Cognitive rehabilitation: A method for improving sustained and selective attention in adolescents with attentional deficits

Glinda Rae Bullock
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COGNITIVE REHABILITATION: A METHOD FOR IMPROVING SUSTAINED AND SELECTIVE ATTENTION IN ADOLESCENTS WITH ATTENTIONAL DEFICITS

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ABSTRACT

Cognitive Rehabilitation: A Method for Improving Sustained and Selective Attention in Adolescents With Attentional Deficits

By

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Dr. Beatrice Babbitt, Examination Committee Chair
Professor of Education
University of Nevada, Las Vegas

Attention Deficit Disorder (ADD) is an inherited neuropsychological disorder affecting 3% to 5% of the school-aged population of the United States and having no identified single cause. The primary treatment recommended for those suffering from attentional deficits is multimodal, which includes psychostimulant medication in the form of methylphenidate (Ritalin) and behavioral/educational interventions. However, there is a subset of sufferers who, though taking psychostimulant medications and undergoing behavioral and educational interventions, continue to suffer the symptoms of attentional deficits: distractibility, impulsiveness and aggressive behavior.

Those affected by acquired brain injuries as the result of some external trauma or neurological disorder suffer the same symptoms of attentional deficits as those diagnosed with ADD. As a treatment, a process called cognitive rehabilitation is implemented to
remediate or improve these deficits, allowing the subjects to regain preinjury level information processing. The primary approach to cognitive rehabilitation is attention process training using computers.

The purpose of this study was to determine the effectiveness of cognitive rehabilitation as a method of improving the sustained and selective attention of four (4) male middle-school students with diagnosed childhood attention deficit disorder and who were being treated with psychostimulant medications. Using a correlated sample, pretest-posttest design, the subjects were pretested to determine current levels of attentional functioning and posttested after exposure to a hierarchical attention training program, which included three weeks of sustained attention training and three-weeks of selective attention training. The results were mixed. All four subjects experienced some improvement in sustained and selective attentional functioning from pretest to posttest on at least two of the three measures of attention. However, only the selective attention results were significant. This indicates that cognitive rehabilitation could be an effective intervention strategy in the treatment of ADD and further study and replication are warranted with a change to a two-group comparison or multiple baseline design.
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CHAPTER 1

INTRODUCTION

The purpose of this study was to determine the effects of using a process-specific approach to cognitive rehabilitation in the form of attention training on the sustained and selective attention of adolescent males diagnosed with attention deficit disorder (ADD) and treated with stimulant medication. This study was conducted to answer the following questions: (a) Is it possible to use a cognitive rehabilitation technique that is process-specific and in the form of attention training computer software to improve sustained attention? (b) Is it possible to use a cognitive rehabilitation technique that is process-specific and in the form of attention training computer software to improve selective attention?

This research is important for four reasons. First, ADD is the most common psychiatric disorder of childhood (Hancock, 1996; Hoza, Pelham, Sams, & Carlson, 1992), and it is estimated that approximately 3% to 5% of school-aged children manifest significant attention deficit symptomatology (U.S. Department of Education, 1994). Psychostimulant medications in the form of Ritalin, Dexedrine, or Cylert have been the primary treatment for attentional deficits for the last four decades. However, a review of 155 controlled studies of children treated with stimulant medication found that a positive response was indicated in only 55% to 60% of the subjects so treated.
(Miller, 1996). This leaves 40% to 45% who showed no positive response or whose symptoms were worsened. The intervention used by this research could offer some relief to this subset of a population that is difficult to treat. Second, as the impact of attentional deficits on learning becomes more manifest, the ability to train attention could diminish the negative educational consequences of such deficits and facilitate the acquisition of new learning. Third, the software used in this study is simple, cost-effective, and easily used in a regular classroom setting. Finally, this research has the potential to expand the knowledge base in the area of treatment strategies for attentional deficits because (a) very few studies have investigated the use of cognitive rehabilitation in the form of attention training with this population, and (b) the resulting information can give teachers a new strategy for educating a very challenging population.

Attention Deficit Disorder (ADD): History and Prevalence

The definition of ADD has changed many times over the years. Historically, Goldstein and Goldstein (1990) report that the Greek physician, Galen, prescribed opium for restless infants. In a series of lectures to the Royal College of Physicians, Dr. George Still (as cited in Flick, 1998), described children who were aggressive, defiant, impaired in attention, and overactive. These children, he labeled as having a “deficit of moral control” (p.19).

Later, American doctors recognized the symptoms identified by Still (1902) in children who were survivors of an encephalitis epidemic (Flick, 1998). These
children were left with brain damage. Other children who had not been exposed during the epidemic, but exhibited the same symptoms, were also identified as brain damaged. These children appeared physically normal, and the term “minimal brain damage” was devised to identify them. Clements (1966) later coined the term “minimal brain dysfunction” to identify this cadre of symptoms currently known as attention deficit disorder.

The first official classification of hyperactivity appeared in the 1968 Diagnostic and Statistical Manual of Mental Disorders, Second Edition (DSM-II). At that time, overactivity, restlessness, distractibility, and a short attention span characterized the disorder, especially in young children with the behavior diminishing in adolescence (DSM-II, 1968).

In 1980, the term was changed in the DSM-III to Attention Deficit Disorder (ADD). Three subtypes were identified: ADD with hyperactivity, ADD without hyperactivity; and ADD residual type with the person having once met the criteria for ADD with hyperactivity but signs of hyperactivity are no longer present and other signs of the illness remain. The definition of ADD with hyperactivity was characterized by the child displaying signs of developmentally inappropriate inattention, impulsivity, and hyperactivity (DSM-III, 1980). In 1987, the new DSM-III-R changed the term to reflect distractibility as the primary dysfunction and the two categories were changed to Attention Deficit Hyperactivity Disorder and Undifferentiated Attention Deficit Disorder without Hyperactivity. Three subtypes were identified: ADHD-Combined Type, ADHD-Predominantly Inattentive Type, and ADHD Predominantly Hyperactive-
Impulsive Type. The DSM-IV, released in 1994, and the DSM-IV-TR, released in 2000, integrate the two previous categories of the DSM-III-R by combining them into one category, which became Attention-Deficit/Hyperactivity Disorder (ADHD) with the three previously mentioned subtypes, Combined Type, Predominately Inattentive Type and Predominately Hyperactive-Impulsive Type along with an additional category of Attention Deficit Hyperactivity Disorder Not Otherwise Specified for disorders with the prominent symptoms but without meeting the specified criteria.

The diagnostic criteria for ADHD included the following: (1) six or more of the following symptoms of inattention: fails to pay attention to details, difficulty sustaining attention to tasks, does not listen, fails to follow instructions, poor organizational skills, loses things, easily distracted, short-term memory problems and (2) exhibits six or more of the following symptoms of hyperactivity/impulsivity: hyperactivity - fidgets and squirms, often out of seat in classroom, runs around as if motor driven and noisy, talks excessively; impulsively blurts out answers to questions before their completion, does not wait their turn, and are intrusive (DSM-IV-TR, 2000, p 92).

ADD may also be characterized by the comorbidity or coexistence of more than one psychiatric disorder at a time and may include conduct disorder, oppositional defiant disorder or any other disruptive behavior disorder, as well as a mood or anxiety disorder (DSM-IV-TR, 2000). Additionally outlined in the DSM-IV-TR (2000) are associated features of ADD and variations that depend upon age and developmental stage, including: low frustration tolerance, temper outbursts, bossiness, stubbornness, excessive and frequent insistence that their requests be met, mood lability,
demoralization, dysphoria (a feeling of physical discomfort), rejection by peers, and poor self-esteem.

The academic achievement of children with ADD is often impaired and devalued by the child, typically leading to family conflict and conflict with school authorities. The inadequate self-application to tasks that require sustained effort is often interpreted by others as laziness, oppositional behavior, or a poor sense of responsibility. Family relationships are further characterized as problematic, resentful, and antagonistic, with parents often believing that all of the troublesome behavior is willful.

For the purposes of this study, the term attention deficit disorder (ADD) will be used. It is defined as a neurophysiological disorder with a syndrome of psychological symptoms that can include impulsivity, motor overactivity, and attentional impairments identified in the American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (2000), as having three subtypes: (1) combined type; (2) predominantly inattentive type; and (3) predominantly hyperactive-impulsive type. Additionally, attentional deficits can include a cluster of associated characteristics: disorganization, poor peer or sibling relations, aggressive behavior, poor self-concept or self-esteem, sensation seeking behavior, day dreaming, poor coordination, memory problems, persistent obsessive thinking, inconsistency, and an inability to filter out background noises (Flick, 1998).

In a study of elementary school-aged children in Tennessee (Cantwell, 1997), DSM-IV inattentive subtypes were present in 4.7% of the population. Primarily the hyperactive-impulsive subtype was present in 3.4%, and a combined type was present in
4.4% of the children. Attention deficit disorder is much more prevalent in males, 9 to 1 in clinical samples and 4 to 1 in epidemiological samples (Baumgaertel, Wolraich, & Dietrich, 1995; Cantwell, 1994; Wolraich, 1997). Individuals with ADD form a heterogeneous group. The comorbidity and variability of the primary and associated features of this disorder add to its complexity, clouding the clinical picture and making diagnosis and treatment difficult.

**Attention**

For accurate diagnosis and to determine treatment for ADD, the characteristics of normal attention are identified and an attempt is made to ascertain the possible changes in attention that could cause deficits. Attention is a complex and integral part of the whole cognitive process, and its deficits are a focal point for the current study. As such, a clear understanding of cognition and its processes is necessary to the clarity of this investigation.

**Cognition**

William James (1890) wrote, “Attention is a cognitive process that enables us to choose the sort of a universe we will inhabit” (p. 24). It is reasonable to assume that if individuals experience a dysfunction or disruption in this process, the choices those individuals are able to make become limited. Such is the plight of individuals with attentional deficits of which children are arguably the most vulnerable and the most extensively affected.
Webster's II: New Riverside University Dictionary (1984) defines cognition as the mental faculty or process by which knowledge is acquired as through perception, reasoning, and intuition. Flavell, Miller, and Miller (1993) define cognition as a broad based concept that encompasses all of the mental processes, operations, and systems that are conceptualized in the acquisition and use of knowledge. More precisely, cognition explains those concepts regarding organized, goal-directed behavior.

Flavell and his colleagues (1993) further postulate that each of the component processes involved in cognition play a vital role in the operation and development of each of the other processes. Each process affects and is affected by the other processes. In other words, the mind is more than just a collection of unrelated cognitive components, but is rather, a very complex and organized system of interacting components.

The components of cognitive functioning include: working memory, long-term memory, the executive system, and the response/process system. The accompanying component processes of cognition include (1) attentional processes, (2) perceptual processes, (3) the memory and learning processes, (4) organizational processes, and (5) reasoning and problem solving processes. These systems and processes integrate to facilitate functional-integrative performance, which includes efficiency, level, scope, and manner of integration (Flavell, Miller, & Miller, 1993).

The component processes of cognition as identified by Dodd and White (1980) are the activities involved in the incorporation, interpretation, deliberation, and retrieval of information to formulate a response. The most important of these is attention, the
process under study in this investigation.

Attention negotiates access to and holds information in consciousness. Its components include basic arousal, directing attention and filtering out irrelevant information, shifting particular objects of attention, and dividing attention among two or more objects or events. What one attends to is determined by the characteristics of the impinging external or internal stimuli, by the level of arousal or alertness of the individual, by momentary intentions, and long-term goals. Control over attention is necessary for the effective and efficient processing of information in situations that are often less than ideal (Ylvisaker & Szekeres, 1998).

In order to understand appropriate attentional functioning, it is essential to examine the neurological correlates for information processing, structures of the brain that support attentional functioning, and the structure of the cells that compose the nervous system.

**Nervous System**

The nervous system is the means by which we receive, process, and respond to information from the environment. It is divided into two systems: the peripheral nervous system (PNS), which is composed of the spinal nerves and the cranial nerves and receives and transmits information between the environment and the central nervous system (CNS), which is composed of the brain and the spinal cord. The brain is the organ in our bodies that most directly controls our thoughts (Sternberg, 1996).
The limbic system is the area of the brain that is responsible for emotions, sleep, body regulation, hormones, sexuality, smell, production of most of the brain's chemicals, and is where the subject of this study, attention, begins. Recent research has revealed that attention systems are located throughout the brain (Jensen, 1998). The frontal lobes and limbic system play equally important roles in the attentional process. The frontal lobe (cerebral cortex) mobilizes the attentional resources of voluntary attention and is involved with goal directed behavior by controlling attention and inhibiting impulsive responses. The inhibitory mechanisms of the cortex inhibit inappropriate behaviors. The limbic system, along with the brain stem and reticular formation, regulates attention, motivation, and emotion (Das, Naglieri, & Kirby, 1994). The limbic system regulates vigilance. The reticular formation, the attention center of the brain, is the key to turning the brain on. The brain stem reticular formation serves as a point of convergence for signals from the external world and the interior environment.

Attention must be initiated by a signal from the reticular formation before it can be elicited from the frontal lobes (cerebral cortex). In order for a neural signal to become a source of attention the signal itself must be worth attention. According to Sokolov's Neuronal Model (1960) this signal is called an orienting response (OR) and is the building block of attention and learning. Whenever a stimulus novel or new to an individual's experience is presented, an OR is elicited through the reticular formation that either inhibits or stimulates attention, depending upon the relevance of the stimulus. When this process functions normally, it provides relevant neural connections needed
for the processing and learning of information, and the ability to maintain attention to the components of a relevant task. Over time the OR elicited for the same task diminishes, resulting in habituation. If this process yields no reduction in the OR, the resulting effect is an over stimulation of the reticular formation and its systems. There would be an excessive OR and the effect would be a person who is easily startled, hypervigilant, touching everything, talking excessively, and restless and hyperactive.

As was previously discussed, attention is an extremely complex process and involves an equally complex set of circumstances to produce. So, what happens during this process that results in a dysfunction? What is the nature of an attentional deficit? Hynd, Semrud-Clikeman, Lorys, Novey, Eliopoulos, and Lyttinen (1991) speculate that there may be subtle differences in the brains of children with ADD that appear structural in nature. This next section will deal with neuroanatomical, neuropsychological, and neurochemical dysfunctions that are speculated as being related to attentional deficits.

Attentional Deficits

When a deficit is found in attentional processes, all elements of attention can be negatively affected. Mirsky (1987) postulated that attention has separate aspects and that these aspects of attention could involve different but interconnected regions of the brain forming a system, much like an electrical circuit. Deficits in attention appear to be dependent upon where in the affected system of the brain the dysfunction occurs, which could account for the enormous amount of heterogeneity among affected
subjects.

When the frontal lobe does not control the direction of attention, then any stimulus may evoke an unspecific orienting response and promote distractibility. It is further suggested that in attention deficit disorder, the limbic system and the frontal areas do not work in cooperation as they should, leading to the nonselectivity of attention resulting in an inability of the subject to filter out superfluous stimuli (Das, Naglieri, & Kirby, 1994).

Hynd, Semrud-Clikeman, Lorys, Novey, Eliopulos, and Lyytinen (1991) studied the area measurements of the corpus callosum on MRI scans and found that the corpus callosum appears smaller in children with ADD compared to normal controls. Hynd, Semrud-Clikeman, Lorys, Novey, and Eliopulos (1993) and Rapoport (1996) through brain imaging studies conducted at the National Institutes of Health found evidence that children with ADD differed from normal children in the width of the right frontal region of the brain and the seat of motor activity, the basal ganglia. There is an asymmetry in the caudate and globus pallidus of the basal ganglia in normal children, where the right side appears larger than the left. This asymmetry is missing in children with ADD. These two areas, according to the authors, are considered essential for directing focus and blocking out distractions.

Chelune, Ferguson, Koon, and Dickey (1986) found that there is reciprocity in the pathways between the reticular formation and the diencephalic structures that mediate around and stimulate behavioral inhibition to irrelevant stimuli in humans. Impairments in these structures have been shown to be related to impulse control and the kinds of
cognitive impairments found with ADD.

Neurochemically, ADD is specifically related to a neurotransmitter imbalance or defect in neural connections such as a dysfunction in the production of the neurotransmitters norepinephrine or dopamine resulting in a decrease in brain stimulation and a dysfunction in the neurocircuits underlying attention (Hynd, Hern, Voeller, & Marshall, 1991). Shaywitz, Cohen, and Bowers (1977) were the first to propose a dopamine theory for ADD. A number of recent studies have also supported this theory (Castellanos, Giedd, Marsh, Hamburger, Vaituzis, Dickstein et al., 1996; Hynd, Hern, Voeller, & Marshall, 1991; Jensen, 1998). Castellanos and his associates (1996) postulated that ADD symptoms are associated with the overactivity of a dopamine circuit, which is regulated by inhibiting receptors and feedback from the cerebral cortex.

Current research by Zametkin et al. (1990) and others using advanced technology suggest that ADD has a physiological cause with a genetic determinant. Using positron emission topography in a study of glucose metabolism, they found that there is less activity in the brain of an ADD sufferer, and this lack of activity has been observed in the frontal regions of the brain.

Many scientists believe that the patterns of frontal lobe under-activity during concentration seen in ADD subjects is due to insufficient production of neurotransmitters found in the frontal lobe areas (Barkley, 1995; Hynd, Semrud-Clikeman, Lorys, Novey, Eliopoulos, & Lytinen, 1991; Rapoport, 1996). It is also speculated that these neurotransmitter dysfunctions are caused by insufficient...
myelination of the nerve fibers in the brain (Ingersoll & Goldstein, 1992).

Myelination acts as insulation in an electrical circuit. This insulation protects the connections to other neurons from short circuits. When there is insufficient insulation (myelination), there is a short circuit and the impulse(s) facilitated by that circuit are delayed, diverted or arrested completely.

