4/18/95

Tape IA - slow and fast conditions

Tape IIA - slow and fast conditions

Tape IIIA - slow and fast conditions

Tape IVA - fast and slow conditions

Tape IIB - fast and slow conditions

Sentence Stimuli-4 word: Combination Alphabetize and reverse together 63-72
Semantic Categories-Set B

4/24/95

Tape IVA - slow and fast conditions

Tape IIB - slow and fast conditions

Tape IIIB - slow and fast conditions

Tape IVB - slow condition only

Sentence Stimuli-4 word: Alphabetize 73-76, 51-56; Reverse 41-50; Progressive 11-20;
Combination alphabetize and reverse together 61-70.
Semantic Categories-Set B

4/25/95

Tape IVA - slow and fast conditions

Tape IVB - slow and fast conditions

Tape IC - slow and fast conditions

Tape IIC - slow and fast conditions

Sentence Stimuli-4 word: Alphabetize 31-40; Reverse 1-10; progressive 51-60;
Semantic Categories-Set C

4/27/95

Tape IVB - slow and fast conditions

Tape IIIC - slow and fast conditions

Tape IVC - slow and fast conditions

Sentence Stimuli-4 word: Combination alphabetize and reverse 73-76, 51-56.

4/28/95

Tape III C - slow and fast conditions

Tape IV C - slow and fast conditions

Paragraph Listening - Side A

Sentence Stimuli-5 word: Alphabetize 1-10; Reverse 1-10

5/1/95

Tape III C - slow and fast conditions

Tapes IV C - slow and fast conditions

Paragraph Listening - Side B

Sentence Stimuli-5 word:

Alphabetize 11-20, Progressive 1-10.

5/2/95

Tapes III C - slow and fast conditions

Tapes IV C - slow and fast conditions

Paragraph Listening - Side C

Sentence Stimuli-5 word: Alphabetize 21-30; Reverse 11-20

END OF PHASE B(1) - TESTING

5/4/95

- 1) Paced Auditory Serial-Addition Test
- 2) Revised Attention Process Test
- 3) Digit Vigilance Test
- 4) Multiple Task Visual Attention Test

5/9/95

Sustained

Stimulus sheet #4 - Cross out all 6's and every 3rd 4.

Read and scan - article #7. (Comprehension questions)

Cross out all circles and triangles*

Stimulus sheet #8 - Cross out every other odd number

Selective

Stimulus sheet #5 - Cross out all 9's & 2's (Overlay A)

Stimulus sheet #6 - Cross out all 1's & 6's (Ovelay B)

Number Mental Control Stimuli 4 Numbers/ 0-100:

Ascending 11-20

Descending 1-10

Reverse 4-13

5/11/95

Sustained

Stimulus sheet #4 - Cross out every 3 & every 3rd 4.

Read and scan - Article #8, (Comprehension questions)

Stimulus sheet #8 - Cross out every othe odd number

Cross out all circles and triangles*

Intensive sustained: Stimulus sheet #6 - Cross out all 9's & 0's

Selective

Stimulus sheet #6 - Cross out all 9's & 1's

Alternating

Working down two columns of numbers, first cross out even numbers.

Alternate these two tasks accordingly, at the switch command. Continue to the end of the sheet, (10 sec. intervals)

Number Mental Control Stimulus 4 number/0-100:

Ascending 21-30; Descending 31-40

Reverse 11-20

5/12/95

280

Sustained

Cross out all circles and triangles*

Stimulus sheet #6 - Cross out all 9's and 0's (Intensive)

Stimulus sheet #8 - Cross out every other odd number

Selective

Stimulus sheet #6 - Cross out all 1's & 9's (Overlay B)

Alternating

Stimulus sheet #8 - Working down two columns of numbers, first cross out even numbers. Alternate these two tasks accordingly, at the switch command. Continue to the end of the sheet, (10 sec. intervals)

Stimulus sheet #5 - On the given sheet of paper, you will alternate between two cycles, each with three numbers, (i.e 2, 9, 5 and 9, 2, 5) in that order. First, start by crossing out the number 2. At the switch command change to crossing out the number 9, and then 5 at the next switch command. This completes the first cycle. Change to the 2nd cycle, and cross out first 9, then 2, and then 5, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Stimulus sheet #6 - On the given sheet of paper, you will alternate between two cycles, each with two numbers, (i.e 1, 9, and 1, 6,) in that order. First, start by crossing out the number 1. At the switch command change to crossing out the number 9. This completes the first cycle. Change to the 2nd cycle, and cross out first 1, then 6, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Number Mental Control Stimulus 4 number/0-100:

Ascending 31-40

Descending 21-30

Reverse 31-40

5/16/95

Sustained

Cross out all circles and triangles*

Stimulus sheet #6 - Cross out all 9's and 0's (Intensive)

Stimulus sheet #8 - Cross out every other odd number

Selective

Stimulus sheet #6 - Cross out all 1's & 9's (Overlay B)

Alternating

Stimulus sheet #5 - On the given sheet of paper, you will alternate between two cycles, each with three numbers, (i.e 9, 2, 5 and 2, 9, 5) in that order. First, start by crossing out

the number 9. At the switch command change to crossing out the number 2, and then 5 at the next switch command. This completes the first cycle. Change to the 2nd cycle, and cross out first 2, then 9, and then 5, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Stimulus sheet #6 - On the given sheet of paper, you will alternate between two cycles, each with two numbers, (i.e 1, 6, and 1, 9,) in that order. First, start by crossing out the number 1. At the switch command change to crossing out the number 6. This completes the first cycle. Change to the 2nd cycle, and cross out first 1, then 9, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Stimulus sheet #8 - Working down two columns of numbers, from left to right, first cross out even numbers.

Alternate these two tasks accordingly, at the switch command. Continue to the end of the sheet, (10 sec. intervals).