Researchers (Barkley, 1995; Hynd et al, 1991; Rapoport, 1996) support the idea that ADD is associated with underlying neurological dysfunctions involving the frontal lobes and cerebral cortex. Further, this converging body of evidence, taken from lesion studies in animals and humans, brain imaging studies, EEG studies, responses to medication and genetic studies, supports the premise that ADD is primarily biologically based and points to a dysfunction in the frontal cortex area of the brain.

Attentional deficits are often observed in individuals with acquired brain injuries that are focused in those same frontal areas of the brain. There is considerable research, primarily with adults, concerning plausible interventions for restoring attentional functioning in patients so afflicted (LaRose, Gagnon, Ferland, & Pepin, 1989; Mateer, Kerns, & Eso, 1996; Sohlberg & Mateer, 1987; Sohlberg, Mc Laughlin, Pavese, Heidrich, & Posner, 2000).

Brain Dysfunctions and Attention Deficits

Brain dysfunctions can take the form of closed head injuries (CHI), traumatic brain injuries (TBI), and any neurological or cognitive disease, or head injury. Brain injury can result in a range of disabilities, from death to minor cognitive dysfunctions, which
are subtle and reflect minor problems with motor coordination, memory, problem solving skills, and the focus of this inquiry, attention. Such disabilities, however, may only be apparent on formal neuropsychological examinations (Ewing-Cobbs et al., 1998).

Brain injuries can result in a redistribution or disruption of electrical impulses and changes to cerebral and frontal structures. Attentional capacity is reduced, causing those so afflicted to experience stimulus overload and the need for making intense mental effort and concentration essential to tasks that were formerly exercised with ease (VanZomeren, 1987).

Attentional deficits are among the most frequently observed cognitive dysfunctions identified in individuals following a serious brain injury (Ylvisaker & Szekeres, 1998). Importantly, they are subsequently among the first deficits to be restored in patients whose injuries are much more serious than the minimal brain dysfunctions associated with childhood attention deficit disorder.

Treatment for ADD

The treatments for ADD have also changed over the years and to date there is no cure (NIMH #96-3572, 1996). There are, however, specific treatments and interventions that have shown some success with the symptoms of this ailment. Flick (1998) reports that the most prescribed treatment for ADD is psychostimulant medications, primarily in the form of methylphenidate (Ritalin). However, methylphenidate has proven to be only temporary, not effective for everyone so
afflicted, not effective in the treatment of many of the associated features and has some prohibitive side effects. Other interventions include: psychotherapy, which helps ADD sufferers by facilitating their acceptance of themselves despite their disorder; cognitive-behavioral therapy, which guides ADD individuals into changing their behavior, allowing compensation for the disorder; social skills training, which helps those so afflicted to learn replacement behaviors that substitute for inappropriate ones; support groups, which serve as a connection for people with common concerns; and parenting skills training, which provides parents with tools that assist in the management of an ADD child’s behavior (Barabasz & Barabasz, 1996; Lilienthal, 1998; NIMH, 1996; Whalen & Henker, 1991).

Other controversial treatments that have shown to be intermittently effective with ADD symptoms include: biofeedback, restricted diets, allergy treatments, medications to correct problems in the inner ear, megavitamins, chiropractic adjustments and bone re-alignment, treatment for yeast infection, eye training, and special colored glasses (NIMH #96-3572, 1996). Most experts, however, recommend a multimodal treatment for ADD (Flick, 1998). This involves a combination of academic, behavioral, and medical interventions to help children succeed at home and at school (Dulcan & Scott-Benson, 1997). Many of these same treatments have been used with some success to treat the attentional deficits of those suffering acquired brain injuries as well (Ylvisaker & Szekeres, 1998).

None of the above treatments have been found to be totally effective. This leaves a large subset of a very difficult population with no source of treatment that yields a
positive response or whose behavior is worsened by the treatment, making the current research very important. The intervention employed in this research could offer some relief to this treatment-disenfranchised group and to the education professionals who work with this population.

The human brain and nervous system are capable of an enormous amount of plasticity and are fundamentally altered by experience. When neurons are damaged, other neurons compensate by taking over the lost function (Merzenich et al., 1996). This is seen most dramatically with stroke patients who are able to reorganize their neural apparatus through therapeutic measures to reestablish lost functions such as speech. All of this neural reorganization happens in response to stimulation and physical activity, i.e., use of the neural pathways established through experience. Movement and practice build and elaborate these pathways. If certain functions can be restored or reorganized in patients who have experienced more serious brain damage, the lost attentional functioning apparent in a minimal brain dysfunction such as ADD might also be restored or developed to a level of appropriate functioning through the same process, a process called cognitive rehabilitation.

Cognitive Rehabilitation

Rehabilitation is about learning, and attention mediates learning. As the impact of attentional deficits on learning become more manifest, training attention in those so afflicted could diminish the negative educational consequences of such deficits and facilitate the acquisition of new learning. Improving the performance of children with
attentional deficits through attention-process training is the focus of cognitive rehabilitation in this investigation.

The cognitive and behavioral changes resulting from brain injuries and neurological dysfunction are seen as a major impediment to the successful rehabilitation of those so afflicted. Because of the increased implications of these changes, a new intervention evolved called Cognitive Rehabilitation (Diller & Gordon, 1981; Gianutsos, 1980; Meier, Benton, & Diller, 1987; Miller, 1984;).

Cognitive rehabilitation or remediation is the process of retraining or improving cognitive brain functions. It is indicated in situations where an individual has sustained brain dysfunctions and/or injuries resulting from a variety of circumstances. Cognitive rehabilitation is used primarily in cases of post concussion syndrome, head injury, as well as other neurological conditions. Treatment is focused in the following areas:

(a) Improving performance by retraining discrete aspects of cognition using process-specific retraining exercises organized within a hierarchical curriculum, or

(b) Promoting compensation of specific cognitive impairments by teaching specific strategies to accommodate for lost functions (Ylvisaker & Szekeres, 1998).

The goals of cognitive rehabilitation are to remediate cognitive weaknesses, develop compensatory strategies, and enhance cognitive skills. Further, cognitive rehabilitation seeks to improve attention, concentration, mental efficiency, memory, and impairments identified by a neuropsychological evaluation (Liberto, Tomlin, Lutz, Nash, & Shapiro,
For brain injured children and adults, a program of rehabilitation is instituted. Cognitive processes such as attention, memory, concept formation, and thought organization are the most directly affected by serious brain damage (Averbach & Katz, 1992) and cognitive rehabilitation is indicated as a method of assisting the victims of brain injury to diminish acquired cognitive deficits. The National Institutes of Health (1998) has recognized cognitive rehabilitation as necessary to the treatment of traumatic brain injuries.

To specifically improve cognitive deficits as a part of cognitive rehabilitation, Powell (1981) and Miller (1984) identify two basic approaches: non-directed stimulation or practice and directed or specific stimulation. The non-directed stimulation approach, the most commonly used, involves a process where a rehabilitation subject is required to practice a task for which functioning has been lost to some degree. The directed or specific stimulation approach requires an analysis of the relationship between the brain and the task to be performed and how they interact (Powell, 1981). This approach involves three steps: (1) neuropsychological assessment, which identifies the lost functions and their correlates; (2) identification of a task, which directly reflects a skill associated with the lost functions; and (3) the introduction of repeated and structured practice that reflects a hierarchy of changing parameters of increasing complexity, quantity, speed of presentation, or the amount of cueing given.
Sohlberg and Mateer (2001) went further in their approaches to the remediation of cognitive deficits by specifically identifying four approaches to the cognitive rehabilitation of attention:

(a) attention process training (APT)

(b) using strategies and environmental supports

(c) use of external aids

(d) psychosocial supports

These approaches align closely with those espoused by Ponsford (as cited in Wood & Fussey, 1990), which include practice, specific stimulation, the behaviorist approach, compensation, and environmental manipulation.

Attention process training uses cognitive exercises designed to remediate and improve attentional systems and it is based upon neuropsychological theory. Attention process training postulates that attentional skills can be improved by providing opportunities for stimulating a particular aspect of attention. Practice is the most basic method of learning skills and treatment using attention process training involves having subjects engage in a series of repetitive drills or exercises that provide practice on tasks with increasing attentional demands. This practice regimen assumes that cognitive functions respond to exercise and are thereby strengthened.

The use of strategies and environmental supports includes self-management strategies and changes in the environment to assist a subject in compensating for attentional problems. The strategies used involve self-management and encompass self-instructional routines that help a subject focus on a task. Many subjects are helped by
strategies that allow them to be more deliberate in focusing their attention. Treatment could include orienting procedures that might help subjects sustain attention or screen out distractions; pacing strategies, which are helpful when a subject experiences fatigue and has problems concentrating over an extended period of time; and a key idea log to be used when a subject finds it difficult to switch between tasks. The subject can learn to write down key questions or ideas that come to mind but these can be addressed later.

Environmental supports for management of attentional deficits involve the careful assessment of the environment. The environment is set up to minimize the effects of an attentional deficit and has two categories, (1) task management which requires that tasks affected by an attentional disorder be made clear and the client and clinician generate strategies to contend with the issues uncovered; and (2) environmental modifications, where physical space is organized to reduce the effects of a deficit on the subject's attention, memory, and organizational capabilities.

Psychosocial support, according to the authors, addresses the emotional and social factors that can result from and/or are worsened by an attentional deficit. Persons experiencing a life altering change in their ability to function appropriately might experience grief or anger, which could also affect a person's ability to process information. Treatment would include supported listening, brain injury education, relaxation training, psychotherapy, and grief therapy.

For the purposes of this investigation, attention process training (APT) (Sohlberg & Mateer, 1987) was the approach utilized. APT is hierarchical and uses practice in the form of repetitive drills or exercises to stimulate specific aspects of attention.
Repetition is a basic and commonly used method of teaching and learning skills and is a normal part of a regular classroom environment. These aspects of APT make it a viable, minimally disruptive, and potentially effective intervention for attention deficit disordered children. Sohlberg and Mateer’s 1987 study was used as the model for this investigation. Their study used the process-specific stimulation approach to cognitive rehabilitation in the form of Attention Process Training (APT) to improve attention in adult subjects with acquired brain injury.

The use of computers is also a focal point of this investigation. According to Ponsford (1990), “The use of computers in the rehabilitation of cognitive deficits has increased so rapidly in recent years that it has become almost synonymous with the term cognitive rehabilitation” (p. 48). Computers have been used to improve cognitive deficits using both the non-directed and directed stimulation paradigms that were discussed earlier and have been the basis for the design, the assessment, and the stimulation of specific functions such as reaction time, visual scanning, speed of information processing, recent memory, problem solving and the primary focus of this investigation, attention (Bracey, 1983; Gianutsos, 1980; Lynch, 1983).

Several documented studies have proven the effectiveness of computer-assisted training for the improvement of cognitive deficits. In a series of single case studies, Ponsford and Kinsella (1988) found that patients with severe head injuries exposed to a computerized attention training intervention made steady improvement in attention over time. In a similar study, Sturm, Dahman, Hartje, and Wellmes (1997) found that subjects treated using a computer training intervention made significant improvement
on a battery of neuropsychological tests that measure cognitive functioning. Sohlberg and Mateer's study (1987) yielded similar results. Additional studies conducted by Wood and Fussey (1987) and Sturm, Willmes, Orgass, and Hartje (1997) yielded results that indicated no difference between the experimental and control groups after computer-assisted attention training.

There have been relatively few studies documenting the effects of computer assisted attention process training. The above studies indicated mixed results. The first three studies showed that computers and software programs designed to improve attention in those with deficits have the capacity to yield positive improvements. The second set of studies using computer assisted training as an intervention for those stricken with attention deficits, yielded mixed results. This indicates that further research is needed. The previous studies require replication; more studies are needed with children rather than adults, specifically children with other forms of attentional deficits such as the children who are the focus of the current investigation.

In their 1987 study, Sohlberg and Mateer delineated attention as a multidimensional cognitive process, which they identified, as having five levels: focused attention, selective attention, sustained attention, divided attention, and alternating attention. Focused attention is defined as the ability to respond discretely to specific visual, auditory, or tactile stimuli. Sustained attention is the ability to maintain a consistent behavioral response during continuous or repetitive activity. Selective attention is the ability to maintain a cognitive set, which requires activation and inhibition of responses dependent upon discrimination of stimuli. Alternating attention is the capacity for
mental flexibility, which allows for moving between tasks having different cognitive requirements. Divided attention is the ability to simultaneously respond to multiple tasks.

The intervention used in Sohlberg and Mateer's 1987 study was based on experimental attention literature and used a process-specific stimulation model as its theoretical basis. To facilitate the training process, the authors developed the Attention Process Training (APT) program that assigned hierarchical tasks to each of their previously identified five levels of attention. These tasks are computer generated and become progressively more difficult.

Sohlberg and Mateer (1987) used a process-specific stimulation model with adults. Positive and promising results emerged. The intervention used in the current study employs this same model—the process specific stimulation model used by Sohlberg and Mateer (1987) and involves the training of the affected processes using repetitive, task-related exercises. This model proposes a treatment in relation to underlying mechanisms of cognitive dysfunction based on a biological approach to cognitive rehabilitation. The intervention model for this investigation involves use of a task specific computer program to train and/or build damaged or under developed attentional components. Specifically, the current investigation uses specific tasks directed at stimulation of the attentional processes instrumental in improving the sustained and selective attention of adolescent males with ADD.
Sustained and Selective Attention

The current study uses sustained and selective attention-process training to investigate the effectiveness of cognitive rehabilitation by using an attention training software program on adolescent males with childhood attention deficit disorder. Sustained attention refers to the ability to maintain a consistent behavioral response during continuous and repetitive activity with two subcomponents: vigilance, the ability to remain on task; and mental control, referring to the manipulation and holding of information in the mind. A deficit would mean an inability to attend to a task long enough to complete that task (Sohlberg & Mateer, 2001).

Sustained attention was assessed in this study because a number of investigations found that children with ADD were unable to sustain attention as well as their "normal peers" (Amen & Turbott, 1986; Barkley, DuPaul, & McMurry, 1990; Sykes, Douglas, & Morgenstern, 1973). A task that has been extensively used to assess sustained attention, the Continuous Performance Task, is one in which a subject monitors a video display for the occurrence of a prearranged stimulus (Pearson, Yaffee, Loveland, & Lewis, 1996).

Selective attention is the ability to focus attention to relevant stimuli while ignoring irrelevant stimuli and uses tasks that compare performance in non-distracting conditions to performance in distracting ones. Deficits in selective attention generally show a decrease in performance when distractive elements are introduced into a task (Pearson, Yaffee, Loveland, & Lewis, 1996).
Selective attention was made an element of this investigation due to information collected from other investigations that have shown that children with ADD are typically less able to attend to relevant stimuli over irrelevant stimuli as compared to their "normal peers" (Ceci & Tishman, 1984; Pearson, Lane, & Swanson, 1991; Rosenthal & Allen, 1980).

Problem Statement

Conventional theorists have identified two basic approaches to cognitive rehabilitation: (1) non-directed stimulation and (2) directed/process specific stimulation. Research has yielded mixed results in the improvement of attention with either approach. However, these studies have primarily used adult subjects with mild to extensive acquired brain injuries. Sohlberg and Mateer (1987) used a process specific approach to the cognitive rehabilitation of adults, and obtained positive results in their investigation. The current research hypothesized that this same approach could yield positive, significant results for children diagnosed with childhood attention deficit disorder. The resulting approach used exercises to practice hierarchically arranged specific tasks, which directly reflect the skills to be improved, in this case sustained, and selective attention.

The purpose of this study was to investigate answers to the following questions:

1. Is it possible to use a process-specific approach to cognitive rehabilitation in the form of attention training computer software and improve sustained attention?
2. Is it possible to use a process-specific approach to cognitive rehabilitation in the form of attention training computer software and improve selective attention?

These questions will be addressed by testing adolescent male subjects, using their scores on the Cognitive Assessment System (CAS) subtests of attention to establish a baseline level of attentional functioning, introduce the Hierarchical Attention Training Plus (HATP) cognitive training computer software as an intervention, and retest the subjects to detect comparative changes in attentional functioning over time. It is postulated that there will be an improvement in the scores of each subject on the attentional subtests of the CAS over time in the areas of sustained and selective attention.
CHAPTER 2

REVIEW OF LITERATURE

The purpose of this review and analysis is to examine the research related to the effects of cognitive rehabilitation on the sustained and selective attention of adolescents diagnosed with Attention Deficit Disorder (ADD). The intervention proposed in this investigation uses an attention-process training computer software program developed primarily for use with adults who have severe acquired brain injuries. This chapter addresses the issue of pertinent studies in the literature that best illustrate the following areas of this study: (a) ADD history, causes, and current treatments, and what is known about the effectiveness of the treatments discussed, (b) normal attentional functioning, and the brain structures that support normal attentional functioning, (c) interventions used with acquired brain injured adults and children to restore preinjury attention, their effectiveness, and the use of computer software to enhance their effectiveness, and (d) the use of cognitive rehabilitation techniques as methods of improving attention in children with diagnosed ADD.
Childhood Attention Deficit Disorder: Causes and Treatments

Causes

The etiology of ADD appears to be extremely heterogeneous in nature with many contributing factors resulting in much controversy and speculation over the last two decades. Researchers have identified no single cause for ADD, but a number of risk factors that can affect cognitive development and behavioral expression have been found. These risk factors can include: poor parenting, other mental health diagnoses, fetal alcohol/drug syndrome or effects, birth or perinatal injuries, and developmental delays that are often present at the same time, leading to the assumption that a combination of forces can impede early development (Biederman et al., 1995). Researchers have speculated on hypothetical causes which include: diet and food allergies (Feingold, 1976; Jacobson & Schardt, 1999), environmental toxins (David, Hoffman, & Sverd, 1976; Moon, Marlow, Stellern, 1985), poor parenting practices (Burte & Burte, 1994; Goodman & Stevenson, 1989; Taylor, Schacher, Thorley, & Wieselberg, 1986), genetic defects (Goodman & Stevenson, 1989; Farone, Biederman, Chen, & Krifcher, 1992) and perinatal and birth injuries (Colletti, 1979; Goodman & Stevenson, 1989; Sprich-Buckminster, Biederman, Milberger, Farone, & Lehman, 1993). Potential contributors to the etiology of ADD will be discussed below.

Diet and Food Allergies

In 1976, Dr. Benjamin Feingold, a pediatric allergist, asserted that certain foods and food additives could trigger an attention deficit disorder. Dr. Feingold reported that
after placing his ADD patients on a diet free of artificial food colors, flavorings, preservatives, and salicylates, which occur in some foods naturally (e.g. apricots, berries, tomatoes), between 30 and 50 percent of those patients were found to be sensitive to these food additives and experienced an improvement in their ADD symptoms upon withdrawal. His research involved over 3,000 different food additives and over 1,200 cases in which food additives appeared to be linked with behavioral and learning disorders including ADD.

Feingold’s assertions and diet came under much scrutiny. As a result, other researchers immediately began to try to replicate his study. The early studies focused primarily on the effects of artificial coloring, flavorings, and salicylate-containing foods (Jacobson and Schardt, 1999). Conners, Goyette, Southwick, Lees, and Andrulonis (1976) conducted the first replication study using Feingold’s diet on 15 children with an average age of eight years and diagnosed with childhood Attention Deficit Disorder. Over a four-week period, Conners and his colleagues compared the effects of the Feingold diet with a control diet that included artificial food colorings, flavorings, and foods containing salicylates. To keep the participants from guessing which diet had eliminated the food additives, the researchers sought to make both diets appear experimental through their presentation of the diets for consumption. Some subjects received the restricted diet first while others received it second. The results indicated that of the 15 children, four children (about 27%) improved on the Feingold diet as compared to controls with two subjects showing dramatic improvement as indicated by parent reports.
There were two potential sources of flaws in this study. First, the researchers indicated that despite their attempts at control, it was possible that some of the parents might have been able to determine which diet their child received. This would potentially influence their judgment as to the efficacy of the treatment. Secondly, there appeared to be an “order effect”. It seemed that the subjects who consumed the restricted diet after the control diet had greater effects as compared to subjects who received the restricted before consuming the control diet.

In another study conducted by Kaplan, McNicol, Conte, and Moghadam (1989), the families of 24 ADD preschool-aged boys were part of a ten-week study where all food was provided. A within subjects crossover design was used and the study was divided into three periods of baseline, a three-week placebo, and an experimental diet period of four weeks. The diet used eliminated artificial colors and flavorings, chocolate, monosodium glutamate, preservatives, caffeine, and any substance that families reported might affect their specific child. The diet was also low in simple sugars and dairy free.

The parental reports indicated that ten of the subjects experienced a significant improvement in behavior on the restricted diet; four reported a more modest improvement, leaving ten subjects who received no positive effects. There were only negligible placebo effects. Parental reports can be very subjective, especially since whatever substances parents thought were a problem were eliminated. Their expectations were that the restricted diet would result in an improvement.
The possibility that food additives can affect the behavior of children with attentional deficits is real. Research has shown that some of the symptoms of ADD have proven to be associated with sensitivity to food additives and restricting the consumption of these food additives reduces symptoms of ADD for some children. That same research does not necessarily indicate causation. There is no indication of a causal relationship between ADD and the presence of sensitivity to food additives by ADD sufferers.

Environmental Toxins

Our modern environment contains a variety of toxins that engender detrimental effects that have been linked to abnormalities in behavior, perception, cognition, and motor subtleties during early childhood that can be disabling over time (David, Hoffman, & Sverd, 1976). Children exposed to these toxins are often left with permanent neurological abnormalities in the form of attentional deficits, emotional lability and behavioral reactivity (Moon, Marlow, Stellern, 1985). One of those toxins is lead.

Elevated lead levels were identified by David, Clark, and Voeller (1972) as a possible contributing factor in attentional deficits. Unborn fetuses and young children are particularly susceptible to the neurotoxic effects of lead because they are in a period of rapid growth and development of the central and peripheral nervous systems. Lead is found in dust, soil, and flaking paint in areas where leaded gasoline and paint were once used. It is also present in water pipes. The National Institutes of Mental Health (1996)
report that controlled animal studies suggest that children exposed to lead may develop symptoms associated with ADHD, but only a few cases were ever found.

A study conducted by Minder, Das-Smaal, Brand, and Orlebeke (1994) investigated lead contamination as a possible specific cause of attentional deficits in children. The subjects used were forty-three boys, age eight to twelve years, attending a special school for children with educational and/or learning problems. Sustained, selective, and divided attention was measured using neuropsychological tests containing both computerized and paper and pencil tasks, and reaction time tasks. The test used was the Neurobehavioral Evaluation System (NES) (Baker & Letz, 1986) and the Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974). As an assessment of lead presence, lead concentration in the subject’s hair was measured using a fluorescent x-ray technique. Information was collected regarding any confounding factors that would affect the results. A multiple regression analysis was used to evaluate the contribution of lead levels to variance in the performance of subjects on the administered neuropsychological tests.

The results indicated that children with relatively high concentrations of hair lead reacted slower in simple reaction time tasks as compared to children with low concentrations of hair lead. Additionally, the subjects with higher concentrations of lead in their hair were less able to change their focus of attention even after the correction of the confounding influences for their delayed reaction time.

This was basically a well-designed study. The researchers made successful attempts to control for confounding extraneous influences and showed an association between
some specific attentional problems and hair lead levels.

An investigation conducted by Kahn, Kelly, and Walker (1995) hypothesized that children meeting diagnostic criteria for Attention Deficit Disorder or developmental delay would have blood lead levels higher than a control group. The study was conducted in a military medical center, which accepts referrals for the children of both active duty and retired military service members. The children used were known or suspected of having a neurodevelopmental disorder.

Forty-three children, ages one to eight years of age were used in the study. The subjects were identified as follows: (1) a developmental profile was established for those subjects suspected of being developmentally delayed and was confirmed by a developmental pediatrician. Those subjects used were identified as having a twenty-five percent delay or better in all developmental areas and (2) ADHD subjects met DSM III-R criteria for ADHD using parent report, teacher completed ADHD rating scales, and a neurodevelopmental evaluation by a developmental or pediatric psychologist. The control group counted eighty-five and was recruited from pediatric clinics, and matched the experimental group on the basis of age, sex, and socioeconomic status.

Blood lead levels were analyzed for lead content, all participants were notified of their blood lead levels, and counseling was provided for those identified with elevated levels. An analysis of variance was used to compare blood lead levels. The resulting blood lead levels had a documented mean of 2.33 parts per million (ppm) with a standard deviation of 1.5 for the experimental group compared to a 2.26 mean lead level for the control group. There was no significant difference between the means of the
groups. This indicated no significant association between a clinical diagnosis of ADHD or developmental delay and blood lead levels.

This was a well-organized study with appropriate controls and minimal flaw. The researchers indicated that the area where the study was conducted (Pacific Northwest) is typically low risk for lead poisoning but the population on a military base is relatively transient with people coming and going regularly. Even with this fact, the results remained stable across the groups adding more credibility to the study.

It is estimated that nearly one million children in the United States under six years of age show concentrations of lead in their blood, most of which come from exposure to lead-based paint from living in deteriorating buildings. However, lead concentration levels are not high enough to produce symptoms similar to those of attention deficit disorder (Raloff, 2001). The above studies yielded mixed results indicating that there is some evidence to support the idea that environmental toxins in the form of elevated blood lead levels can produce symptoms of attentional deficits in children. Elevated blood lead levels can cause permanent brain damage by impairing the brain’s hard wiring (Raloff, 2001). However, there is no evidence to indicate that every child displaying ADD symptoms do so because of exposure to lead.

**Poor Parenting Practices**

Some researchers have studied the possibility that dysfunctional family dynamics may cause attention deficit disorder (Burte & Burte, 1994; Goodman & Stevenson, 1989; Taylor, Schachar, Thorley, & Wieselberg, 1986). Goodman and Stevenson
(1989) took on a very ambitious investigation that used 507 pairs of monozygotic and
dizygotic twins to determine the etiological role of genes, family relationships, and
perinatal adversity in hyperactivity. For the portion of the study that dealt with family
dynamics, parents were interviewed in their homes by a trained interviewer. The
information was obtained about the quality of relationships in the home using a
modified version of the methods used by Rutter and Brown (1966). The interviewer
was able to rate the quality of the parent’s marriage as well as the warmth and criticism
of the parents toward each twin separately. Parents completed a self-rating
questionnaire (Malaise Inventory, Rutter, Tizard, & Whitmore, 1970) to determine
tendencies to suffer anxiety, depression, and physical ailments associated with a
psychological component.

Correlations between hyperactivity scores and seven measures of adverse family
factors were obtained and included: marital discord, low maternal warmth, low paternal
warmth, high maternal criticism, high paternal criticism, high maternal malaise, and
high paternal malaise using Spearman’s Rho.

The results indicated that all correlations were positive but small. Even when all of
the family factors were considered together using forced entry multiple regression, the
correlations between family factors and hyperactivity scores remained modest. The
family factors that contributed most to this correlation were maternal criticism at 0.17
with p<.001 level of significance. The second highest correlation was maternal
malaise, which was a 0.23 at a p < .001 level of significance. This study did reveal a
weak association between hyperactivity and family dysfunction.
The limitations of this phase of the study brought out by the researchers proceeded from the fact that the hyperactivity scores were based on scores on a parental rating scale. Because of the criticism, coldness, and distress of the parents, it is possible that their ratings of their ADHD children might have been exaggerated or identified symptoms that were nonexistent. Many of the measures of family dysfunction used in this study could be explained by environmental variables such as poverty or that ADD itself can evoke in parents criticism, coldness, malaise, and marital strife.

A 1995 study conducted by Biederman, Milberger, Farone, Kiely, Guite, Mick, Ablon, Warburton, Reed, and Davis investigated whether features of the family environment were associated with ADHD. Biederman and his colleagues rationalized that although past and current research had indicated that the etiology of ADHD has a genetic component, children with ADHD come from disorganized and sometimes psychopathological families that create dysfunctional environments and cause the disorder. They further postulated that the role of these environments in the transmission of ADHD is unclear. As a result, the researchers used the Keller, Beardslee, Dorer, Lavori, Samuelson, and Klerman (1986) model to test the following hypotheses: (1) family-environment adversity factors will be greater among children with ADHD compared with control children; (2) family-environment adversity factors increase the risk for comorbidity in ADHD; and (3) intelligence protects children from the negative influences of adversity.

One hundred forty-five children with ADHD were compared with one hundred twenty controls. The subjects were Caucasian, non-Hispanic males between the ages of
six and seventeen years. They were randomly selected from ADHD referrals to the Pediatric Pharmacology Unit of the Massachusetts General Hospital with controls selected from active outpatients at pediatric medical clinics. Exposure to parental psychopathology and parental conflict were used as indicators of adversity. Their impact on ADHD and related psychopathology and dysfunction (behavior problems and competencies) in children was assessed using the Child Behavior Checklist (Achenbach, 1991; Achenbach & Edelbrock, 1983), which was completed by the mothers of the subjects.

As a measure of family conflict, the Family Environment Scale (Moos & Moos, 1974) assessed the quality of interpersonal relationships within families. Exposure to parental psychopathology was assessed, determining the approximate proportion of a child’s life lived with an affected parent; which parent was affected (mother only, father only, both parents); and the severity of exposure to parental psychopathology as indexed by the number of parental disorders to which a child had been exposed during their lifetime.

The results of the investigation indicated that family adversity factors were greater among children with ADHD as compared to controls for all of the adversity variables. Statistical significance was observed for parental conflict, diminished family cohesion, number of parents psychiatrically ill during the child’s lifetime, and proportion of the child’s life exposed to maternal psychopathology. The research further identified no association between an adverse family environment and an increase in psychiatric comorbidity (inclination toward depression, conduct disorders, etc.) in the ADHD
sample as compared to controls. Finally, in the interaction between the variables of adversity and full scale IQ, it was found that intelligence offered no protection against the negative effects of family adversity.

Though this study identified important associations between family adversity factors and ADHD, this study also had several limitations. First, the researcher identified limitations in this study which included: the researcher's inability to assess the direction of the associations between ADHD and family adversity because of the cross sectional nature of the study; the researchers were unable to determine the degree to which the information obtained could be generalized to non-referred ADHD children in the community because the sample was selected from a clinic; the researchers were unable to directly interview the younger children involved in the study indicating a source for possible bias; and measures of the family environment were not comprehensive because they only dealt with a few specific aspects of the family environment. Second, one of the measures of ADHD used in this study was the Child Behavior Checklist (Achenbach, 1991; Achenbach & Edelbrock, 1983), which is a rating scale that was completed by a parent, in this case, the mother. These parents were identified as psychopathological. How reliable would their ratings of their children be? Third, there were problems with the validity of the measure for assessing the effects of exposure to parental psychopathology.

Despite its limitations, this investigation expanded the basic knowledge regarding family dysfunction and ADHD. Associations were identified between family adversity factors and ADHD. No association was found between ADHD and an increase in
related psychiatric disorders and the fact that an ADHD subject might have a high IQ does not protect those so afflicted from the effects of family adversity.

Perinatal and Birth Injuries

The most commonly mentioned environmental risk factors for child psychopathology are pregnancy, delivery, and infancy complications (PDICs). These factors have the potential for seriously impacting the development and functioning of the human brain. High rates of perinatal complications have been observed in children with learning disabilities (Colletti, 1979) and incarcerated delinquent children (Lewis & Shanak, 1979). However, the literature examining the impact of PDICs and ADD shows conflicting findings.

Goodman and Stevenson’s 1989 study dealt with perinatal adversity as a possible cause of attention deficit disorder. Goodman and his associate set out to determine what effects, if any, perinatal adversity has on hyperactivity using 570 pairs of thirteen year-old, monozygotic, and dizygotic twins. The relative risk of perinatal adversity was judged by using absolute birth weight, relative birth weight compared with co-twin, and birth order. The researchers hypothesized that if hyperactivity were secondary to perinatal injury, the prevalence of hyperactivity would be higher in the low birth weight twins in the test sample as compared to the remaining twins. Similarly, hyperactivity should be more common in the lighter than in the heavier member of a same sex twin pair, and in the second born rather than in the first born of a same-sex twin pair.
Using the McNemar test for matched samples, Goodman and Stevenson (1989) determined that the results did not substantiate any of the above predictions. The presence of hyperactivity in the sample did not differ significantly between low birth weight twins and the remainder of the subjects and no difference between first and second born twins was identified. Additionally, using the Kolmogorov-Smirnov 2-sample test to compare the hyperactivity scores of the low birth weight twins with the heavier twins, no significant differences were detected. This challenged the hypothesis that perinatal adversity causes hyperactivity.

This was a reasonably informative study with good controls. A representative sample of monozygotic and dizygotic twins was used and the measures of hyperactivity used had clinically relevant correlates. The results of this phase of the study found that perinatal adversity was not related to later hyperactivity.

In another study, Sprich-Buckminster, Biederman, Milberger, Farone, and Lehman (1993) used 73, six to seventeen year-old- Caucasian, non-Hispanic, and nonadopted boys who met DSM-III (American Psychiatric Association, 1980) attention deficit disorder criteria based on clinical interviews with a child psychiatrist. Twenty-six of the subjects served as psychiatric controls and 26 of the subjects were normal controls, along with their first-degree relatives. The subjects were consecutively obtained outpatients from the new referrals of a child psychiatry center. The twenty-six normal controls had socio-demographic characteristics similar to those of the experimental group. The purposes of the study was to determine whether perinatal complications were relevant to the manifestation of attention deficit disorder and to measure the

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prevalence of disorders comorbid to ADD and their familial connections.

To begin the research, Sprich-Buckminster and her colleagues (1993) evaluated the role of pregnancy, delivery, and infancy complications (PDICs) in the etiology of attention deficit disorder by addressing the following hypotheses: (1) PDICs are not risk factors for ADD; (2) PDICs are specific risk factors for ADD; (3) PDICs are nonspecific risk factors for psychopathology; (4) PDICs are risk factors for diseases comorbid with attentional deficits; and (5) PDICs are risk factors for nonfamilial ADD.

The presence of perinatal complications were assessed using the Diagnostic Interview for Children and Adolescents, Parent Version (DICA-P) (Herjanic & Campbell, 1977; Herjanic & Reich, 1982) module on pregnancy, delivery, and infancy complications with information obtained from mothers by trained interviewers blind to the experimental group. Once the data were collected, an odds ratio analysis was conducted to determine the ratio of the odds for the presence of pregnancy, delivery, or infancy complications (PDICs) among the subjects studied. Sprich-Buckminster’s (1993) odds ratio analysis revealed an association between ADD and the risk for PDICs. The group with the strongest connection to PDICs was the subtype, disorders comorbid with ADD without a familial connection. In contrast, the subtype, non-comorbid with familial ADD group showed less divergence from normal controls in their risk for PDICs. The increase in risk for PDICs in nonfamilial ADD children and the lack of evidence for increased risk among familial ADD patients suggests that PDICs may be part of a non-genetic etiologic process in ADD, especially for children who have comorbid disorders. This further suggests the possibility that the presence of PDICs
might indicate a causal relationship with ADD.

The results from this study should be considered in light of its limitations. The authors of this investigation reported that the obstetric records from which some of the information was obtained were not always complete or available, indicating that there might have been important information that was left out. Further, the authors also indicated that some of the information collected came from retrospective reporting, which can result in recall bias. Recall bias could result in false positive associations between pregnancy, delivery, infancy complications (PDICs) and ADD.

There is currently no assessment tool that specifically measures attentional deficits. Much of the materials and information collected is subjective and based on rating scales. Further, this information is often collected from a parent whose opinions can sometimes be unreliable. There has been much criticism over the years of rating scales because of the numerous threats to the validity of scores based on rating scales (Bracken, Keith & Walker, 1998). Some rater effects that have been studied include: the unintentional distortion of the results; the formation of halo effect by the rater or the subject; stereotyping of certain subjects based on others of a similar group; differences in perception; and/or leniency/stringency errors (Rudner, 1992).