Number Mental Control 4 numbers/0-100: Reverse 21-30

5/19/95

Sustained

Stimulus sheet #6 - Cross out all 9's and 0's (Sustained Attention Intensive)

Cross out all circles and triangles*

Stimulus sheet #6 - Cross out all 1's and 6's

Stimulus sheet #8 - Cross out every other odd number

Alternating

Stimulus sheet #6 - On the given sheet of paper, you will alternate between two cycles, each with two numbers, (i.e 1, 6, and 1, 9,) in that order. First, start by crossing out the number 1. At the switch command change to crossing out the number 6. This completes the first cycle. Change to the 2nd cycle, and cross out first 1, then 9, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Stimulus sheet #5 - On the given sheet of paper, you will alternate between two cycles, each with three numbers, (i.e 9, 2, 5 and 2, 9, 5) in that order. First, start by crossing out the number 9. At the switch command change to crossing out the number 2, and then 5 at the next switch command. This completes the first cycle. Change to the 2nd cycle, and cross out first 2, then 9, and then 5, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Stimulus sheet #8 - Working down two columns of numbers, from left to right, first cross out even numbers. Alternate these two tasks accordingly, at the switch command. Continue to the end of the sheet, (10 sec. intervals).

Number Mental Control Stimuli- 5 Numbers/0-100: Ascending 1-11

5/29/95

282

Sustained

Stimulus sheet #6 - Cross out all 9's and 6's

Stimulus sheet #8 - Cross out every other odd number

Stimulus sheet #6 - Cross out all 9's and 2's (Intensive task)

Selective

Cross out all 9's and 6's (Overlay B)

Alternating (10 sec. intervals)

Stimulus sheet #6 - On the given sheet of paper, you will alternate between two cycles, each with two numbers, (i.e 9, 1, and 6, 1,) in that order. First, start by crossing out the number 9. At the switch command change to crossing out the number 1. This completes the first cycle. Change to the 2nd cycle, by crossing out first 6, then 1, with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done

Stimulus sheet #5 - On the given sheet of paper, you will alternate between two cycles, each with three numbers, (i.e 5, 2, 9 and 5, 9, 2) in that order. First, start by crossing out the number 5. At the switch command change to crossing out the number 2, and then 9 at the next switch command. This completes the first cycle. Change to the 2nd cycle, and cross out first 5, then 9, and then , with each subsequent switch command. This completes the 2nd cycle. Alternate accordingly between these two cycles till the whole sheet is done.

Stimulus sheet #8 - Working horizontally, from left to right, go through each row, crossing out first, even numbers. At the switch command, change to crossing out odd numbers. Alternate these two tasks accordingly, at subsequent switch commands. Continue to the end of the sheet.

Stimulus sheet #7- Number count down: Items 1-7 (Time 2)

5/30/95

Sustained

Stimulus sheet #4 - Cross out every 6 and every 3rd 4

Stimulus sheet #5 - Cross out all 9's and 2's

Stimulus sheet #5 - Working from top to bottom, and left to right, cross out any numbers in each row, that is 1 more, or 1 less than the one above it.

Stimulus sheet #6 - Cross out all 9's and 2's (Intensive)

Stimulus sheet #8 - Cross out every other odd number

Cross out all circles and triangles*

Alternating

Alternating alphabet stimuli -(15 sec. interval)

In the blanks, first, fill in letters that alphabetically come after those preceding the blanks.

At the switch command, change to filling in letters that come before those preceding the blanks. Alternate accordingly with each switch command.

Card sort - Sort deck of cards according to suit and name (letter T).

6/1/95

Sustained

Stimulus sheet #8 - Cross out every other odd number

Cross out all circles and triangles*

Stimulus sheet #5 - Working from top to bottom, and left to right, cross out any numbers in each row, that is 1 more, or 1 less than the one above it.

Stimulus sheet #4 - Cross out all 3's and every 3rd 4

Stimulus sheet #6 - Cross out all 9's and 2's (Intensive)

Alternating

Alternating alphabet stimuli -(15 sec. interval)

In the blanks, first, fill in letters that alphabetically come before those preceding the blanks. At the switch command, change to filling in letters that come after those preceding the blanks. Alternate accordingly with each switch command.

Card sort - Deck of cards sorted according to suit and name (letter N)

" " " (letter I).

Number Mental Control Stimulus 4 number/0-100:

Ascending 11-20; Reverse 11-20

6/2/95

Sustained

Stimulus sheet #6 - Cross out all 9's and 2's (Intensive)

Stimulus sheet #4 - Cross out all 6's and every other 3

Cross out all circles and triangles*

Stimulus sheet #5 - Working from bottom to top, and left to right, cross out any numbers in each row, that is 1 more, or 1 less than the one above it.

Stimulus sheet #8 - Cross out every other even number

Alternating

Alternating alphabet stimuli -(15 sec. interval)

In the blanks, first, fill in letters that alphabetically come before those preceding the blanks. At the switch command, change to filling in letters that come after those preceding the blanks. Alternate accordingly with each switch command.

Card sort - Deck of cards sorted according to suit and name (letter E)

" " " (letter T).

**These tasks were designed from the Mesulam Spatial Relation Test sheets*

END OF PHASE A(2) - TESTING

(04)

6/6/95

284

- 1) Paced Auditory Serial-Addition Test
- 2) Revised Attention Process Test
- 3) Digit Vigilance Test
- 4) Multiple Task Visual Attention Test

PHASE B(2)

AUDITORY ATTENTION TRAINING

(04)

6/8/95

Tape IVB - slow and fast conditions -sustained attention

Tape IIC - slow and fast conditions "

Tape IIIC - slow and fast conditions "

Tape IVC - slow and fast conditions "

6/15/95

Tape IVB - slow and fast conditions -sustained

Tape IC - slow and fast conditions "

Tape IIC - slow and fast conditions "

Tape IIIC - slow and fast conditions "

6/16/95

Tape IVB - slow and fast conditions -sustained

Tape IIIC - slow and fast conditions "

Tape IVC - slow and fast conditions "

6/19/95

Tape IVC - slow and fast conditions -sustained

Tape ID - slow and fast conditions -Alternating task

Tape IID - slow and fast conditions "

Sentence Stimuli-5 word: Alphabetize 31-40; Reverse 11-20

6/20/95

Tape IID - slow and fast conditions -Alternating task

Tape IIIE - slow and fast conditions -Selective with cafeteria noise

Tape IIF - slow condition only -Selective with distractor story

Sentence Stimuli-5 word: Alphabetize 41-50; Reverse 21-30

6/24/95

Tape ID - slow and fast conditions -Alternating task

Tape IID - slow and fast conditions "