Finally, the range in the ages of the subjects was from six years to seventeen years. There is a large disparity in this group because of their developmental stage and the level of frontal lobe development in the younger subjects as opposed to the older ones. Depending on how much disparity is present, this could be a source of some discrepancy in the resulting data. An inherent flaw in traditional between-groups
research methods is that within-group variability increases error variance, which can make it difficult to obtain statistically significant differences between groups (Lloyd, Tankersley, & Talbott, 1994).

Despite the limitations of this study, the finding that an association may exist between ADD and pregnancy, delivery, and infancy complications (PDICs) is an important one. This is important because the most recent research has indicated that ADD has a genetic basis. Based on the results of this study there may be a non-genetic etiologic process involved in ADD, making this area worth much further study.

Genetic Defects and the Neurobiological Correlates of ADD

Recent research indicates that attention deficits tend to run in families. In Goodman and Stevenson’s 1989 study, a large representative sample (570 pairs) of thirteen-year-old, male, monozygotic (MZ) and dizygotic (DZ) twins were tested to determine the extent to which ADD is heritable. Two derived measures, the freedom from distractibility (FFD) (Goodman & Stevenson, 1989) and “E” scan attentiveness (ESA) scales (Goodman & Stevenson, 1989) were used to estimate the inattentiveness in three classes of twins: (1) recognized MZ twins; (2) unrecognized MZ twins; and (3) same-sex DZ twins. To determine heritability, the resulting scores were compared using Pearson’s r. This yielded an interclass correlation, which was used to measure how closely the members of a twin pair resemble each other. The resulting correlation coefficients represented heritability.
Genetic analyses using twin data generally compare the degree of similarity of MZ twins with the degree of similarity of same-sex DZ twins. When the degree of similarity between MZ twins is greater than that of same-sex DZ twins, the result is a phenomenon called expectancy. In their analyses of the heritability of ADD, to control for expectancy and determine true genetic effects, the authors used data about both misclassified and correctly classified twin pairs in their investigation. Subsequently, interclass correlations were computed for the two attentiveness scores (FFD and ESA) and for three hyperactivity scores (generated by mothers, fathers, and teachers, respectively) to measure how closely the members of a twin pair resembled each other. The resulting correlation coefficients ranged from .52 to .60 and indicated that the twins were closely similar. The heritability scores were calculated as twice the difference in interclass correlations of all MZ and all same sex DZ twins.

The heritability scores indicated that between 30 and 40 % of the variability in the test subject scores could be attributed to inherited genetic affects, with common environmental effects (expectancy, which includes poverty and/or a defect in a member of the twin pair) accounting for a further 10-30% of the variance. The three hyperactivity scores provide evidence for substantial heritability, with Mother’s score for all MZ twins at .68 as compared to a -.08 for DZ same-sex twins, Father’s score at .48 as compared to .21 and a score of .62 for Teachers as compared to .26. The overall underlying genetic effects were found to account for 50% of the observed variance in measures of childhood hyperactivity and inattentiveness in comparisons between monozygotic and diazygotic twins. Family resemblances appeared to indicate shared
genes rather than shared environment. Heritability for ADD was estimated at 64%.

The authors recognized that this study had some limitations. They found that the interviewers who gathered information from the parents to determine the zygosity of the twins overestimated their similarities. Though they made an attempt to control for this by including both recognized MZ twins and unrecognized MZ twins, this aspect was not completely controlled and this source of error remained partially unchecked.

In another study conducted by Samuel, George, Thornell, Curtis, Taylor, Brome et al. (1999), the familial transmission of ADHD in African-American families was investigated. A sample of 37 first-degree relatives of middle-class African-American children with DSM-III-R defined ADHD and 52 first-degree relatives of non-ADHD comparison children were matched for ethnicity, age, and gender. DSM-III-R structured interviews provided the basis for the psychiatric diagnoses in relatives. The subjects were male and female probands (test subjects) between the ages of six and seventeen years with (n=19) and without (n=24) the clinical diagnosis of DSM-III-R attention deficit hyperactivity disorder (ADHD). The ADHD relative group comprised 9 adolescents, 3 children, and 25 parents. The control group comprised 7 adolescents, 5 children, and 40 parents. The ADHD probands were identified from two referral sources: The Harvard Community Health Plan and the Massachusetts General Hospital. The non-ADHD comparison children were selected from the pediatric medical clinic at the above-mentioned sites as well as from advertisements in the African-American community (newspapers, churches, and community centers).
Six African-American blind raters conducted the comparisons using DSM-III-R structured interviews, which were conducted with the mothers and direct interviews with siblings, except for those children younger than 12 years of age and included methods of cultural sensitivity. Data collection personnel were of African-American heritage and all personnel received cultural competency training using the Ethnic Validity Model as a conceptual framework. The training addressed issues such as the interpretation of colloquial phrases, indicators of cooperation, and signs of distress. Psychiatric assessments of siblings were made using the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic version (K-SADS-E) (Orvaschel, 1985).

The groups were compared using logistic regression with groups as the dependent variable. Because the nonindependence of siblings from the same family leads to inaccurate estimates of statistical significance, the analyses were adjusted by using Huber’s (1967) formula to produce robust statistical tests for both linear and logistic regression. All tests of significance were two-tailed and set at the 5% level of significance.

The results indicated that relatives of ADHD probans had significantly higher rates of ADHD as compared to the non-ADHD controls. The ADHD probands were more likely to have a family history of these ADHD diagnoses. The first-degree relatives of ADHD probands evidenced higher prevalence of oppositional defiant disorder (17% over controls), antisocial personality disorder (16% over controls), generalized anxiety disorder (12% over controls), and alcohol or drug abuse or dependence (40% versus
17% over controls). The researchers concluded that ADHD is a familial disorder in African-American children.

This pilot study reflected good effort with good controls but must be interpreted in the context of its methodological limitations. The researchers felt that because they assessed a small number of subjects, the statistical power to detect group differences was limited. The subjects were primarily from middle-class African-American families, the results may not generalize to other social class strata, even white social class strata. Additionally, the lack of direct psychiatric interviews with children younger than 12 may have decreased the sensitivity of some diagnoses, especially the internalizing disorders such as anxiety and depression. However, despite its limitations, this study documents the familiality of ADHD.

Advances in technology have gone even further to identify a neurobiological basis for ADD, beginning with the work of Satterfield and Dawson (1971) on psychological parameters, up to the most recent research in brain imaging (Zametkin, 1990). Additional research in several disciplines including genetics, neuroanatomy, and neuropsychology also point to a strong biological basis for ADD, supporting the above-mentioned research and suggesting a genetic cause.

Research by scientists in Denmark (Lou, Henrikson & Cruhn, 1984) investigated three dimensional regional cerebral blood flow in 13 children with dysphasia and/or attention deficit disorder using xenon 133 inhalation and emissions computed tomography scans of the frontal lobes. Lou and his colleagues determined that ADD was associated with a brain dysfunction. They found reduced blood flow in the frontal
lobes of every ADD child examined. This indicated that perhaps reduced blood flow contributes to ADD, since the frontal lobes of the brain play a critical role in regulating attentional activity, and emotional reactions.

Further research in the U. S. used Positron Emission Tomography (PET) scans of ADD adults to determine the efficiency with which the brain used glucose while performing tasks requiring attention. Zametkin's 1990 study investigated the hypothesis that cerebral glucose metabolism, which determines the rate and effectiveness of the brain's ability to metabolize glucose, might differ between normal adults (controls) and adults with a history of ADD in childhood who continued to have symptoms. Each patient was also the biological parent of an ADD child, and none of the subjects had ever been treated with stimulant medication. To measure cerebral glucose metabolism, glucose was administered intravenously to 50 "normal" adults and 25 ADD adults while performing an auditory attention task. Images were obtained for 30-minutes using a PET scan. Whole brain and regional rates of glucose metabolism were measured with computer assistance by trained researchers, working independently, who were blind to the subject's status (control vs. ADD). The results indicated that: (1) global glucose metabolism was 8.1% lower in the ADD subjects than in the controls; (2) in adults with ADD, glucose metabolism rates were significantly reduced as compared with values of controls in 30 to 60 specific regions of the brain. Among the regions so affected were the premotor cortex and the superior prefrontal cortex. The results indicated that ADD adults had far less activity in the frontal regions of the brain in comparison to the non-ADD adults (Zametkin et al., 1990).
Some scientists believe that the patterns of frontal lobe under-activity during concentration are due to abnormalities in the speed of the conduction of neurotransmitters found in the frontal lobe areas. It is speculated that these neurotransmitter abnormalities are caused by insufficient myelination of the nerve fibers in the brain (Flick, 1998; Jensen, 1998; Ingersoll & Goldstein, 1992; Zametkin, 1990).

Myelin is a white fatty substance surrounding the body of the axon portion of a neuron, which insulates and protects the axon from the electrical interference by adjacent neurons and speeds up the conduction of informational impulses along the axon. Myelin is distributed in segments along the axon that are broken up by the nodes of Ranvier. These are small gaps in the myelin coating of the axon. With the extended conductivity created by myelination, the neurotransmitters are pushed across the synaptic gap from the terminal buttons at the end of the dendritic branches of the axon to the next neuron at increased speeds. When an axon is unmyelinated, the conduction of impulses to the next neuron is much slower resulting in the slowing of information processing (Steinberg, 1996).

Only a limited number of studies were found in this area including a 1996 study conducted by Ucles, Lorente, and Rosa, which used 15 children, 3 to 7 years of age, and suffering from ADD to determine whether a delay in laying down myelin could be a possible explanation for ADD. The subjects were compared to 23 age-matched "normal" children using EEG and transcranial magnetic stimulation. Transcranial magnetic simulation is a relatively new procedure using powerful electromagnets to stimulate areas of the brain non-invasively. Stimulation of certain areas of the brain
has helped scientists map the brain without opening it up.

An analysis of the data using a two independent samples t-test revealed a significant difference between the experimental and control group on the computerized EEG spectral analysis at a .05 level of significance. The results using transcranial magnetic stimulation yielded an overall significant difference in right/left brain stimulation at a .001 level of significance. These results suggested that delayed myelination at the brain stem reticular formation where the alpha rhythm brain waves are activated and at the corticospinal metabolic pathway, resulted in a slowing of the impulses that govern the signaling for the release of neurotransmitters. This area of research warrants further study.

Neurotransmitters are created in the neuron from amino acids and the supply is controlled by enzymes that keep them in balance with the demands of normal cell activity. There are two primary types of neurotransmitters: monoamines and neuropeptides. For the purposes of this study only monoamines will be discussed.

Monoamines are made of single amino acids derived from food and carried by the blood into the brain. The monoamines are the neurotransmitters primarily involved in attention deficit disorder and include the following: dopamine, norepinephrine, serotonin and gamma amino butyric acid (GABA). The amount of information that flows between the neurons of the brain is dependent upon the amount of neurotransmitters being produced. Each person's genetic make-up is responsible for that person's levels of neurotransmitters from birth. Too much or too little of a specific neurotransmitter results in too much or too little information flow, which can result in...
ADD or some other cognitive or emotional problem.

Dopamine and norepinephrine act as stimulants in the brain and are produced through a series of chemical reactions, or metabolic pathways. Dopamine appears to influence several important activities, including movement, attention, and learning. Norepinephrine seems to be involved in the regulation of alertness. Serotonin appears to be related to arousal and sleep as well as mood, appetite, and sensitivity to pain. GABA seems to have direct inhibitory effects on axons, resulting in an increase in the threshold of excitation (Sternberg, 1996).

In a 1993 study, Cook et al. set out to determine if, based on the response of patients with ADHD to stimulant medications there was an association between ADHD and the dopamine transporter gene. The transporter is a regulator of extracellular dopamine (Coyle & Snyder, 1969) and a principal target of standard hyperactivity medications in the brain (Volkow et al., 1998).

Fifty-six families participated in the study, twenty-four of which consisted of just the mother and affected child and four consisted of father and affected child. The inclusion criteria were: DSM-III-R diagnosis of ADHD, availability of one or more biological parents, and consent to collect blood. The affected children ranged in age from 4-17 years. They were clinically assessed for level of intelligence using the Wechsler Preschool and Primary Scale of Intelligence (PPSI) for ages 4-5 years and the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) for the subjects aged 6-16 years (Wechsler 1967; Wechsler, 1991). Parents completed the Achenbach Child Behavior Checklist (CBL) (Achenbach & Edelbrock, 1983) and the Conners Parent
Rating Scale-Revised (Goyette, Conners, & Ulrich, 1978). Additionally the CBCL and ADD-H: Comprehensive Teacher’s Rating Scales (ACTeRS) (Ullmann, Sleator, & Sprague, 1991) were completed by teachers.

Though DNA from various individuals is more alike than different, many regions of human chromosomes exhibit a great deal of diversity and are termed polymorphic (meaning many forms) and are used in the diagnosis of many genetic diseases. Many polymorphisms are located in 95% of the human genome that does not encode proteins. A special type of polymorphism, termed a VNTR (variable number of tandem repeats), is composed of repeated copies of a DNA sequence that lie next to one another on the chromosome. Cook and colleagues extracted DNA from the subjects using whole blood and a normal saline mouth rinse. They used this procedure to analyze and make their determination as to the association between the dopamine transporter and ADHD. The researchers tested for the independence of the transmission of each parental allele. It was determined that the chance that each allele would be transmitted to an offspring was 50%, given the null hypothesis of no association. If the transmission of an allele deviated from that pattern, based on a standard chi-square test, evidence for association would exist.

Cook and his colleagues’ results indicated that there was a deviation from the above 50%. There was as much as 76% of a deviation, indicating that there was initial evidence of an association between ADHD and the dopamine transporter gene. It logically follows that if there is a connection between ADHD and the dopamine transporter gene, this would increase the susceptibility to ADHD. This abnormality in
the transportation of the neurotransmitter would affect the brain's ability to transport the correct amount of that neurotransmitter to the conduction sight of an impulse, slowing or eliminating the continuation of that impulse to the next cell.

These studies of ADD subjects using PET scans, CT scans, EEG's, and brain imaging establish the idea that ADD is associated with some form of underlying neurological dysfunction involving functions and structures of the frontal lobes and cerebral cortex of the human brain and that the anomaly may be genetic. Further, the converging body of evidence regarding possible causes of ADD, taken from studies involving diet and food allergies, environmental toxins, and poor parenting practices indicate that they are risk factors and/or are contributory factors but does not support causation.

To summarize, research regarding several hypothesized causes of Attention Deficit Disorder was reviewed in this section. The most valid, reliable and consistent results appear to indicate the presence of dysfunctions in the frontal lobes and cerebral cortex resulting in atypical brain functioning involving the conduction of neurotransmitters. Further, gene studies involving the dysfunction of specific dopamine receptors and the fact that the use of psychostimulant medications improves the conduction of these neurotransmitters support the assertion that ADD has a genetic basis.

The other researched causes appear to show an association to ADD but the results are mixed and appear to be noncausal, with one exception, which requires further research to be considered valid. This research indicating that ADD is inherited and related to a frontal lobe dysfunction, along with the groundbreaking research conducted
by Erickson, Perfilieva, Bjork-Eriksson, Alborn, Nordborg, Peterson, and Gage (1998) documenting neurogenesis in the adult human brain, leaves the door open to research regarding interventions that could improve or remediate inefficient frontal lobe functioning.

Treatments

Psychostimulant Medication

For the last fifty years the primary treatment for ADD has been psycho-stimulant medications in the form of Methylphenidate (Ritalin), Dextroamphetamine (Dexedrine), and Pemoline (Cylert), with Methylphenidate being the most used (Flick, 1998). Psycho-stimulant medications have been reported to reduce the primary symptoms of ADD in approximately 55-60% of children so afflicted. Attention increases, social behaviors improve, and impulsivity decreases with the use of psycho-stimulant drugs (Barkley, 1990). Psycho-stimulants produce a variety of neurochemical effects and they neurologically control the level of the neurotransmitters dopamine and norepinephrine in the brain.

Psychostimulants work by releasing stored dopamine from presynaptic vesicles. This decreases dopamine reuptake and inhibits monoamine oxidase activity. This subsequently produces postsynaptic agonist activity, meaning that the reuptake of a neurotransmitter after its release is prevented, and increases the level of these specific neurotransmitters in the brain enabling the child to function normally (Silver, 1992). Psychostimulants are generally dose dependent, meaning how well they work depends
upon how much the child is prescribed. Common side effects include insomnia, decreased appetite, weight loss, headache, irritability, and stomachache (Flick, 1998).

The use of stimulants began with Bradley's (in Flick, 1998) 1937 discovery of a change in the behavior and school performance of children whom he treated with the amphetamine, Benzedrine. Psychostimulant medication began to be extensively used around 1957 with the introduction of methylphenidate. The attention of children taking psychostimulant medications improved along with their performance on I. Q. tests and the level of the improvement appeared to be linked with the level of the drug used (Flick, 1998).

A review of 155 controlled studies with over 5,000 children treated with stimulant medication conducted by Miller (1996) found that these studies reported a positive response to the medication in 55% to 60% of the subjects. This leaves 40% to 45% who showed no positive response or whose behavior was made even worse.

Swanson et al. (1993) reviewed and examined 341 reviews of the use of stimulant medication with children suffering from attentional deficits. A computer search of four databases was initiated, Medline, ERIC, PsychInfo, and GPO. The accumulated reviews indicated that those children who had a positive response, which varied in number from 60 to 75%, exhibited temporary management of overactivity, inattention, and impulsivity as well as improvements in following directions. Hyperactivity and aggressive behavior was also reduced, resulting in an increase in the amount of academic work completed. However, this "review of reviews" also found that psychostimulant medications were ineffective or intolerable for 5% to 40% of children.
with attentional deficits and that a large portion of children being treated with methylphenidate also showed improvement on the placebo.

Swanson and his co-authors (1993) suggested further limitations of psychostimulant treatments that have important implications for the classroom. They suggested that psychostimulant medications might be overused in the United States, which has been suggested by other researchers. Current estimates suggest that over 500,000 children in the United States are treated with stimulants each year (Safer & Krager, 1984). Of those 500,000 children so treated, 40% could be considered questionable and could further constitute overuse (Swanson, Cantwell, Lerner, McBurnett, & Hanna, 1991). Further, they postulated that because psychostimulants remain in the blood for such a short time (approximately 4 hours) the benefits are limited in duration. This results in more frequent and higher dosing which could complicate treatment and possibly result in cognitive toxicity. Added to this was the fact that many children with ADD have adverse responses to stimulants. In addition to the above limitations, researchers emphasize that in most cases of psychostimulant treatment, the treatment is stopped within 2 years and no residual effects are noted after the pharmacological effects dissipate (Swanson et al., 1993).

Multimodal Treatment

Though psychostimulant medications have been the primary treatment for attentional deficits for the last four decades and have proven to be an effective temporary treatment for some individuals stricken with attentional deficits, there remain 40% to 45% of
ADD sufferers who either show no positive response to psychostimulant medications, their condition worsens, or they are unable to tolerate the medication at all. Additionally, compliance with long-term stimulant therapy is relatively poor (Brown et al., 1987; Firestone, 1982). Finally, psychostimulants are not a cure for attentional deficits. These are only a “band aid”, in that their effects are temporary and because of these inadequacies, clinicians who treat children with attentional deficits recommend a “multimodal” treatment (Flick, 1998).

A multimodal treatment involves a combination of educational, behavioral, and medical interventions to help children succeed at home and at school (Dulcan & Scott-Benson, 1997). Behaviorally, students with attentional deficits may require techniques for monitoring and controlling their own behavior, social skills training, counseling, anger management, and support and parenting groups. Medical interventions would include medication and/or some form of psychotherapy (Abramowitz & O’Leary, 1991). From an educational perspective, children with attentional deficits are often too hyperactive or inattentive to function in a regular classroom, even with medication and a behavior management plan. They often need special seating arrangements, a planned area for the release of excess energy, posted rules, and rewards appropriate to their behavior. A multimodal approach assumes a shared responsibility for a child’s school success between a child’s parents or caretakers, health care professionals, and school personnel—teachers, administrators, special educators, school psychologists all working together to design effective interventions that address a child’s individual needs. The reality of a multimodal plan, however, is that scarce resources and manpower often
leave the classroom teacher with the entire responsibility for the implementation and monitoring of the success of the plan (Flick, 1998).

In 1993, a study was conducted by Grizenko, Papineau, and Sayegh to determine the effectiveness of a multimodal day treatment program for children with disruptive behavior problems. Thirty children (23 boys and 7 girls) with disruptive behavior disorders assigned to a day treatment program (treatment group) or the waiting list (control group) were compared on measures of behavior, attention, self-perception, academics, peer relations, and family functioning and evaluated by standardized questionnaire. A demographic questionnaire to document family history was also completed. The children used in this study were between 5 and 12 years of age; of normal intelligence; had a DSM-III-R (American Psychiatric Association, 1987) diagnosis of ADHD, oppositional defiant disorder (ODD), conduct disorder, or adjustment disorder with disturbance of conduct; a willingness of the parents to participate in family therapy; no neurological or physical disorder that would limit participation; and not too physically aggressive or suicidal to participate in day treatment.

All children were assessed using standardized questionnaires to evaluate present levels of behavior. A quasi-experimental research design with repeated measures was used at intake, discharge and a six-month follow-up to compare the two groups' progress over time.

The day treatment program provided multimodal therapy with a psychodynamic orientation. Activities consisted of a daily two and one half hour block of special
education, and a three-hour block of psychotherapy including individual and play therapy, social skills training, task groups, psychodrama, and pet, art, and occupational and group therapies. Integrative family therapy was conducted weekly and medication in the form of methylphenidate was used when indicated. The average length of time spent in the program was 4.4 months with a standard deviation of 1.3 months. The average length of time spent by subjects on the waiting list was 3.9 months with a standard deviation of 1.2 months.

Treatment was administered and monitored weekly by a multidisciplinary team that included: a psychiatrist, psychologist, nurses, social worker, occupational therapist, teacher, and child-care workers. Behavior was assessed using the Revised Child Behavior Profile (Achenbach & Edlebrock, 1983) as completed by the parent. Self-perception and peer relationships were assessed using self-report scales administered to the children and included the Hare Self-Esteem Scale, Depression Self-Rating Scale and the Hopelessness Scale for Children (Corcoran & Fisher, 1987) as a measure of self-perception. Peer relationships were assessed using the Index of Peer Relations (Corcoran & Fisher, 1987) and the Matson Evaluation of Social Skills with Youngsters (Matson, Rotatori & Helsel, 1983). Family functioning was evaluated using the General Scale of the Family Assessment Measure (Skinner, Steinhauer, & Santa-Barbara, 1983). Academic performance was measured with the Wide Range Achievement Test-Revised (WRAT) (Jastak & Wilkinson, 1984).

Multivariate analysis of covariance revealed that the treatment group improved significantly more on the measures of behavior (Revised Child Behavior Profile) and
self-perception (Hare Self-Esteem Scale) as compared to the control group. No group
differences were found in the areas of peer relations, family functioning, and academics.
At the 6-month follow-up, the improvement in behavior and self-perception was
maintained but academic performance remained below average.

The authors have noted several study limitations. First, family functioning was rated
in the normal range by both parents and children. It was revealed, as a process of the
therapy sessions in which all families participated, that the families did experience some
relationship problems that they failed to report on the General Scale of Family
Assessment Measures used. Families, the authors discovered, tend to minimize
systemic problems, choosing instead to focus on the relationship difficulties with the
identified patient. This may have resulted in an underestimate of some family problems.
Sample selection lacked randomization because the subjects were sequentially rather
than randomly assigned to the control and treatment groups. This limits the
generalizability of results. Finally, though this study presented good information
regarding the effectiveness of a multimodal treatment for disruptive behavior problems,
it is the belief of the current researcher that the inconsistency in the duration of
treatment for all of subjects limited the effectiveness of the treatment and limited the
reliability of the results. Despite these limitations, a multimodal intervention with a
psychodynamic orientation was effective in improving behavior and self-perception.

In a related study, Ialongo, Horn, Pasco, Greenberg, Packard, Lopez, Wagner, and
Putter (1992) evaluated the effects of a multimodal intervention versus a
methylphenidate alone intervention on 96 ADHD children with 78 of the children
completing the protocol. The authors combined short-term psychostimulant therapy with social learning and cognitive-behavioral interventions. These interventions were aimed at teaching ADHD children the skills underlying the regulation of behavior. Ialongo and his colleagues hypothesized that psychostimulants would facilitate the learning of these skills by increasing attention and concentration and decreasing hyperactivity and impulsivity during the course of the behavioral interventions.

The subjects were between the ages of 7 and 11 years and were referred for treatment of chronic inattentiveness, impulsivity, and overactivity to a university based psychological clinic. The children were randomly assigned to one of the following six treatment conditions: (1) medication placebo alone, (2) 0.4 mg/kg stimulant therapy alone, (3) 0.8 mg/kg stimulant therapy alone, (4) medication placebo plus behavioral parent training and child self-control instruction, (5) 0.4 mg/kg dose stimulant therapy plus behavioral parent training and self-control instruction, and (6) 0.8 mg/kg dose stimulant therapy plus behavioral parent training and self-control instruction.

The subjects were randomly assigned to one of the three medication conditions, all medication was dispensed in a double-blind fashion, and all subjects received medication seven days per week, which along with side effects, was monitored by a pediatrician. The behavioral parent training and self-control instruction groups met weekly for twelve, 90-minute sessions that included presentations, discussions, and role-playing. The self-control intervention consisted of instruction in a seven-step problem-solving plan along with deep muscle relaxation, presentations, modeling by
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The preliminary results indicated that there were no differences between the treatment groups on any subject or demographic characteristics except for race. There were a significantly greater number of nonwhite children in the placebo alone condition than in the other treatment conditions, which were primarily made up of white middle-income subjects. To evaluate the treatment effects, the outcome measures were divided into four distinct domains: parent report, teacher report, child report, and observational data. Repeated measures multivariate analyses of variance (MANOVA's) were computed on the resulting scores for each of these subsets of dependent variables.

For the parent report MANOVA, an inspection of the multivariate F's yielded a significant pretest to posttest treatment effect (3.03 with .004 alpha level) for the parent behavior plus self-control conditions on all of the previously identified measures. All of the observational data for the medication groups showed significant effects for both the high and low doses of stimulant medication on the posttest as compared to pretest. The treatment groups using behavioral interventions only exhibited no variability in the outcomes of the pretest to posttest measurement scores. These results indicated that subjects who received stimulant medication showed significantly greater improvement from pre-test to post-test in observed off-task behavior than did children who received placebo and showed significantly greater deterioration in post-test to follow-up scores than did children who received placebo. The non-medicated children exhibited no pre-test to post-test change or post-test to follow-up change with respect to the other treatment conditions. Most significant is the fact that no evidence of better maintenance of treatment gains at follow-up was found for the subjects who received the
combination of stimulant medication and behavioral parent training plus child-self control instruction as compared to the non-medicated controls.

Nine months later, after the withdrawal of the psycho stimulant medication, virtually no evidence in support of the original hypothesis was found. There were varying degrees of degradation in posttest gains in teacher rated inattention, hyperactivity and impulsivity, direct observations of off-task behavior, performance on laboratory measures of attention and impulsivity and sight vocabulary for subjects using the combined treatment and subjects using the medication alone.

This was an excellent study with good controls. The assumptions were well considered and reasonable. However, the authors revealed in their own criticism of this study, that the fact that the treatment was time-limited also limited the effectiveness of the study. The current researcher, however, reasons that extending the time that subjects were exposed to the intervention in this study might have derived some further improvement in subject functioning as a result of the benefits of the therapy. However, it is doubtful that it would have changed the effectiveness of the combined intervention used because once the psychostimulant medications are discontinued so is their effect. Further, the adjuncts to the medication intervention failed to maintain their effectiveness as well. After nine months, both parent and teacher reports indicated a return to the before treatment behavior in all areas of assessment.

In 1995, the National Institute of Mental Health in collaboration with the U. S. Department of Education, through a cooperative group, which included: Arnold, Abikoff, Cantwell, Conners, Elliot, Greenhill, Hechtman, Hinshaw, Hoza, Jensen,
Kraemer, March, Newcorn, Pelham, Richters, Schiller, Severe, Swanson, Vereen, and Wells, began a longitudinal multimodal treatment study of children with Attention Deficit Hyperactivity Disorder (MTA) (1999). This was the first major clinical investigation in the history of both agencies to focus on a childhood mental disorder. This study examined the long-term effectiveness of medication versus behavioral treatment versus both medication and treatment as an intervention for ADHD and compared state-of-the-art treatment with routine community care. The researchers posed three questions: How do long-term medication and behavioral treatments compare with one another? Are there additional benefits when they are used together? What is the effectiveness of systematic, carefully delivered treatments vs. routine community care?

In a parallel-groups design, 576 children (ages 7-9 years) with ADHD (96 at each site) were thoroughly assessed and randomly assigned to four (4) treatment conditions: (1) medication alone, (2) psychosocial treatment alone, (3) the combination of both, or (4) community care for fourteen months. The subjects were assigned 24 subjects per treatment condition per site at six sites.

The behavioral treatment included parent training, child-focused treatment, and a school based intervention organized and integrated within the school year. The parent training involving 27 group and 8 individual sessions, began weekly and ran concurrently with biweekly teacher consultations. The child-focused treatment program was an 8-week summer program, conducted 5-days-per-week, 9-hours per day. The program employed intensive behavioral interventions administered by counselors and
aids in a group based recreational setting. It included a point system tied to specific rewards, time-out, social reinforcement, modeling, group problem solving, sports skills, and social skills training.

The outcome measures were parent and teacher ratings from the SNAP Intervention and Hyperactivity-Impulsivity Scales (Swanson, 1992), plus behavior observations from the Classroom Observation Code (Abikoff, Gittelman-Klein, & Klein, 1980). For oppositional/aggressive symptoms, measures were parent and teacher ratings from the SNAP-ODD Scale (Swanson, 1992). For internalizing symptoms, measures were parent and teacher ratings from the Social Skills Rating System (SSRS) internalizing scale (Gresham & Elliot, 1989) and child self-report ratings from the Multidimensional Anxiety Scale for Children (March, 1998; March, Parker, Sullivan, Stallings, & Conners 1997). The parent-child relations’ measures were parent ratings on two scales from the Parent-Child Relationship Questionnaire (Firman & Giberson, 1995) and included power assertion and personal closeness.

Medication management began with a 28-day, double blind, daily dose of methylphenidate, using 5 randomly ordered repeats each of placebo, 5mg, 10mg, and 15mg or 20mg. Combined treatment provided all of the treatments outlined previously for medication management and the behavioral treatment. Community care recipients were not given treatments but were provided a report of their initial study assessments, along with a list of community mental health resources.

Community care showed no significant treatment gains in posttest results as compared to pretest results. Post results indicated that medication management out-
performed behavioral treatment and community care significantly as compared to pretest results over time with significant differences in the degree of change. Further, combined treatment and medication management treatments were clinically and statistically superior to behavior treatment and community care in reducing ADHD symptoms. However, the most significant finding of this investigation was that the combined treatment (multimodal) condition yielded no significantly greater benefit for the subjects than medication management alone for core ADHD symptoms (NIMH, 2000).

This is a very ambitious study and yielded some important information. The circumstances of the study were ideal. However, real life is seldom ideal. There was high adherence by the subjects and their families to the medication management and behavioral treatment protocols in this study. This could be considered ideal. The families involved received best practice treatment with the U. S. Government picking up the tab. However, in a practical real-life situation resources are often inadequate and treatment is only as good as the family’s ability to pay. This makes real-life application questionable.

All four groups of subjects in the above studies showed improvement in behavior as the result of the combined treatments with significant differences in degree of change over time. Though there were some behavior changes at school, those changes did not necessarily spill over into home situations. Multimodal treatments require a great deal of cooperation from the professionals and this is not always possible. Additionally, the study, which showed the most test subject improvement, was carried out under ideal conditions.
conditions with a great deal of cooperation from parents and other professionals, unlimited funding, and time which is not a practical nor realistic situation for most ADD sufferers and their parents. The extra service did prove helpful but did not result in consistent and permanent change.

The above studies show that multimodal treatment, when appropriately used can aid in the improvement of many of the problems associated with Attention Deficit Disorder. However, multimodal treatment involves a large number of professionals, which also means an increase in cost. Additionally, the combinations used in multimodal treatment do not offer treatment that is any more effective than medication treatment alone for the limited population served.

**Attention and Localization of Functioning**

**Attention**

Webster's New World College Dictionary (2001) defines cognition as the mental faculty or process by which knowledge is acquired as through the senses using perception, reasoning, and intuition. Flavell, Miller, & Miller (1993) define cognition as a broad-based concept that encompasses all of the mental processes, operations, and systems that are conceptualized in the acquisition and use of knowledge. More precisely, cognition explains those concepts regarding organized goal-directed behavior. Each of the component processes involved in cognition affect and is affected by the other processes. The mind is not just a collection of unrelated cognitive components, but also rather an organized system of interacting components (Flavell, Miller, &
The component systems in cognitive functioning include working memory, long-term memory, the executive system, and the response/process system (Ylvisaker & Szekeres, 1998). The accompanying component processes of cognition include: perceptual processes, memory, and learning processes, organizational processes, reasoning and problem solving processes, and the process under investigation in this study, attention (Ylvisaker & Szekeres, 1998).

"Attention is the phenomenon by which we actively process a limited amount of information from the enormous amount of information available through our senses, our stored memories, and other cognitive processes" (Sternberg, 1996, pg. 69).

The human brain is not designed for continuous, focused attention. In fact attention can only be sustained at a high and consistent level for about ten minutes or less (Jensen, 1998). Humans have natural attentional high and low cycles of arousal throughout the day. These are ultradian rhythms and last from ninety to about one hundred-ten minutes per cycle. The brain shifts its cognitive abilities on those cycles and there are literally changes in blood flow and breathing that affect learning (Klein, Pilon, Prosser, & Shannahoff-Khalsa, 1986).

It logically follows that attentional deficits mean a disruption in these cycles resulting in decreased blood flow and a disruption in the production of brain chemicals, which are the “life-blood” of the attentional system. These chemicals include: neurotransmitters (serotonin, dopamine, acetylcholine, norepinephrine); hormones; and peptides. The brain’s chemicals have a great deal to do with what students pay attention
Researchers suspect that of all the chemicals, norepinephrine is the most involved in attention. When we are drowsy our norepinephrine levels are low and when we are too hyper and stressed, the levels are high (Hobson, 1994). These conditions could result in either an inability to maintain appropriate attention or just the opposite, the problem of attending to everything.

Attention is necessary to cognitive perceptual efficiencies. Attentional dysfunctions are characterized by a person’s inability to process all of the information necessary for optimal task performance. Attentional deficits are characterized by: (1) insufficient alertness, which refers to a lack of readiness in the central nervous system to receive information or the lack of readiness to discharge motor neurons; (2) impaired selectivity, the inability to choose relevant information and simultaneously suppress irrelevant information and (3) inflexibility, the inability to shift from one thought or activity movement to another (Ben-Yishay, Rattok, & Diller, 1979).

Localization of Attentional Functioning

Attention directs the process by which the variety of brain functions can move to the center stage of the mind at any given moment (La Berge, 1995). In order to understand appropriate attentional functioning it will be necessary to examine how the entire nervous system processes information, structures of the brain that support attentional functioning and the structure of the cells that compose the nervous system.

The nervous system has two parts, the central nervous system (CNS) and the peripheral nervous system (PNS). The PNS is comprised of all nerve cells except those
of the brain and spinal cord and includes spinal nerves and cranial nerves, and has as its primary purpose the transmission of information between the CNS and the outlying nerves. The CNS is composed of the brain and spinal cord, which are encased in bone (Sternberg, 1996).