Tape IIID - slow and fast conditions "

Sentence Stimuli-5 word: Alphabetize 51-60; Progressive 1-10

6/26/95

Tape IIF - slow and fast conditions -Selective with distractor story

Tape IID - slow and fast conditions -Alternating task

Tape IID - slow condition only "

Sentence Stimuli-5 word: Alphabetize 61-70; Reverse 31-40

6/27/95

Tape IID - slow conditions only -Alternating task

Tape IVD - slow condition only "

Tape IIF - slow and fast conditions -Selective with distractor story

Sentence Stimuli-5 word: Reverse 41-50; Progressive 11-20

6/29/95

Tape IID - slow and fast conditions -Alternating task

Tape IIIF - slow and fast conditions -Selective with distractor story

Stimulus sheet #7 - Number count down (items 1-7). Time 3

Sentence Stimuli-5 word: Reverse 51-60; Progressive 21-30

END OF PHASE B(2) - TESTING (04)

7/1/95

PROMS (Distractors: Memory Questionnaire, Math Problems)

7/2/95

TCF; CVLT; Stimulus sheets #1-3(c)

7/3/95

1) PASAT

2) DVT

3) RCF

4) RAPT

5) MTVAT

APPENDIX D. CUSTOMIZED ASSESSMENT INSTRUMENTS

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Multiple Task Visual Attention Test Sheet
 APT
 Attention Process Training
 McKay Moore Sohlberg, PhD & Catherine A. Mateer, PhD
 CENTER FOR COGNITIVE REHABILITATION

STIMULUS SHEET # 8

98	5	66	1	29	65	37	68	83	37	67	31	24	42	23	71	42	64	82
36	67	6	21	9	38	69	41	96	97	4	25	43	38	96	39	66	8	95
72	7	82	7	56	55	8	42	70	98	85	3	54	41	26	2	20	81	44
46	11	10	76	8	9	86	97	39	43	84	32	84	19	98	40	44	65	23
39	96	29	40	56	9	75	41	10	69	43	99	1	85	70	27	48	7	45
83	12	36	22	36	20	55	10	66	11	18	86	89	28	77	49	6	45	24
11	58	97	13	23	57	35	87	52	80	29	12	25	58	80	53	25	5	59
46	84	09	35	14	34	19	24	17	87	64	30	13	78	2	26	4	92	46
59	12	15	98	88	63	85	40	39	23	28	16	27	14	31	47	92	80	93
13	26	90	99	1	79	3	18	33	50	47	29	21	62	15	51	32	48	54
60	16	78	17	37	27	34	18	88	17	71	22	16	30	48	91	31	16	72
77	28	37	62	25	38	24	36	19	20	52	86	32	49	50	53	56	17	60
53	96	42	7	4	89	11	47	32	22	59	67	47	12	95	14	87	66	43

APT-II

Math Calculation for Divided Attention Task

ADDING AND CARRYING

1.	6 52 <u>+9</u>	5 83 <u>+4</u>	86 81 <u>+56</u>	21 49 <u>+43</u>	89 67 <u>+50</u>
2.	87 19 <u>+72</u>	60 54 <u>+38</u>	31 28 <u>+44</u>	79 98 <u>+83</u>	20 74 <u>+627</u>
3.	70 57 <u>+202</u>	51 91 <u>+329</u>	42 93 <u>+516</u>	78 12 <u>+490</u>	63 85 <u>+854</u>
4.	367 520 <u>+124</u>	238 153 <u>+875</u>	413 648 <u>+381</u>	146 73 <u>+718</u>	243 10 <u>+256</u>
5.	91 31 78 <u>+68</u>	15 75 76 <u>+31</u>	23 22 87 <u>+99</u>	648 60 52 <u>+944</u>	930 15 37 <u>+376</u>
6.	685 691 274 <u>+394</u>	597 283 406 <u>+938</u>	263 161 247 <u>+459</u>	760 218 322 <u>+938</u>	461 919 653 <u>+597</u>
7.	57 35 12 83 <u>+58</u>	43 51 74 32 <u>+38</u>	86 65 84 48 <u>+97</u>	94 21 39 45 <u>+80</u>	40 83 26 29 <u>+33</u>

APT-II Math Calculation for Divided Attention Task

Adding Larger Numbers

ADD AND CHECK

1.	47 <u>+42</u>	50 <u>+38</u>	84 <u>+15</u>	63 <u>+24</u>	78 <u>+10</u>	42 <u>+56</u>
2.	51 <u>+22</u>	70 <u>+19</u>	61 <u>+15</u>	12 <u>+78</u>	81 <u>+17</u>	75 <u>+22</u>
3.	52 <u>+35</u>	30 <u>+46</u>	69 <u>+20</u>	34 <u>+52</u>	328 <u>+560</u>	415 <u>+383</u>
4.	603 <u>+285</u>	577 <u>+321</u>	458 <u>+201</u>	413 <u>+584</u>	762 <u>+125</u>	210 <u>+648</u>
5.	307 <u>+652</u>	805 <u>+163</u>	781 <u>+135</u>	432 <u>+245</u>	854 <u>+133</u>	386 <u>+402</u>
6.	4,825 <u>+3,054</u>	1,756 <u>+6,213</u>	6,073 <u>+2,515</u>	4,281 <u>+3,428</u>	2,352 <u>+6,043</u>	7,084 <u>+2,713</u>
7.	18,946 <u>+51,032</u>	70,128 <u>+16,642</u>	54,223 <u>+32,584</u>	38,684 <u>+20,314</u>	76,521 <u>+13,054</u>	36,745 <u>+42,031</u>
8.	56,092 <u>+23,805</u>	72,033 <u>+21,583</u>	27,514 <u>+22,384</u>	30,649 <u>+54,320</u>	67,254 <u>+31,844</u>	49,943 <u>+19,428</u>
9.	662,184 <u>+234,013</u>	729,832 <u>+240,144</u>	229,056 <u>+500,832</u>	367,455 <u>+422,301</u>	51,084 <u>+27,505</u>	72,115 <u>+38,734</u>
10.	81 <u>+15</u>	346 <u>+252</u>	45 <u>+42</u>	3,720 <u>+4,256</u>	3,817 <u>+4,162</u>	482 <u>+16</u>

...