The brain is divided into the forebrain, midbrain, and hindbrain. The forebrain is at the top and front of the brain and is comprised of the cerebral cortex, basal ganglia, limbic system, thalamus, and the hypothalamus. The midbrain is comprised of the superior and inferior colliculi, gray matter, and the reticular formation. The hindbrain comprises the medulla oblongata, the pons, and the cerebellum.

The cerebral cortex has two cerebral hemispheres (left and right) that are connected by bundles of nerve fiber known as the corpus callosum, which allows each side of the brain to exchange information with the other side. Scientists further divide the brain into four areas called lobes: occipital, frontal, parietal, and temporal (Sternberg, 1996).

The basic unit of the brain is the neuron of which there are three types, afferent (sensory), efferent (motor), and interneurons residing only within the CNS. Neurons share four common structures: cell body, dendrites, axon, and terminal buttons. The cell body handles metabolic functions with a nucleus that holds genetic information. Dendrites extend out from the neuron and receive transmitted signals. The axons are slender fibers that run the length of the cell body, take signals from the cell body, and conduct these signals the entire length of the fiber to the terminal buttons. The terminal buttons release neurotransmitters from the synaptic vesicles (Wang & Freeman, 1987) into the synapse, which facilitates the continuation of a signal to surrounding neurons.
Myelin, a fatty-like substance that forms around well-used axons speeds up electrical impulses and reduces interference from other nearby reactions.

Once stimulus has been received, each brain cell acts as a tiny battery powered by the difference in the concentration of sodium and potassium ions across the cell membrane with changes in voltage powering the transmittal of the signals (Jensen, 1998). The cell body sends an electrical discharge outward to the axon, which stimulates the release of neurotransmitters into the synaptic gap. Once in the gap, the chemical reaction triggers or inhibits new electrical energy in the receptors of the contacted dendrite and the process is repeated in the next cell.

Normal attention begins in our senses, specifically, our visual system, which sends more than 80% of the information processed to the brain in non-impaired learners. Information flows back and forth between our eyes and the thalamus and then to the visual cortex creating a feedback loop. This feedback loop is the mechanism that shapes attention so that an individual can focus on something in particular, like a teacher lecturing or reading a book (Kosslyn, 1992). Attentional functioning involves stimulating neurons associated with a particular task and suppressing unimportant sensory information. The brain adjusts incoming images to assist in the attentional process.

The visualization of and attention to incoming stimuli is a balancing between the construction and feedback of those stimuli. The brain’s susceptibility to paying attention is influenced by priming. An individual is more likely to pay attention to something if he or she prompted to do so. Neuroimaging methods have shown
increased neuronal firing in the frontal lobes and anterior cingulate when an individual
is working hard to pay attention. The right parietal lobe is involved in attentional shifts
(alternating attention). If a person is looking for a nondescript pink scarf in a closet, the
left frontal lobe tells the midbrain area how to sort incoming data. When something is
being ignored, the brain has an innate mechanism for shutting down input related to that
image and the lateral geniculate nucleus suppresses the input of all other resembling
objects, other scarves, belts, neckties and any other object that looks anything like that
particular scarf. The brain will then try countless possibilities within seconds and either
come up with the scarf, look somewhere else, or give-up (La Berge, 1995).

Traumatic Brain Injury (TBI)

Certain types of brain damage can be said to be associated with impairments in
attention and take the form of closed head injuries (CHI), traumatic brain injuries, and
any other neurological or cognitive disease or head injury. However, since all brain
injuries involve some type of trauma, this investigation will concentrate on traumatic
brain injury (TBI) specifically. Many of these injuries involve some of the same
symptoms of deficits in attention as those documented in studies of childhood attention
deficit disorder. The history and causes of TBI, approaches to the treatment of those
attentional deficits associated with TBI, and how those treatments could be used with
the sufferers of childhood ADD will be discussed in this section.
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assaults. The highest incidence of TBI due to firearms is among people fifteen to twenty-four. Assault is also a major cause of TBI in the very young, with child abuse in the form of shaken baby syndrome being the primary source. Sports and recreation related injuries account for only 3% of hospitalized TBI. However, approximately 90% of sports related TBI is mild and occurs most frequently among people ages five to twenty-four who have many decades of life ahead (NIH, 1998).

In the United States, an estimated 1.5 to 2 million people acquire TBI each year. The resultant brain injuries may not be readily observable. TBI can include a range of disabilities from extreme physical impairments to minor cognitive dysfunctions. Minor cognitive dysfunctions, a focus of this study, are subtle and reflect minor problems with motor coordination, memory, problem solving skills, and the primary focus of this investigation, attention. These minor disabilities may only be apparent on formal neuropsychological examinations (Ewing-Cobbs, Levin, & Fletcher 1998). Brain injuries can result in a redistribution or disruption of electrical impulses and changes in cerebral and frontal structures. Attentional capacity is reduced, causing those so afflicted to experience stimulus overload, making mental effort more intense and concentration essential to tasks that were formerly exercised with ease (van Zomeren, 1987).

Attentional deficits are among the most frequently encountered cognitive dysfunctions identified in individuals following a TBI (Beers, 1992; Binder, 1986; Donders, 1993; Mateer, Kerns, & Eso, 1996). Most importantly, they are subsequently among the first deficits to be restored in patients whose injuries are much more
extensive than the minimal brain dysfunction associated with childhood attention deficit disorder (Mateer, Kerns, & Eso, 1996).

Treatments for Attentional Deficits Following a TBI

In the treatment of attentional deficits following a traumatic brain injury, the most common therapeutic interventions enhance the capacity of an individual to process and interpret information and improve their ability to function in social, vocational, educational, and other community environments. These interventions can be functional and contextual or integrative. Functional and contextual interventions involve rehabilitation using everyday activities in everyday environments and integrative interventions are a form of rehabilitation that require the collaborative efforts of a multidisciplinary team. Common interventions used to remediate these deficits include: pharmacologic interventions, interventions for motoric disorders, assistive technologies, social-environmental compensation, and cognitive rehabilitation (Ylvisaker, 1998). The most used of these interventions are pharmacologic, assistive technology, or cognitive rehabilitation. The following sections will separately discuss these three approaches.

Pharmacologic Interventions

The role of pharmacologic interventions in TBI rehabilitation is to improve the brain's natural ability to produce and use neurotransmitters. Medications act as a therapeutic support for an affected neurotransmitter neuron allowing for more normal activity until that neuron is recovered (O'Shanick, 1987). Medication selection is based
upon target symptoms, best route of administration, onset of action and side effects. Based upon the information obtained from the medical evaluation and the site of the TBI, a pharmacologic intervention is chosen from the agents available, which includes: anticonvulsants, antidepressants, antianxiety agents, antiparkinsonian agents, anticholinergic agents, antihypertensives, narcotic antagonists and psychostimulants.

Anticonvulsants in the form of phenobarbital are used to prevent seizures (Post & Uhde, 1983). Antidepressants assist in the alleviation of depressive symptoms (Richelson, 1996). Antianxiety agents are used as a calming agent (Hyman, 1988). Anticholinergic agents deal with sleep disorders (O'Shanick 1998). Antiparkinsonian agents increase dopamine activity or cholenergic activity (Cedarbaum, 1987). Antihypertensives are used for aggressive and impulsive behavior (Grendyke & Kanter, 1986). Narcotic antagonists decrease self-injurious behavior and suicidal tendencies (Buzman, Thomas, Dubrovsky, & Treadway, 1995). For childhood attention deficits as well as attentional deficits from other sources of brain damage, psychostimulant agents (e.g. methylphenidate, dextroamphetamine) are often used to decrease daytime drowsiness, increase attention, and concentration, and improve mood lability temporarily (Wilens, Biederman, Spencer, & Prince, 1995).

Assistive Technological Interventions

Assistive technology is another intervention that is sometimes used for children with TBI and offers a number of possibilities for achieving greater independence. There are assistive technologies available for seating and mobility, visual impairment,
and hearing loss. For the purposes of this study, emphasis is placed on cognitive prostheses, which include calendars for writing down assignments; cue cards to help process written information; speaking clocks that verbally announce the time; watch alarms that help keep a person on time; and desktop computers.

The cognitive deficits that can occur as the result of TBI include memory loss, impairment in processing new information, an inability to organize one's thoughts, and a loss of problem solving skills. An inability to memorize or recall new information can profoundly compromise a child's ability to function effectively in a traditional school environment. A decreased ability to organize one's thoughts can make it impossible to complete a routine task. These cognitive deficits can additionally prevent a child from pursuing leisure activities or maintaining good peer relationships. Assistive technology can be of significant help in dealing with these problems.

For the child with TBI who is having difficulty processing written information, cue cards and other paper materials can be developed using graphics (Doss & Reichle, 1991). Children unable to read the time on the clock might be able to process the information if the time is spoken using watches with voice modules. Some also come equipped with alarms that remind individuals to move to the next task along with electronic date and address books. Computers can help people record notes, thoughts, and data in large amounts with little effort. Through speech synthesizers, computers can verbalize information that aids in the processing and organization of information. Another approach using computers is the application of computer-based systems with custom software modules designed to present information and train cognitive deficits by
delivering prompts to practice and remediate those deficits appropriate to a user's specific impairment (Napper & Narayan, 1994).

Cognitive Rehabilitation

The final traditional intervention used for TBI is cognitive rehabilitation. Cognitive rehabilitation or remediation is the process of retraining or improving cognitive brain functions. Areas of cognitive processing are the most affected by brain damage and have direct implications for attentional functioning (Averbach & Katz, 1992). The goals of cognitive rehabilitation are to remediate weaknesses, develop compensatory strategies, practice skills, and improve attention, concentration, mental efficiency, memory, and impairments identified by neuropsychological evaluations (Liberto, Tomlin, Lutz, Nash, & Shapiro, 1993). Cognitive rehabilitation, as a method of assisting the victims of brain injury to diminish acquired cognitive deficits, is recommended by the National Institute of Health (1998) as essential to the treatment of traumatic brain injury.

The theoretical rationale for the cognitive rehabilitation of attention is organized into three broad categories and includes: the mental exercise model, the behavioral shaping model, and the functional reorganization model. The mental exercise model assumes that practicing a mental function will improve that function. The behavioral shaping model uses the principles of learning theory to increase the probability of a given response. The functional reorganization model asserts that improvement occurs because the goal in question is now achieved by a different arrangement of spared
mental functions. This model uses specific training procedures to identify which alternative processes are mediating the improvement and attempt to foster those processes (Luria, 1963). The theoretical model for cognitive rehabilitation to be used in this inquiry is based upon the research of Sohlberg and Mateer (1987), which uses the mental exercise model. They believed that practicing tasks requiring attention would improve attentional functioning.

The cognitive rehabilitation techniques, which encompass the treatments for cognitive impairments resulting from TBI, generally fall into one of the following specific categories: (1) traditional or (2) computer-assisted. Traditional cognitive rehabilitation techniques attempt to alter aspects external to the individual. This includes environmental modifications, changed expectations for the individual, and the use of specialized teaching strategies (e.g. speech therapy, recreation therapy) that would generally be undertaken by parents, teachers, and other caregivers and would not necessarily require any special action on the part of the individual. Computer-assisted cognitive rehabilitation techniques are categorized as employing two different intervention approaches: task specific and hierarchical. The task specific approach involves the administration of computer software that targets specific cognitive deficits. An intervention of this nature would expose a subject with attentional problems to programs that specifically train attention. Hierarchically engineered interventions train individuals using a sequence of programs that move from a basic or fundamental level to more complex overall cognitive functions (Chen, Thomas, Glueckauf, & Bracy, 1997).
This researcher believes that an individual is responsible for his/her own learning and that any learning begins and ends with the individual. Thus, this investigation focuses on computer-assisted cognitive rehabilitation techniques that are task specific but use restorative strategies that are hierarchically arranged. These restorative strategies involve implementing exercises that allow the individual to practice those tasks that are specific to the cognitive processes found to be dysfunctional. This process specific approach using computers has yielded some positive results with the rehabilitation of attentional deficits in TBI patients (Sohlberg & Mateer, 1987). This model proposes a treatment as it relates to the underlying mechanisms of cognition and the neurobiological structures involved in specific attentional dysfunctions. This is reflected in the model of attention training developed by Sohlberg and Mateer (1987), which was identified in Chapter I as having five levels of attention: focused, sustained, selective, alternating, and divided.

Cognitive Rehabilitation Using Computers

The use of computers in the rehabilitation of cognitive deficits has increased very rapidly in recent years and has become almost synonymous with cognitive rehabilitation (Ponsford, 1990). Computers have been very valuable in the cognitive rehabilitation and education of those with attentional deficits resulting from TBI. Children especially appear to be more motivated when using computer programs to learn skills and stay on task for longer periods of time (Ford, Poe, & Cox, 1993). Computers may be used to introduce new material using graphics, words, and sound to attract and hold a child's
attention and computers can be used for individual practice on any type of repetitive
task (mastery practice) in spelling, language arts, mathematics, or any other area.
Computers may also be used in simulation or virtual activities to prepare subjects for
situations in the real world that might be harmful and increase problem-solving skills.
According to Boysen (1994), the range of uses for the computer is almost limitless.

Bender and Bender (1996) have identified five major assistive characteristics of
interventions that use computers: (1) computer software can be sequenced allowing for
shorter assignments for students with short attention spans; (2) computers can excite
and motivate students to complete tasks; (3) computer-assisted instruction can improve
attitudes toward learning; (4) computer-assisted training offers a student the opportunity
to practice eye-hand coordination; and (5) computer-assisted software can call for
numerous responses allowing for more opportunities for practice.

Chen, Thomas, Glueckauf, and Bracy (1997) recognize two types of computer-
assisted cognitive rehabilitation intervention approaches: task specific and hierarchical,
the approach used in this study. The task specific approach administers computer
programs that target specific cognitive deficits in test subjects. The hierarchical
approach trains subjects on a sequence of programs that are arranged hierarchically
from basic to higher levels of cognitive functioning.

In their 1987 study, Sohlberg and Mateer tested the effectiveness of the computer-
assisted, Attention Process Training (APT) hierarchical, multilevel, treatment program
designed to remediate attention deficits in brain-injured persons. The subjects selected
for the study were four (4) traumatically brain-injured adults, ages twenty-five to thirty
years, who presented with mild to moderate attention deficits and were participants at the Center for Cognitive Rehabilitation. The Center for Cognitive Rehabilitation is a post-acute, day treatment, brain injury program. The subjects were randomly selected from the Center’s client list of patients admitted for a 2-week cognitive and psychosocial evaluation. The assessment results were used to determine the cognitive processes to be addressed and the level of difficulty involved in each subject’s individual training.

A significant impairment in the attentional skills and visual processing ability as well as hierarchies of treatment tasks were identified for each test subject on each of the above mentioned five levels of attention, with the goal being to examine the relationships between the implementation of the APT model and changes in attentional skills. The tasks developed for each subject were arranged in hierarchies of difficulty based upon both their complexity and processing speed requirements. A variety of computer programs, commercially available attention tasks, and original treatment materials, were adapted for use in each of the levels of the attention-training model. The computer hardware in use at this time was not capable of verbal commands, so specially prepared audio recordings of commands supplemented those tasks requiring verbal commands.

A multiple baseline across behaviors design replicated across the four subjects and as a measure of attentional change, a pretest/posttest administration of the Paced Auditory Addition Task (PASAT) (Gronwall, 1977) and Spatial Relations Subtest (SR) from the Woodcock-Johnson Psychoeducational Battery (Woodcock & Johnson, 1977)
The PASAT provided an estimate of the subject's ability to register sensory input, rapidly process the information verbally, as well as retain and use a complex set of instructions. Subjects listened to the audiotape of a string of digits and were required to add each number to the one preceding it. Each score represented the percentage of correct responses made prior to the presentation of the next stimulus. The SR is a test of spatial perception and judgment requiring the identification of discrete spatial components, which would form a whole target figure.

Each of the subjects received between seven (7) and nine (9) individual cognitive retraining sessions per week focusing specifically on attention, visual processing, or memory, according to the treatment phase and four to eight weeks of attention training with the length of training determined by the severity of the deficit.

Research findings for each of the four subjects were displayed using a multiple baseline across cognitive areas. Large intersubject variability prompted the use of calculated z scores as opposed to raw scores in order to facilitate the comparisons of PASAT scores.

Following the achievement of a stable baseline, Subject 1 demonstrated an increase in PASAT scores from the initiation of the attention training phase of the treatment in visual process training and memory training, demonstrating an increase in z-scores of from -8 to -1.4 representing a dramatic increase in attentional abilities. During the baseline condition, there was a gradual improvement in Spatial Relations (SR) subtest scores in the absence of specific visual process training from 33 to about 37. Following
the initiation of the visual process training, SR scores increased significantly (40 to 43). With the initiation of memory training, absolute SR scores decreased (39 to 42) but remained above the baseline.

Subject 2 demonstrated an increase in PASAT scores following the introduction of attention training (-1). After withdrawal of the attention training, the scores remained stable at -1 with a slight increase to 0 during the memory-training phase. Throughout visual processing and memory treatment phases, SR remained stable throughout the visual process baseline period, despite provision of attention training. SR scores improved over the course of visual process training (43 to 50) and remained high throughout the next cognitive process treatment.

Subject 3’s PASAT scores were stable during the pretreatment phase. Following attention training, scores increased and stabilized above baseline scores at 0. SR scores increased from a baseline of 45 and stabilized at 50 with a slight decrease to 48 at the memory-training phase.

With Subject 4, to control for possible order effect, the attention training and visual process training periods were reversed. He received visual process training prior to the remediation of attention. His SR scores were extremely poor during the pretreatment phase. SR scores showed a dramatic improvement during the visual processing phase (up to 48 and stabilizing at 40 over a baseline phase score of 27). However, SR scores then went into a slow but steady decline over the subsequent twenty weeks. Scores remained above baseline levels but were not considered stable. Though 4 years post injury, Subject 4 made a significant increase in his z-scores as measured by the PASAT
PASAT scores rose during the course of visual training in the absence of specific attention training but leveled off at -5. At the conclusion of the attention training phase, the subject’s z-scores reached -1.