11.	408 <u>+241</u>	69,043 <u>+20,516</u>	27 <u>+40</u>	523 <u>+271</u>	881,042 <u>+121,446</u>	56 <u>+22</u>
12.	7,244 <u>+2,351</u>	8,563 <u>+1,234</u>	5,042 <u>+2,835</u>	7,136 <u>+1,042</u>	3,674 <u>+3,103</u>	5,548 <u>+2,342</u>
13.	8,027 <u>+1,932</u>	3,329 <u>+4,060</u>	6,203 <u>+2,361</u>	4,815 <u>+2,114</u>	8,047 <u>+1,832</u>	1,966 <u>+4,032</u>
14.	6,001 <u>+2,573</u>	2,347 <u>+2,412</u>	7,580 <u>+1,316</u>	4,116 <u>+4,572</u>	7,038 <u>+2,521</u>	2,413 <u>+4,334</u>
15.	405 <u>+561</u>	216 <u>+423</u>	537 <u>+252</u>	640 <u>+118</u>	885 <u>+102</u>	235 <u>+452</u>
16.	716 <u>+263</u>	24,207 <u>+15,072</u>	54,156 <u>+30,422</u>	32,854 <u>+43,104</u>	25,401 <u>+22,367</u>	69,821 <u>+20,104</u>
17.	946 <u>+32</u>	415 <u>+61</u>	723 <u>+75</u>	302 <u>+83</u>	729 <u>+50</u>	655 <u>+43</u>
18.	53 <u>+436</u>	13 <u>+206</u>	62 <u>+914</u>	47 <u>+532</u>	58 <u>+811</u>	34 <u>+205</u>
19.	3,224 <u>+ 641</u>	7,152 <u>+ 807</u>	8,210 <u>+ 326</u>	9,348 <u>+ 341</u>	2,416 <u>+ 502</u>	3,468 <u>+ 330</u>
20.	547 <u>+6,151</u>	296 <u>+4,203</u>	638 <u>+5,141</u>	513 <u>+6,256</u>	704 <u>+8,235</u>	652 <u>+3,144</u>
21.	52,364 <u>+2,305</u>	35,086 <u>+1,213</u>	20,316 <u>+8,271</u>	27,290 <u>+2,607</u>	54,763 <u>+4,134</u>	80 <u>+709</u>

APT-II
Math Calculation for Divided Attention Task

SUBTRACTING BY BORROWING

1.	53 <u>-36</u>	28 <u>-19</u>	97 <u>-28</u>	85 <u>-16</u>	44 <u>-27</u>	68 <u>-59</u>
2.	57 <u>-29</u>	61 <u>-34</u>	92 <u>-83</u>	38 <u>-18</u>	48 <u>-29</u>	51 <u>-36</u>
3.	763 <u>- 9</u>	478 <u>- 9</u>	532 <u>- 8</u>	514 <u>- 6</u>	261 <u>- 4</u>	188 <u>- 9</u>
4.	251 <u>-38</u>	742 <u>-27</u>	927 <u>-18</u>	381 <u>-53</u>	793 <u>-86</u>	640 <u>-27</u>
5.	896 <u>-88</u>	692 <u>-85</u>	548 <u>-37</u>	695 <u>-88</u>	588 <u>-79</u>	482 <u>-75</u>
6.	371 <u>-269</u>	684 <u>-547</u>	143 <u>-128</u>	467 <u>-349</u>	355 <u>-237</u>	653 <u>-409</u>
7.	458 <u>-349</u>	691 <u>-227</u>	854 <u>-536</u>	794 <u>-478</u>	652 <u>-239</u>	498 <u>-379</u>
8.	278 <u>-119</u>	445 <u>-108</u>	784 <u>-545</u>	893 <u>-655</u>	972 <u>-408</u>	331 <u>-125</u>
9.	3,633 <u>- 794</u>	4,125 <u>- 638</u>	2,961 <u>- 972</u>	5,648 <u>- 648</u>	6,345 <u>- 258</u>	1,827 <u>- 918</u>
10.	7,792 <u>-4,829</u>	8,235 <u>-3,516</u>	2,047 <u>-1,839</u>	5,167 <u>-2,758</u>	4,660 <u>-1,857</u>	7,133 <u>-2,924</u>

.....

11.	9,113 <u>-2,058</u>	2,474 <u>-1,185</u>	3,323 <u>-2,196</u>	9,457 <u>-3,379</u>	4,375 <u>-2,088</u>	5,126 <u>-3,048</u>
12.	7,488 <u>-2,499</u>	6,337 <u>-3,878</u>	6,154 <u>-2,165</u>	9,310 <u>-4,975</u>	3,124 <u>-2,368</u>	8,725 <u>-4,956</u>
13.	2,328 <u>-1,489</u>	5,181 <u>-2,397</u>	8,760 <u>-5,764</u>	7,395 <u>-2,498</u>	7,227 <u>-4,285</u>	5,684 <u>-2,993</u>
14.	8,233 <u>-7,148</u>	6,145 <u>-4,139</u>	5,608 <u>-2,786</u>	1,875 <u>-1,096</u>	7,620 <u>-4,586</u>	4,144 <u>-2,139</u>
15.	4,871 <u>-2,984</u>	6,524 <u>-3,576</u>	2,775 <u>-1,799</u>	4,726 <u>-3,946</u>	8,673 <u>-1,888</u>	2,865 <u>-1,977</u>
16.	96,973 <u>-4,982</u>	42,763 <u>-5,589</u>	75,823 <u>-6,458</u>	87,214 <u>-6,209</u>	59,656 <u>-5,458</u>	42,356 <u>-9,485</u>
17.	38,182 <u>-8,491</u>	87,421 <u>-9,530</u>	78,253 <u>-9,682</u>	34,818 <u>-5,847</u>	92,309 <u>-8,958</u>	69,762 <u>-4,974</u>
18.	86,583 <u>-5,999</u>	47,757 <u>-6,858</u>	81,912 <u>-1,943</u>	93,532 <u>-9,544</u>	83,124 <u>-4,876</u>	41,591 <u>-5,694</u>
19.	35,876 <u>-8,977</u>	66,180 <u>-7,293</u>	74,925 <u>-23,936</u>	53,286 <u>-43,689</u>	42,755 <u>-22,697</u>	54,278 <u>-32,489</u>
20.	45,118 <u>-21,279</u>	22,483 <u>-19,584</u>	62,537 <u>-56,849</u>	55,130 <u>-43,273</u>	25,614 <u>-16,726</u>	28,786 <u>-19,797</u>
21.	678,054 <u>-97,347</u>	327,583 <u>-58,946</u>	227,150 <u>-82,366</u>	732,122 <u>-51,475</u>	934,662 <u>-66,539</u>	923,644 <u>-849,357</u>
22.	482,637 <u>-297,148</u>	822,472 <u>-631,584</u>	673,612 <u>-297,641</u>	834,124 <u>-535,217</u>	543,950 <u>-418,513</u>	437,032 <u>-214,877</u>

**APT-II
ATTENTION QUESTIONNAIRE**

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

I. **RATING SCALE***: Please answer the following questions about your (or _____'s) attention as it applies to daily functioning by ticking the box which offers the best description.

DESCRIPTION	Not a problem or no change from before	Only gets in the way on occasion (less than once a week)	Sometimes gets in the way (about 1-3 times per week)	Frequently gets in the way (is a problem most days)	Is a problem all the time (affects most activities)
1. Seem to lack mental energy to do activities					
2. Am slow to respond when asked a question or when participating in conversations					
3. Can't keep mind on activity or thought because mind keeps wandering					
4. Can't keep mind on activity or thought because mind feels "spacy" or "blank"					
5. Can only concentrate for very short periods of time					
6. Miss details or make mistakes because level of concentration decreased					
7. Easily get off track if other people milling about nearby					
8. Easily distracted by surrounding noise					
9. Trouble paying attention to conversation, if more than one other person					
10. Easily lose place if task or thinking interrupted					
11. Easily overwhelmed if task has several components					
12. Difficult to pay attention to more than one thing at a time					

13.					
14.					

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

Total Score: add a) through d) _____

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

Describe Attention Breakdown (include setting and approx. frequ.)	What do you do when it occurs?
Example: I cannot concentrate when I am preparing dinner because the noise from the children playing around my feet and even in the next room distracts me. I forget ingredients or parts of the meal and usually feel totally frustrated during this time. This happens for every dinner.	I often yell or blow up at the children or cry while I am cooking. Sometimes I just give up and make something simple like sandwiches.
1.	
2.	
3.	
4.	
5.	

*Scale adapted from Ponsford, J. & Kinsella, G. (1991) Rating Scale of Attentional Behavior. *Neuropsychological Rehabilitation*, 1 (4) 241-257.
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**APPENDIX E. PARTICIPANT RECRUITMENT, INFORMED CONSENT,
AND HEALTH HISTORY DATA FORMS**

Recruitment Flyer	298
Prospective Subjects' Information Sheet	299
Consent Form A (Client Participant)	302
Consent Form B (Significant Other Participant)	305
Subject's Medical Release Form	307
Comprehensive Health History	308
Subject Demographic Data Form.....	314
Significant Other Demographic Data Form.....	315
Script for Receiving Subjects' Prospective Memory Responses	316

**UNIVERSITY OF WASHINGTON STUDY
VOLUNTEERS WANTED**

The Department of Psychosocial Nursing at the University of Washington is conducting a study to determine the effectiveness of attention training on attention and memory deficits following traumatic brain injury.

Participants must meet the following criteria:

1. Eighteen to 40 years of age.
2. Suffered brain injury because of an accident 12 or more months ago, and experiencing attention problems as result thereof.
3. At least one of the following because of the accident:
 - No more than 30 minutes in coma;
 - Loss of memory for events immediately before or after the accident;
 - Alteration in mental state at the time of the accident;
 - No more than 24 hours of post-traumatic amnesia.
4. Willingness to participate in a 13-week study at no cost, involving attention and memory assessments, attention training exercises, written questionnaires, and keeping of a daily record of own attention performances.
5. Eight or more years of schooling.
6. Understanding and good use of the English language.
7. No previous or current history of neurologic disease, psychiatric disorders, substance abuse, or any history of mental incompetence.
8. No severe motor or sensory impairments affecting vision, hearing, or ability to write.
9. No history of mental retardation and learning disability before the accident.
10. No previous exposure to a formal attention training program.
11. Have someone together with whom they spend at least four (4) hours per week, in a social, learning, or working relationship.

If you, or someone you know meet the above criteria, please contact:

Julia Mekwa at [REDACTED]

PROSPECTIVE SUBJECTS' INFORMATION

Study to Investigate the Usefulness of Attention Training Technique in Reducing Attention Problems Following Mild Brain-Injury.

Investigator: Julia N Mekwa, R.N. M.Soc.Sc., Ph.C.

(This information is for you to read, to make sure you understand the study explained to you in our discussion. The criteria for admission to the study is attached).

You are being asked to participate in a research study conducted by the School of Nursing at the University of Washington. The study will investigate the usefulness of Attention Process Training (APT). This is an attention training technique designed to reduce attention problems in persons with mild brain injury. Attention training is standard care in the treatment of attention problems due to brain injury. Research suggests that poor attention performance resulting from mild brain injury may improve significantly with appropriate training techniques. The APT technique which is still under investigation, was developed based on theories of attention and clinical observations in rehabilitation settings. The study will find out what influence attention training has on poor memory performance. Only four (4) subjects will be admitted to the study.

Your participation in the study will help promote better understanding of attention training effects in mild brain injury. It will also help promote better use of resources in attention training programs. Of benefit to you will be the possible improvement of attention and memory performances. You may also develop better understanding of your attention problems. This in turn may improve your total daily functioning.

WHAT BEING IN THE STUDY INVOLVES

If you agree to be in the study, you will be asked to take (1) attention and memory tests, (2) self-evaluation tasks, and (3) attention training exercises. This will take many hours of your time. Below is a description of study activities for subjects:

1. Assessment

The first assessment for attention and memory performances, will take 1 hour 40 minutes. Subsequent assessments, testing attention only, will take 40 minutes each. Only one assessment per subject, per day will be done. The total number of assessments per subject will be randomly assigned from 3-6. Subjects will also be required to complete a 10-minute Attention Questionnaire. The questionnaire guides you to list your individual attention problems in daily functioning. With your permission, the same Questionnaire will be completed by your significant other (family member/spouse/friend /employer etc.,).