This was a good study with good controls. Current theories regarding attention being discussed in experimental literature were incorporated into this study. The results demonstrate the potential for improvement in attentional skills in brain-injured persons given specific attention training. However, even the authors were unable to identify the contributions of the individual training components. Secondly, the authors did not control for spontaneous improvement in the attention of the subjects. Control for spontaneous improvement should have begun with the criteria for the selection of subjects. Subjects should have been selected based on a similar post injury period and injuries should have been similar in severity and kind, keeping spontaneous recovery at least equal. Further, there was also a great deal of variability in the extent of each subject’s injury. Future research should attempt to find a more homogeneous group and control for some of the more extraneous factors.

In a related study, La Rose, Gagnon, Ferland, and Pepin (1998) tested whether computer games could be an efficient therapeutic tool in a cognitive rehabilitation program and bring about a functional improvement in spatial abilities such as visual scanning (visual attention), and tracking. These selected abilities were studied because they are known to be deficient in those with attentional deficits and are required in the execution of the computer game used in this experiment.
Sixty subjects (50 boys and 10 girls) from 8 to 14 years of age were randomly assigned to the control (20) or treatment groups (40). Twenty-six subjects were diagnosed as minimally brain damaged; twenty-four subjects had attention problems without brain damage. Only subjects without prior experience with video games were selected. The microcomputers used were Tandy 1000 and the software used for training was a modified version of “Super Breakout”, adapted for these subjects’ specific characteristics. The Cancellation Test (Diller in LaRose, Gagnon, Ferland, & Pepin, 1989) was used to assess visual scanning and consisted of slashing specific letters among a series of six lines of letters. The Trail Making Test (Reitan, 1958) was used as a measure of visual tracking.

Subjects were seen individually for the administration of the pretest. The post-test for the control group was executed four weeks after the pre-test. Subjects in the experimental group were given twelve hours of video game training (3 hours/week). Training was done individually and supervised by an experimenter. The control group received no treatment.

A multivariate analysis for a factorial design was conducted and the results showed that a training program based on a specific computer game enables individuals showing difficulties with spatial abilities (which relate to visual attention) to improve them significantly. Specifically, this study supports the hypothesis that the computer game is a potential therapeutic medium for cognitive rehabilitation.

This study added to the literature regarding the use of computers in cognitive rehabilitation. However, there were added control contingencies that could have
increased the validity of the study. Some spontaneous recovery is expected for all brain-injured patients and the authors made an attempt to control for this aspect of the study through the random assignment of subjects to the treatment groups. Further control in the form of the random selection of subjects from the larger population who were closer in age, more homogeneous in the age at which the patient incurred the injury, and the point and severity of the injury might have added more validity to the study. Additionally, a twelve-hour treatment program is conceivably not enough time to adequately assess the effectiveness of a treatment developed to affect such complex variables. A longer period for observing treatment effects might have yielded more reliable and even slightly different results. The data presentation in this article alluded to the fact that the control group received no treatment. They were only pretested and after four weeks retested. A comparison group having a placebo treatment of some kind might have yielded slightly different and more reliable results.

Christina Palmese and Sarah Raskin (2000) conducted a study to investigate the effectiveness of the Attention Process Training II (APT-II) computer-assisted program in the rehabilitation of attention in individuals diagnosed with mild traumatic brain injury (MTBI). It was hypothesized that the program would be effective based on the principles of repetition, retraining, and compensation and their success with the same process in previous studies (Cicerone, Smith, & Elmo, 1996; Raichle, Fiez, & Videen, 1994; Raskin & Gordon, 1992). The subjects were three individuals (two men and 1 woman) who volunteered to participate in the study. Each subject had been previously diagnosed with a mild traumatic brain injury (MTBI) and attention-related cognitive
deficits, were one-year post injury, were not taking prescribed medications, and had not been involved in any other cognitive rehabilitation program in at least five years.

All subjects received the Consonant Trigrams Test (Peterson & Peterson, 1959), Paced Auditory Serial Addition Test (Gronwall, 1977), Symbol Digit Modalities Test (Smith, 1993), Stroop Color Word Interference Test (Stroop, 1935), Test of Reading Speed, Digit Vigilance (Lewis & Rennick, 1996), and the Revised Auditory Processing Test (Sohlberg & Mateer, 1989) to determine current levels of attentional functioning and post-training performance. The APT-II program used had a hierarchical construction that built upon existing attentional skills. Tasks became progressively harder and involved the use of manipulation, repetition, and auditory and visual stimuli.

Subjects were administered different aspects of the ATP-II based on the severity and area of their deficit and received one hour of training per weekly session for 10 weeks. The subjects began their training with sustained attention tasks; progression was gradually made to selective, alternating, and divided attention tasks depending on the focus of their rehabilitation. The tasks were either auditory or visual. In week eleven (11) each subject was retested, after which, they were exposed to an educational computer program, educational videos pertaining to brain injury, and mental games and puzzles. No retraining occurred during this period, it was considered a no-treatment control. At the end of six or seven weeks, the subjects were retested using the previously mentioned battery of tests.

Using a single subject research design, the authors determined that the ATP-II retraining program significantly improved attention in individuals with MTBI. In
addition, any rehabilitated cognitive skills remained stable in each individual after a six-week cessation of the rehabilitation program. Subject 1's performance was significantly improved from pretest to posttest on the PASAT, a test of sustained attention and the Visual Divided Attention II portion of the Revised Auditory Processing Test. Subject 2's scores on all four of the neuropsychological tests resulted in improvement from pretest to posttest. The treatment resulted in an increased ability to retain information in his attention for an extended period of time. The authors saw this as a direct result of this subject's increased ability to process information faster. Subject 3's scores did not show the APT-II to be an effective rehabilitation program for him. After training, he was, however, able to work faster under time constraints as was evidenced by his performance on the written portion of the Symbol Digit Modalities Test.

This was a very good study and contributed important information as a beginning vehicle for research in this area. However, a longer experimentation period on a continuous basis might have yielded more generalizable results. The researchers suggested that better control of the independent variable might have been obtained if an ABAB crossover design had been used. This study exercised some control over spontaneous recovery by choosing subjects who were at least a year post injury. Further controls included the exclusion of any subjects with previous psychiatric or neurological disorders and the exclusion of those being treated with medication. Something that could have been a potential problem was the disparity in the ages of the subjects. Further analysis of the test results to determine the effectiveness of the separate components of the treatment would have been justified.
In summary, the above research has demonstrated the effectiveness of cognitive rehabilitation with brain-injured patients suffering attentional deficits. There are some traditional rehabilitation programs that are used to improve attentional deficits with TBI patients that could possibly be used with ADD children (pharmacologic therapy and cognitive rehabilitation). The components of both interventions and literature regarding their successful usage with TBI patients suffering attentional deficits was discussed in this section. Pharmacological interventions are presently in wide usage with children diagnosed with childhood attentional deficits and the literature presented thus far indicates that they have limitations. However, there is very little information concerning the use of cognitive rehabilitation with children who have ADD. The next section of this chapter is dedicated to the available research concerning the use of cognitive rehabilitation with this population.

Using Cognitive Rehabilitation Techniques with Childhood Attention Deficit Disorders

Cognitive rehabilitation therapy is a relatively new concept in the area of neuropsychological research and though there is a rapidly accumulating body of clinical evidence supporting its use with adult TBI patients and its documented success with that population, there is very little available regarding its use with children and even less with children diagnosed with ADD.

Children who suffer with attention deficit disorder share many of the same symptoms as those who suffer with traumatic brain injury. This study endeavors to determine the effectiveness of cognitive rehabilitation using attention training with
childhood attention deficit disorders.

In 1989 a study was conducted by Dennis Williams, a doctoral student at the University of Washington and reported in Mateer, Kerns, and Eso (1996). This study explored the effects of a program of attention process training (APT) based on Sohlberg and Mateer's (1987) model developed for adults with acquired attention deficits following TBI. William's model was modified for use with children demonstrating childhood attentional deficits. Though Sohlberg and Mateer's study used a computer to administer some of the intervention, at this time personal computers were not as readily available and Williams used all paper and pencil tests to administer his attention process training intervention without the benefit of computer.

The subjects used for this investigation were six children ages eight to thirteen years, who had significant, documented histories of attention deficit disorder and learning disabilities. Over a five-week period, the subjects were exposed to an APT program, which included the following training tasks: for sustained attention the subjects were required to listen to an audio tape for target words or sequences of words and press a buzzer when the target was identified; for alternating attention, exercises that required subjects to listen for one type of target word or sequence on audio tapes and then switch to listen for a different type of word or sequence; for selective attention, exercises used any of the sustained attention tasks plus background distracters in the form of noise or movement; and for divided attention, exercises were used, which involved reading paragraphs for comprehension and simultaneously scanning for a target word (e.g., while reading, a subject has to count the number of times the word
"and" was contained in a particular passage). Williams executed the investigation by evaluating changes in performance on the above training tasks; pre- and post test treatment changes on independent psychometric measures of attention; measures of arithmetic and reading efficiency; and a parent-reported measure of attention.

There were four major hypotheses tested: (1) training would have positive effects on non-trained APT tasks; (2) training would generalize to show positive effects on a battery of independent psychometric measures; (3) training would improve performances on measures of reading and arithmetic efficiency; and (4) improvement would be seen in scores on an abbreviated version of the Connors Rating Scale.

Performance changes were monitored twice weekly over a five week intervention period by administration of a battery of psychometric measures sensitive to concentration and information processing efficiency and measuring reading and arithmetic efficiency. Behavior change was determined by pretest and posttest administration of the Teacher and Parent Connors Rating Scales (Goyette, Connors, & Ulrich, 1978). Ninety day follow-up testing investigated the maintenance and generalization of effects.

A combination multiple baseline across groups (three of the subjects were compared to the remaining three) and individuals' design was used to determine the efficacy and generalization of treatment effects. Visual examination of the graphed raw scores for group 1 showed most consistent gains in sustained and selective attention. Group 2 experienced a larger variability in performance on sustained attention measures when compared to group 1. Trends in gain on measures of selective attention were not
consistent for group 2. Performance on measures of alternating attention showed the greatest variability for children in both groups.

Visual examination of graphed raw scores for single subjects revealed the most rapid gains and most consistent performances on sustained and selective attention measures for subjects 1, 2, 3, and 6. Subjects 4 and 5 demonstrated greater variability on these same measures. Subject 4 showed no substantial or consistent gains in either sustained or selective attention. Subject 5 showed peak performance only on the fifth and ninth treatment testings for sustained attention and the fifth testing only for selective attention ending in a gradual decline to near baseline levels over time. All six subjects showed gains of 20% or more on the alternating attention measures. Results supported hypotheses 1 and 2 and some gains were noted on academic efficiency measures but they were not statistically significant and no significant trends of improvement were seen on the Connors Scale. Improvements in processing efficiency, as measured by follow-up testing on the APT battery and psychometric measures, were maintained over a ninety-day period.

This investigation is a good example of APT research with a childhood attention deficit population of children because it indicates that APT can be used with children with a diagnosis of ADD with some degree of success. Because certain developmental stages incur constant changes, differences in test subject performance could have been due to developmental differences. Controlling for age by selecting a sample closer in age might have resulted in a different outcome and given the intervention more validity. Further, as one of the four measures of improvement in test subjects, the subjectivity of
rating scales could raise concerns regarding possible bias on the part of those completing the rating scales, possibly overrating or underrating student results. A more objective measure to support parent and teacher rating scales could further validate results.

In 1998, Linda Laatsch conducted a non-controlled study to explore the effectiveness of cognitive rehabilitation techniques on the attentional skills of four (4) highly motivated college students (subjects A, B, C, D) newly diagnosed with attention deficit hyperactivity disorder and referred to a university-counseling program. Two of the subjects reported a history of depression, two subjects had an alcohol abuse history and all clients were taking Methylphenidate (Ritalin). Three of the subjects demonstrated either visual or verbal memory deficiencies. The author hypothesized that their difficulties in sustained and selective attention impaired their initial encoding of the material to be recalled, making retrieval of the material also significantly impaired.

Each subject was pretested to determine the level of attentional functioning using a battery of neuropsychological tests, which included the WAIS-R, Trails A 7 B; and Wisconsin Card Sorting Test of Perseveration Errors.

Each subject received 50-minute cognitive rehabilitation sessions with a clinical psychologist and specific interventions described according to Luria’s (1980) three functional units and computer-assisted. Unit 1 covered alertness, attention, orientation, and regulation of tone. It used the orientation/focusing of attention tasks, which included tasks that practiced using verbal stimuli so that each subject could focus attention to recall the exact spelling of a word after it disappeared from the computer.
Sustained attention exercises were used in the form of a reading task presented continuously for about ten minutes on the computer. The subject was then asked to focus for an extended period to determine how long each subject could maintain attention. To maintain attention amid distractions, each subject was required to specifically observe what was the most distracting to them and make environmental modifications to the learning and study environments. To exercise dual attention processing (divided attention) the subjects were asked to visibly put questions or comments aside in a corner of their note pad or on a blackboard to be addressed at a later time in the lecture period so as not to interrupt a class.

Unit 2 tasks included the extension of working memory, which involved practice chunking and clustering information; and the use of memory strategies, which used overt rehearsal, subvocal rehearsal, chunking and clustering, and elaboration and visualization. Unit 3 tasks used strategies to reduce impulsivity by slowing down the individual processing of subjects whose processing was so fast that important information was missed. This would enable subjects to retain lengthy material; maximize the application and use of external strategies (e.g., use of an appointment book); and increase self-awareness using a metacognitive awareness allowing for the empowerment of the subject in the restoration of his/her own appropriate level of functioning by becoming internally aware of the presence of a problem and educated regarding strategies for addressing the problem.

The therapy incorporated a developmental metacognitive format and treatment was individualized according to the subject's specific functional difficulties. Subjects were
given individualized strategies to apply to their schoolwork and to help them sustain attention during lectures, examinations, and study periods. Specific computer tasks were used to demonstrate the benefits of the use of those strategies. It was hypothesized that the subjects' difficulties with sustained and selective attention impaired their initial encoding of the material. Therefore, memory issues were also addressed in cognitive rehabilitation therapy sessions.

Though this study was meant to be exploratory in nature, the four subjects studied in this investigation increased their ability to attend more appropriately. Subject A experienced a deficit in working memory due to symptoms of inattention. His specific therapy was to rehearse and chunk phone numbers. The strategies assisted recall and additionally helped him become more efficient in how he maintained information in his working memory, increasing his ability to process larger amounts of incoming stimuli. Subject B found it difficult to sustain attention and process fast during lectures. Additionally, she had problems processing more than one thing at a time or divide attention. To improve her ability to sustain attention, she was required to take notes that summarized the basic ideas being presented, jot down and make personal associations to what she was learning. This enabled her to sustain her attention for longer periods of time because the information was connected to some personal event or personal life situation. To enable her to divide her attention, she practiced setting aside her comments and questions from class lectures on a corner of her note pad, used rehearsal over time to review the questions later and make comments at a time more auspicious instead of interrupting class.
Subject C found it difficult to maintain a strategy to assist recall of presented verbal material, to process more than one thing at a time, and presented as very impulsive. To improve his recall difficulty, he was asked to focus attention to stimulus continuously for short periods of time (5-10 minutes) and gradually extended the task until he was able to attend to relevant information for longer and longer periods. To address his problem with divided attention without interrupting the class during lecture, he practiced setting aside a question or comment on the blackboard in plain sight to be addressed by the instructor at a later time. Finally, to deal with his issues of impulsivity, this subject’s therapy, which involved his slowing his processing, required that he practice performing a complex, verbal memory task. To complete this task, the subject needed to process slowly and meticulously, taking more time to complete.

Subject D had difficulty readying himself for attention-demanding tasks. As a therapy, he was given a computer task using linguistic stimuli to focus his attention so that he could recall the exact spelling of a difficult word after it disappeared from the screen. Subject D further found it difficult to maintain attention amid distractions. His therapy for this disability was to identify something that was a specific distraction for him. This proved to be internal distractions, personal anxiety and worries. The modification that he made to his environment was to listen to soothing music from headphones while studying, calming his anxieties and allowing the blocking of other internal distracters.

He was observed reacting impulsively without spending sufficient time to integrate and process. By increasing exposure time on a complex verbal memory task, his ability
to slow down his processing improved so that he could properly integrate new material.

The four subjects in this study were motivated college students who were experiencing their initial diagnosis of ADD and were highly motivated to make changes. They all had a positive response to Ritalin and were encouraged by their ability to understand what was happening and manage it appropriately. All four subjects experienced an increase in their attentional functioning either directly or indirectly through the improvements in associated processes such as memory (encoding and/or recall). The author identifies this study as exploratory, which is evident in the control of extraneous factors and presentation of the data. Each subject received fifty minutes of cognitive rehabilitation therapy but it was not reported how often these sessions were neither conducted nor did it indicate how long a period the entire intervention lasted. It can only be assumed that since the subjects were in school and the interventions were conducted as an adjunct to college classes, this was over the course of a semester of college. There was an indication that the subjects were administered a pretest but no indication that posttests were administered. The results of this study were stated in narrative form with no numerical/mathematical references. It was assumed that these results were based on qualitative observations of improved functioning for each subject in their college classes, but was not specifically stated. The resulting stated improvements in the ability of test subjects to adequately function subsequent to the interventions seemed to indicate that the use of cognitive rehabilitation techniques with individuals suffering from childhood ADD could be
effective and worthy of further study. The next research step would be to initiate a
controlled study of treatment effects using a randomly selected sample of subjects,
controlling for age, time of identification of disability, a controlled time and amount of
medication, and a psychiatric evaluation supporting a diagnosis of ADD; over a specific
time period; using a younger population; and because attention is such a complex
process, using one or two aspects of attentional processing that has in previous research
been shown to be deficit in ADD populations. All of the subjects had a positive
response to Ritalin but without controls, it is difficult to know whether improvements
were made because of cognitive rehabilitation, or medication, or both. Finally, there is
one aspect of this study that will make replication difficult, that is the fact that the test
subjects used in this study were willing and highly motivated to participate. This is not
a circumstance that is easily replicable.