The information submitted by your significant other will be shared with the you. You will also be required to keep a daily record of your attention breakdowns and how you deal with them. All information gathered will be used to work out your individual plan of attention training.

Tests for attention and memory

Tests will be given to assess the level of attention and memory performances. There are five levels of attention processing identified in the APT technique. These are: focused, sustained, selective, alternating, and divided attention. You may have difficulty performing at one or more of these levels. To have your individual level of difficulty identified, you will have to do these tests.

The test material for attention consists of: (a) taped auditory attention exercises, requiring you to respond according to instructions, e.g., pressing a buzzer when a certain number is called, or doing simple mental additions, etc., (b) paper and pencil tasks, requiring cancellation of numbers, characters, or figures on a sheet of paper in the shortest possible time. Tasks may be single or paired with other tasks. Exercises are varied from one testing session to another.

For memory testing, three standardized tests will be used to assess visual memory, recall and recognition, and the ability to remember carrying out given tasks. Training for memory will not be part of this study.

1.2 Attention Training Tasks

Each training session will take about 40 minutes a day, three days a week, for twelve weeks. Training will alternate between auditory and visual attention exercises. Progress on performance will be evaluated every 3-weeks, by means of tests, the Attention Questionnaire, and reviews of the daily record. At the end of attention training, assessment will again involve attention and memory performances.

OTHER INFORMATION

You will be asked to provide information on your age, education, marital status, diagnoses, health care history, medications, ongoing care. You will also need to tell the investigator about situations that may interfere with your ability to carry out attention training tasks. Where applicable, your permission allowing the investigator to use your head injury medical charts and records will be sought. Information from these records will be used to gain more understanding of attention problems. You may choose not to give any information you do not want to. Such refusal will not disqualify you from the study.

SITE FOR STUDY ACTIVITIES

All testing and training activities will be done at the University of Washington's Health Sciences Building.

RISKS, STRESS, AND DISCOMFORTS

If you agree to participate in the study, you will be required to sign two copies of the consent form. One copy will be given to you, and the other will be retained by the investigator. You will be free to withdraw from the study any time.

All information gathered will be assigned a code number. This information will be kept in a computer or locked file, accessible only to the investigator. The information may be used for publication, education of health care professionals, and further research. Should this happen, your identity will be kept confidential.

Training and testing activities will be done in privacy. A faculty member assigned to my supervision may be present during some activities. Subjects will be continuously informed about their progress.

Subjects will receive no payment for their participation in the study, nor will there be any cost to them. Fatigue may be experienced while completing study tasks. Inability to cope with prescribed tasks may be depressing. Having to disclose personal information may cause some discomfort.

If you have any questions about this study or participation in it, please contact the investigator at [REDACTED]

University of Washington
 School of Nursing
 Seattle, Washington 98195

Consent Form A (Client Participant)

**Attention Process Training (APT): Its Effectiveness in Remediating
 Attention Deficits Following Mild Traumatic Brain-Injury**

Investigator: Julia N Mekwa, R.N., M.Soc. Sc., Ph.C. [REDACTED]

Investigator's Statement:

You are being asked to participate in a study investigating the usefulness of Attention Process Training (APT). This is an attention training technique designed to reduce attention problems in persons with mild brain injury. Attention training is standard care in the treatment of attention problems. Research suggests that poor attention performance due to brain injury, improves significantly with appropriate training. APT, which is still under investigation, was developed based on theories of attention and clinical observations in rehabilitation settings. The study will also find out what influence attention training has on poor memory performance.

The study aims to:

1. Find out how useful the attention training technique is in reducing attention and memory problems found in mild brain injury.
2. Find out whether visual and auditory attention training techniques have a selective influence on on visual or auditory attention problems.
3. Find out whether attention skills learned through APT are transferred to daily life situations.

Your participation in this study will help promote better treatment of persons with poor attention and memory performances caused by brain injury. It will also help promote better use of resources in attention training programs. Of benefit to you is the possible improvement of attention and memory performances. You may develop better understanding of your attention problems. This may improve your total daily functioning.

WHAT BEING IN THE STUDY INVOLVES

If you agree to be in the study, you will be asked to take (1) attention and memory tests, (2) self-evaluation tasks, and (3) attention training exercises. Below is a description of study activities for subjects:

1. Assessment

The first assessment for attention and memory performances, will take 1 hour 40 minutes.

Subsequent assessments, testing attention only will take 40 minutes each. Only one assessment, per day, will be done. You will be randomly assigned a total of 3, 4, 5, or 6 assessment sessions. You will also be required to complete a 10-minute Attention Questionnaire. The Questionnaire guides you to list your individual attention problems in daily functioning. With your permission, the same Questionnaire will be completed by your significant other (family member/spouse/friend/ employer/teacher etc.,). The information submitted by your significant other will be shared with you. You will also be required to keep a daily record of your attention breakdowns and how you deal with them. All information gathered will be used to work out your individual plan of attention training.

2. Attention Training Tasks

Each training session will take about 40 minutes a day, three days a week, for twelve weeks. Training will alternate between auditory and visual attention exercises. Progress on performance will be evaluated every 3 weeks by means of tests, the Attention Questionnaire, and reviews of the daily record. At the end of attention training, assessment will again involve attention and memory performances. Memory training will not be part of this study.

OTHER INFORMATION

You will be asked provide information on your age, education, marital status, diagnoses, health care history, medications, on going care. You will also need to tell the investigator about situations that may interfere with your ability to carry out attention training tasks. Where applicable, your permission allowing the investigator to use your head injury medical charts and records will be sought. Information from these records will be used to gain more understanding of attention problems. You may choose not to give any information if you do not want to. Such refusal will not disqualify you from the study.

SITE FOR STUDY ACTIVITIES

All training and testing activities will be done at the University of Washington's Health Sciences Building.

RISKS, STRESS, AND DISCOMFORTS

If you agree to participate in the study, you will be required to sign two copies of the consent form. One copy will be given to you, and the other will be retained by the investigator. You will be free to withdraw from the study any time.

All information gathered will be assigned a code number. This information will be kept in a computer and locked file, accessible only to the investigator. The information may be used for publication, education of health care professionals, and further research. Should this happen, your identity will be kept confidential.

Training and testing activities will be done in privacy. A faculty member assigned to my supervision may be present during some activities. You will be continuously informed of your progress.

You will receive no payment for your participation in the study, nor will there be any cost to you. You may be fatigued while completing study tasks. You may feel depressed by your apparent inability to cope with the prescribed tasks. Having to disclose your personal information may cause you some discomfort.

If you have any questions about this study and your participation in it, I will be glad to answer them now. You may also call me any time at the number given above.

Investigator's signature

Date

Subject's Statement

The study described above has been explained to me. I voluntarily consent to participate in this activity. I have had an opportunity to ask questions. I understand that any future questions I may have about the research or about my rights as a subject will be answered by the investigator.

Subject's signature

Date

Copies to: Subject
Investigator's file

University of Washington
School of Nursing
Seattle, Washington 98195

Consent From B (Significant Other Participant)

**Attention Process Training (APT): Its Effectiveness in Remediating
Attention Deficits Following Mild Traumatic Brain-Injury**

Investigator: Julia N Mekwa, R.N., M.Soc. Sc., Ph.C. [REDACTED]

Investigator's Statement:

You are being asked to participate in a study assessing the usefulness of Attention Process Training (APT). This is an attention training technique designed to reduce attention problems in persons with mild brain injury. Attention training is standard care in the treatment of attention problems. Research suggests that poor attention performance due to brain injury, improves significantly with appropriate training. APT is however, still under investigation. The current study will use APT's auditory and visual exercises to improve attention performance. These exercises were developed based on theories of attention and clinical observations in rehabilitation settings. The study will also find out what influence attention training has on poor memory performance.

This study aims to:

1. Find out how useful the attention training technique is, in reducing attention and memory problems found in mild brain injury.
2. Find out whether visual and auditory attention training technique have a selective influence on on visual or auditory attention problems.
3. Find out whether attention skills learned through APT are transferred to daily life situations.

Your family member/spouse/friend/ employee has already agreed to be in this study. Your participation in the study will help promote better understanding of attention and memory treatment for mild brain injury. It will also help promote better use of resources in attention training programs. A benefit to your family member/ spouse/ friend/ employee is the possible improvement of his/her attention and memory functioning. During training your family member/spouse/friend/employee may develop better management of his/her attention problems. This may improve his/her total daily functioning.

WHAT BEING IN THE STUDY INVOLVES

If you agree to participate in the study, you will be asked to complete the Attention Questionnaire. The Questionnaire guides you to provide information about your

observations of your family member/ spouse/friend/employee's attention behavior. You will complete this ten- minute questionnaire at the beginning of the study, and every 3rd week after that, for twelve weeks. The subject will be required to complete the same questionnaire about him/herself. The information you give will be shared with him/her in developing the plan for treatment. You will also be asked to provide information on your age, education, marital status, and relationship to the subject. You may choose not to give this information if you do not want to. Such refusal will not disqualify the subject from the study.

To help you understand your family member/spouse/friend/employee's involvement in the study, a copy of "Prospective Subjects' Information" is provided.

RISKS, STRESS, AND DISCOMFORTS

If you agree to participate in the study, you will be required to sign two copies of the consent form. One copy will be given to you, and the other will be retained by the investigator. You will be free to withdraw from the study any time.

All information gathered will be assigned a code number. This information will be kept in a computer and locked file, accessible only to the investigator. The information may be used for publication, education of health care professionals, and further research. Should this happen, your identity will be kept confidential.

You will receive no payment for your participation in the study. You may experience some discomfort in providing the required information.

If you have questions about the study and your participation in it, I will be glad to answer them now. You may also call me any time at the number provided above.

Signature of Investigator

Date

Participant's Statement:

My role in the study described above was explained to me. I voluntarily consent to participate in this activity. I have had an opportunity to ask questions. I understand that any future questions I may have about the research or about my rights as a participant, will be answered by the investigator.

Signature of Significant Other

Date

Copies to: Subject

SUBJECT'S MEDICAL RELEASE FORM

Title: Attention Process Training (APT) - Its Effectiveness In Remediating
Attention Deficits Following Traumatic Brain-Injury

Investigator: Julia N Mekwa, R.N., M Soc. Sci., Ph. C. [REDACTED]

I, _____ hereby give permission to Julia Mekwa to

obtain copies of medical records relating to my head injury, from _____

Dr(s)/ Hospital/ Clinic

for use in the above named study. I understand that costs for obtaining these records will be paid by the investigator. I shall be informed by the investigator about her success or failure to obtain these records. If obtained, the information will be assigned a code number, and my identity shall be kept confidential. These records will be kept in a locked file or computer accessible only to the investigator. I understand that the records will be destroyed after a period of five (5) years. The purpose for which these records will be used has been explained to me. I give this permission voluntarily.

Subject's signature

Date

Investigator's signature

Date

COMPREHENSIVE HEALTH HISTORY

Data _____

Name of person completing this form _____
 Relationship to subject _____

Name of subject _____
 Maiden name _____

Date of birth _____ Age _____

Social Security Number _____

Home address _____ Work _____

Home phone _____ Work phone _____

Marital status:
 _____ married _____ never married _____ divorced _____ separated
 _____ widowed

Name of spouse _____ Years married _____

Dates of previous marriages: from _____ to _____
 from _____ to _____

Children (including stepchildren):
 name _____ age _____

Who currently lives in the home? _____

Do family members have any significant health concerns/needs?

Family Doctor: name _____
 address _____

Who diagnosed your condition? _____

Date of diagnosis _____

MEDICAL PROBLEMS PRIOR TO ONSET OF CURRENT CONDITION.
 yes no give details, if yes

Problems at birth or with early development _____

Loss of consciousness _____

COMPREHENSIVE HEALTH HISTORY

Approximate annual income _____

Leisure activities or hobbies: _____

CURRENT MEDICAL HISTORY

When did you first notice problems with mental abilities, thinking or remembering? _____

Describe your problems _____

Do you have physical problems? _____
 Describe them _____

Changes in vision, hearing, taste or smell _____

Problems with sleep? _____

Changes in sexual activity? _____

Do you take medication?		dosage	date started
name	reason for taking		
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Have you had any treatment for these problems or have you done anything that has helped to make them better? _____

Have you experienced any problems with:
 speaking _____
 understanding _____
 reading _____
 writing _____
 spelling _____

Have you noticed any changes in your personality or how you deal with other people? _____
 If yes, describe: _____

Has there been any changes in your emotional status or moods? _____
 If yes, describe: _____

Have others commented to you about changes in your personality or moods? _____ If so, what did they say? _____

Describe any difficulties in the following areas of your life:
Marital/Family _____

Financial/Legal _____

Housekeeping/Money management _____

Driving _____

HAVE YOU SEEN ANY OF THE FOLLOWING SPECIALISTS?

Neurologist
name _____ dates _____

Psychiatrist
name _____ dates _____

Psychologist or Counselor
name _____ dates _____

Physical, Speech or Occupational Therapist
name _____ dates _____

Have you had neuropsychological testing? _____ Dates _____
By whom _____

What were the results of these tests? _____

Have any other family members had Alzheimer's disease? _____
name _____ relationship _____

COMPREHENSIVE HEALTH HISTORY

	yes	no	give details, if yes
Seizures	___	___	_____
Motor vehicle accidents	___	___	_____
Major falls, sports accidents or industrial injuries	___	___	_____
Stroke	___	___	_____
Diabetes, heart disease or cancer	___	___	_____
Back or neck injury	___	___	_____
Major surgeries	___	___	_____
Psychiatric problems	___	___	_____
Have you ever participated in marriage or individual counseling? With whom and over what time period? _____			

What is your current drug use? _____
alcohol use? _____

Do you wear glasses or contacts? _____

Do you wear a hearing aid? _____

Are you right or left handed? _____

EDUCATION

How many years of school did you complete? _____

Grade school attended _____ year _____

Did you repeat any grades? _____

Were there any problems learning to read or write? _____

Did you attend special education classes? _____

Junior High and High school(s) attended:
name _____ location _____ date _____

Was a High school diploma awarded? _____
GED _____

COMPREHENSIVE HEALTH HISTORY

Estimated grade point average (GPA) _____

Community College, Junior College or Colleges attended:
name _____ location _____ dates _____

Was a degree awarded? _____ Highest degree attained _____
Area of study _____
Approximate GPA _____

Vocational Technical or Trade schools attended:
name _____ location _____ dates _____

Were certifications awarded? _____

MILITARY SERVICE

Did you serve in the military? _____ Dates _____

Which branch? _____

Duties _____

Did you serve in war time? _____ Where _____

Were you injured? _____

Did you receive an Honorable Discharge? _____

What rank did you hold? _____

VOCATIONAL HISTORY

Are you employed? _____
Were? _____

Years working there _____
Describe your job _____

Do you have difficulties at work? _____

Previous employers:			
name	dates	duties	reasons for leaving
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

COMPREHENSIVE HEALTH HISTORY

What aspect of your memory bothers you the most? _____

Do you have difficulty remembering:

names _____
words _____
appointments _____
how to do things _____
your childhood _____
where things are _____

What are your goals for the future? _____

Code _____

Date _____

**SUBJECT DEMOGRAPHIC DATA FORM
ATTENTION PROCESS TRAINING STUDY**

Date of Birth: _____ **Age:** _____ **Gender:** (1) M (2) F **Occupation:** _____

Marital Status: (1) Single (2) Married (3) Widowed

Education: (1) ≤ 8th grade (2) ≤ 12th grade (3) Assoc. Degree

(4) BS (5) Masters (6) Doctoral

Understanding of English Language: (1) Good (2) Fair (3) Poor

Use of English Language (1) Good (2) Fair (3) Poor

Diagnosis Pertaining to Head Injury: _____

Medications

Current: _____

Previous: _____

Health Care History

Current: _____

Previous: _____

**SCRIPT FOR RECEIVING SUBJECTS'
PROSPECTIVE MEMORY RESPONSES**

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Subjects will be informed that they may, or may not find the investigator when they call. This is because the 24-hour interval calls will fall at varied times, when the investigator may be out collecting data. To provide for this instance, a telephone answering machine will be used.

1. When investigator is present

Invest: Good morning/afternoon/evening. This is Julia Mekwa. How may I help you? (The subject will then be expected to identify him/herself by both first and last name, and state the purpose of his/her call). As this is a test for memory, care will be taken not to remind subjects what their expected task is. However, if they do not proceed spontaneously to do this, cues will be given to guide them.

When this is done, the investigator will say: Thank you Mr/Mrs/Ms. ----, I have noted your call.

2. When investigator is not present

Answering machine: Hallo, this is [REDACTED] I am not available to answer your call right now. Please leave a message, and I will return your call as soon as I can. Thank you for calling.

After receiving the message, the investigator will call the subject to acknowledge receipt.

Investigator: Good morning/afternoon/evening. Mr/Mrs/Ms. ----, this is Julia Mekwa. I am calling to let you know that I received your message which was left at (time and day). I have made a note of it. Thank you and have a good day/night.

VITA

JULIA NOBELUNGU MEKWA

Permanent Address:



Republic of South Africa

Education:

- 1996 Ph.D. (Nursing Science), University of Washington, Seattle, WA, USA
- 1990 M.Sc.Sci (Nursing), University of the Orange Free State, Bloemfontein, South Africa.
- 1981 Honours in Nursing Education, University of South Africa, Pretoria, South Africa
- 1976 B.Sc.Nursing, University of the North, Sovenga, South Africa
- 1971 Diploma in Midwifery, Edendale Hospital, Pietermaritzburg, South Africa
- 1970 Diploma in General Nursing, Edendale Hospital, Pietermaritzburg, South Africa

Experience:

- 1985-1990 Lecturer, Department of Nursing Science, University of Bophuthatswana, Mmabatho, South Africa
- 1986-1987 Acting Head, Department of Nursing Science, University of Bophuthatswana, Mmabatho, South Africa
- 1977-1985 Principal, Moroka Community Hospital College of Nursing, Thaba-Nchu, South Africa
- 1971-1973 Clinical Teacher, Nursing Diploma Program, Moroka Community Hospital, Thaba-Nchu, South Africa