Studies using cognitive rehabilitation techniques as a method of improving attention
in sufferers of childhood attention deficit disorder were discussed in this section.
Cognitive rehabilitation is a relatively new concept in neuropsychological research and
has been used primarily with adult TBI patients. But because sufferers of ADD share
many of the same symptoms of attentional deficits as TBI patients, this review reported
on the efficacy of cognitive rehabilitation as an intervention for ADD.

Two studies were discussed that dealt specifically with individuals with ADD. The
first was a study conducted by Dennis Williams (1989) from the University of
Washington. Williams’s study had some limited success using this intervention with
six children with ADD symptoms and learning disabilities. The form of cognitive
rehabilitation used was Attention Process Training. Though this study did not make use of computers, all of his subjects showed some improvement in all of the three areas of attentional functioning measured subsequent to intervention.

The second study was a 1998 study conducted by Linda Laatsch of the University of Chicago School of Medicine. She used computer-assisted cognitive rehabilitation techniques with four motivated college students suffering from ADD and being treated with Ritalin. Though this study was exploratory in nature and without controls, the test subjects experienced improvement in attentional functioning subsequent to the presentation of the interventions.

The above-mentioned studies demonstrated mixed results, which varied by dependent measure. One study used a paper and pencil test out of necessity in the absence of computers. The study used as a model did, however, use computers. Some improvement in subject functioning was noted in both studies, indicating that it could be possible to use a task/process specific approach to cognitive rehabilitation in the form of attention process training alone and with computer assistance to improve sustained and selective attention. This additionally points to the worthiness of further investigation in this area of study.

Summary

This chapter contains a discussion of selected literature regarding possible causes of childhood attention deficit disorder; interventions currently being used to treat childhood attention deficit disorder; the nature of attentional deficits and localization of.
attentional functioning; the similarities between the symptoms of attentional deficits experienced by traumatically brain injured (TBI) patients and those experienced by children with attention deficit disorder; interventions typically used with TBI patients exhibiting attentional deficits; the use of one of those treatments, cognitive rehabilitation with and without computer-assistance and with children diagnosed as attention deficit disordered.

The etiology of ADD, which is an extremely complex and heterogeneous malady, has been identified as having no single cause but a number of risk factors. The most common of those risk factors include, diet and food allergies, environmental toxins, poor parenting practices, perinatal and birth injuries, and genetic defects.

Dr. Feingold’s research (1976) and a similar study conducted by Kaplan, Mc Nicol, Conte, and Moghadam (1989) found an association between artificial food colorings and flavorings, preservatives, and salicylates in the diets of children exhibiting ADD symptomatology. Studies by David, Clark, and Voeller (1972), Minder, Das-Smaal, Brand, and Orlebeke (1994), and Kahn, Kelly, and Walker (1995) found a connection between elevated hair and blood lead levels and ADD symptoms in children. Studies by Goodman and Stevenson (1989) and Biederman and his colleagues (1995) found that children with diagnosed ADD have a history of family adversity and family psychopathology. Because their potential for impacting the learning and development of a child, perinatal and birth injuries are the most serious and commonly mentioned environmental risk factor associated with ADD. Goodman and Stevenson’s 1989 study of monozygotic and diazygotic twins and Sprich-Buckminster and her associates (1993)
found that perinatal and birth injuries are a positive risk factor for ADD and additionally, the Sprich-Buckminster study results suggested that pregnancy, delivery, and infancy complication might be a non-genetic etiologic process in ADD, which could indicate causality. As a single possible cause, none of the aforementioned studies clearly constitute a cause but do qualify as risk factors associated with ADD. Studies by Goodman and Stevenson (1989) and Farone, Biederman, Chen, and Krifcher (1992) demonstrate the clearest evidence for causality in that their research indicates that ADD may be inherited.

The most commonly used treatment for ADD for the last four decades has been psychostimulant medication in the form of Ritalin, which has its limitations. The reviewed literature indicates that most clinicians who treat this population recommend a multimodal treatment, which combines medication, educational, and behavioral interventions into one to address all levels of symptoms. However, there remains a large subset of those so afflicted who do not respond positively to any of the above treatments alone or in any combination. This is the population for which the current researcher began this investigation.

Also included in this chapter is a discussion of the cognitive processes of attention, and the localization of attentional functioning. The reviewed literature in this area characterized attention as an integral component of a much larger cognitive process that is connected to other components of that cognitive process in a major way. Researchers concluded that attention involves the selection and organization of incoming stimuli that is to be used by the brain in the performance of a task. To facilitate the performance of
that task, attentional functioning does not appear to be localized in just one part of the brain but several including a portion of the frontal lobes, cerebral cortex, thalamus, and beginning in the hypothalamus. The nature of the deficit is determined based upon which specific area of the brain is identified as dysfunctional.

The literature further revealed that patients with certain types of traumatic brain injuries (TBI) also experience attention process dysfunctions. World War II patients with head injuries were identified as exhibiting attentional deficits making it difficult for them to focus on specific tasks, divide their attention, maintain attention amid distractions, and plan and organize information related to a task. These deficits were found to be among the most frequently encountered in patients following TBI as well as among the first to be restored.

Next, interventions being used to treat attentional deficits in TBI patients were researched. The most commonly used treatments were pharmacologic, motoric interventions, assistive technologies, social-environmental interventions, and cognitive rehabilitation. Ylvisaker's 1998 research revealed that the interventions most used for attentional process dysfunctions were pharmacologic, as with childhood ADD, and cognitive rehabilitation. The pharmacologic interventions being used for TBI are essentially the same as those used for childhood ADD. Thus, attention was focused on cognitive rehabilitation, it's theoretical framework, techniques for intervention, specifically it's primary vehicle for intervention, computers, and the possibility of the use of computer-assisted cognitive rehabilitation with children suffering childhood attention deficit disorder.
The research reviewed revealed that cognitive rehabilitation itself has several theoretical approaches resulting in three models of rehabilitation, which include the mental exercise model, the behavioral shaping model, and the functional reorganization model. Cognitive rehabilitation also primarily uses computers as its vehicle for intervention. The research identified two approaches to computer-assisted cognitive rehabilitation: task specific and hierarchical. The current study used the mental exercise theoretical model and the hierarchical intervention approach to computer-assisted cognitive rehabilitation. Three studies were reviewed that employed computer-assisted cognitive rehabilitation to remediate attention in test subjects. Sohlberg and Mateer’s 1987 study using Attention Process Training found that despite limitations in their study, the attentional processes of the subjects assessed were significantly improved. La Rose, Gagnon, Ferland, and Pepin’s 1989 study using computer games for cognitive rehabilitation yielded similar positive results in the remediation of visual attention. Palmese and Raskin’s 2000 study using The APT II computer-assisted program to rehabilitate attention in adults with mild traumatic brain injuries also yielded positive results. This appears to indicate that computer-assisted cognitive rehabilitation can result in improvement in the attention of TBI subjects with attentional deficits.

The current investigator hypothesizes that since cognitive rehabilitation has been used successfully as a treatment for improving attention in persons diagnosed with acquired brain injuries (TBI, CHI), it follows that essentially the same results are possible when using the intervention with those who suffer from childhood attentional deficits. This is possible for several reasons. First, the literature reviewed shows that
areas of the brain that are damaged in TBI resulting in attentional deficits are areas of the cerebral cortex and frontal lobes. These areas appear to essentially be the same as those that have been shown as connected to the occurrence of childhood attention deficit disorders. Second, the symptoms for both maladies are similar (e.g., impulsivity, ease of distraction, inability to filter out superfluous stimuli). Finally, both disabilities appear to respond to pharmacological treatment.

The final section of this literature review discusses studies that identified and used cognitive rehabilitation with or without computer-assistance as a treatment for attention deficit disorder. A study using computer-assisted cognitive rehabilitation with adults conducted by Linda Laatsch (1998) resulted in findings similar to those of Sohlberg and Mateer (1987) whose test subjects were also adults, showed an overall improvement in the attentional functioning of test subjects exposed to the intervention. Neither of these studies used children as their focus.

In a 1989 study, Dennis Williams, a University of Washington doctoral student, used Attention Process Training (APT) in a controlled study to improve the attention of test subjects diagnosed with attention deficit disorder and did use children. The results indicated that subjects exposed to APT exhibited a significant improvement in tasks training sustained attention, alternating attention, selective attention and divided attention. Further, the results from the APT test battery also showed a significant improvement in selective attention, sustained attention, alternating attention, and divided attention test scores from pretest to posttest.
These results show that subjects diagnosed with ADD benefited from cognitive rehabilitation therapy with or without the use of computers. However, these two studies do not represent conclusive evidence in support of the current course of treatment in this area but indicate that the same results are possible with children diagnosed with childhood attention deficit disorder. The findings apparent in this literature review support the thesis of this study, that cognitive rehabilitation can be used to successfully improve attentional deficits in those suffering childhood attention deficit disorder.
CHAPTER 3

METHODS AND PROCEDURES

The purpose of this study is to investigate the effectiveness of cognitive rehabilitation in the form of attention training using a computer-assisted program. The software for this computer program was originally designed for use with adults suffering acquired brain injuries. For the purposes of this study, the software was modified for use with adolescent males diagnosed with attention deficit disorder. The primary focus of the study was to investigate the extent to which the process of attention training might improve the sustained attention and selective attention of test subjects.

In this chapter the methods and procedures used in this investigation are described. This chapter is organized as follows: (1) providing a description of the hypotheses; (2) providing a description of the subjects; (3) providing a description of the research instrumentation; (4) providing a description of the design of the study; (5) providing description of the procedures; and (6) providing a description of the collection and analysis of the data.
Hypothesis

The hypothesis for this study was that a modified version of a computer-assisted cognitive rehabilitation software program designed to improve attention in adults with would also improve the sustained and selective attention of adolescent males identified with attention deficit disorder who are also receiving psychostimulant medication as treatment.

More specifically, the focus of this study was to investigate whether scores derived from the attentional subtests of the Cognitive Assessment System (CAS) (Das & Naglieri, 1993) would show a post intervention improvement in the (1) sustained attention of adolescent male subjects with ADD who are taking psychostimulant medication and (2) selective attention of adolescent male subjects with ADD and taking psychostimulant medication. This will be tested against the following hypotheses:

Hypothesis 1: There is a significant difference between the pretest ($\chi_1$) and posttest scores ($\chi_2$) of subjects on the CAS attentional subtests subsequent to the presentation of the (a) sustained and (b) selective attention training software interventions.

Testable Hypothesis - $H_1 : x_1 - x_2 \neq 0$
Hypothesis 2: There is no significant difference between the posttest scores ($x_2$) of test subjects on the CAS attentional subtests and the CAS attentional subtests norming sample mean scores ($\mu$) subsequent to the presentation of the attention training software interventions.

Testable Hypothesis for Comparison to Norming Sample Mean - $H_2: x_2 - \mu = 0$

Test Statistics:

1. Correlated Sample t-test: $t = \frac{S_1 - S_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$

2. Comparison of subjects CAS attentional subtest scores to norming sample mean scores. $0 = X_j - \mu$

Subjects

The subjects chosen for this study were ten adolescent male students attending an education center for children, kindergarten through grade twelve, with severe emotional and behavioral disorders in a large urban school district. The criteria for the acceptance of students into the program at the Center were average intelligence, a reading level of at least fourth grade and an identified eligibility for special education services. Most of the students at the Center who were identified as having Attention Deficit Disorder (ADD) were treated with some form of medication, some with stimulants, some with antidepressants, and others with antihypertensives. In order to identify the subjects to
be used in this study, the confidential folders of all Center children were reviewed. Permission to review these folders was obtained from the appropriate school authorities. The criteria for the selection of the subjects were: (1) all subjects were to have an early childhood psychiatric diagnosis of ADD to minimize spontaneous improvement/maturational effects; (2) all subjects were to have taken psychostimulant medication in the form of Methylphenidate or Dexedrine. This was done because the majority of the students at the Center are being treated by a psychiatrist with some type of medication and specifying which medications the subjects were to use qualified as a control measure; (3) middle school students between the ages of 12 and 13 years were chosen. This criterion was used because at this particular stage of development, the human body is in flux, it is easier to influence change because of the dynamic nature and plasticity of the developing brain and these changes would be fairly noticeable and amenable to further change (Jensen, 1998); and (4) male students because current research indicates that the population of ADD sufferers is dominated by males (Flick, 1998). These demographics are outlined in Table 1.

A total of twenty-one students were identified as meeting the above criteria. Their names were placed in a hat, and ten names were randomly drawn. The researcher met with all ten of these students and explained the purpose of the study. All subjects and their parents were requested to give written permission to participate in the study. Students were asked to sign the Student Permission Form (Appendix A) and the parents/guardians were also given the Parent Permission Form (Appendix A) to sign (Appendix A). Nine parents/guardians returned the permission forms. By the time that
Table 1

Subject Characteristics Summary

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>JJ</th>
<th>PJ</th>
<th>RJ</th>
<th>IJ</th>
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</thead>
<tbody>
<tr>
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<td>13.5</td>
<td>13.9</td>
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<tr>
<td>Placement</td>
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<td>With Natural Mother</td>
<td>Group Home</td>
</tr>
<tr>
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<td>AD/HD</td>
<td>AD/HD</td>
<td>AD/HD</td>
</tr>
<tr>
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<td>Conduct Disorder</td>
<td>Depression</td>
<td>Conduct Disorder</td>
</tr>
<tr>
<td>Medication</td>
<td>Ritalin, Depakote</td>
<td>Dexedrine</td>
<td>Ritalin</td>
<td>Dexedrine</td>
</tr>
</tbody>
</table>
all of the permission forms were completed and returned by the school district, students, and parents/guardians, the regular spring semester was over. Consequently, only the students who would be attending summer school were included in the study.

The four students who were included and completed the study were JJ, PJ, RJ, and IJ. Subject #1, JJ, was a 12-year-old black, adolescent male with an early childhood diagnosis of Attention Deficit Disorder (ADD) from age five and living in a foster home in state custody. Subject #2, PJ, was a 13 year-old white adolescent male with an early childhood diagnosis of ADD from age five, living in the home of and in the legal custody of his natural father. Even with medication he remained extremely hyperactive. Subject #3, RJ, was a 13 year-old adolescent male with an early childhood diagnosis of ADD from age four. He was in the custody of his natural mother who has a history of incarceration for the sale of drugs and alcohol abuse. He was taking medication for attention deficit disorder with hyperactivity but continued to be very hyperactive and easily distractible. Subject #4, IJ, was a 13 year-old white adolescent male. He was living in a state supported boys group home and had an early childhood diagnosis of ADD from age five for which he was taking psychostimulant medication.

Independent Variable-Intervention

The Hierarchical Attention Training Plus program (HATP) (See Appendix B) was the software used for the attentional training of the subjects in this investigation and the stimulus presented by the software was identified as the independent variable. The software was developed by Lorie Houston-Dillon and Frederick I. Werner (1995, 1990,
and distributed by Parrot Software. The HATP was developed for patients
with acquired traumatic brain injuries, aphasia, learning and language disabilities, and
cognitively impaired patients in the mid to high ability levels for the purpose of
improving attentional processing. This software was chosen because it is similar to the
Attention Process Training Program (APT) developed by Sohlberg and Mateer (1987).
The HATP program materials consist of a group of hierarchically organized tasks that
exercise different components of attention and include sustained, selective, alternating,
and divided attention. The program's tasks place increasing demands on complex
attentional control and working memory systems.

The HATP software package contains forty-eight combinations of attentional
activities at varying degrees of difficulty. A specific target stimulus in the form of a
series of three letters or numbers is presented. Subsequently, a series of stimuli is
displayed for a period of two seconds, the user is then to watch and listen for the
identified target stimulus, and respond only when that stimulus appears by clicking the
mouse. After the target stimulus is presented, a new comparative stimulus is presented.
When any other stimuli (a distracter) appear, the user makes no response. The program
automatically tracks the progress of each subject, including response time and displays
or prints progress reports at any time (See Appendix B).

The attention levels addressed by this software include: (1) sustained attention using
exercises that require a subject to listen and watch for target sequences on the computer
screen then press the mouse when the target is identified (2) selective attention, which
employs tasks with background placement of visual and/or auditory distracters; (3)
divided attention exercises that require the completion of a sustained attention task while simultaneously performing a reaction time computer task; and (4) alternating attention exercises that require a subject to listen for one type of target word or sequence. Options for the manipulation of the stimulus include control of the stimulus display time and memory requirement adjustment, which involves a two second time limit for the presence of the target stimulus on the screen. With the addition of a Sound Blaster Sound Card, cues can be either written, spoken or both. For the purposes of this study, the stimulus was continually present on the screen, and the cues were both written on the screen and spoken.

Dependent Variable-Measuring Instrument Scores

The dependent variables in this investigation were the measures of sustained and selective attention, the Receptive Attention, Expressive Attention, and Number Detection subtest scores of the Cognitive Assessment System (CAS) (Das & Naglieri, 1993) (See Appendix B). The CAS is a norm-referenced measure of intelligence based on the Planning, Attention, Simultaneous, and Successive (PASS) cognitive processing theory. The PASS Cognitive Processing Theory was developed around a view of intelligence postulated by A. R. Luria (1980). He theorized that planning is the cognitive process by which the individual determines, selects, and uses a strategy or methods to efficiently solve a problem. Attention, Luria theorized, is a cognitive process by which the individual selects a particular stimulus, focuses on that stimulus, and inhibits attending to a
competing stimulus (a distracter). Simultaneous processing involves the integration of separate stimuli into a single, whole, or group. Successive processing involves working with things in a specific order.

The CAS assesses these processes for individuals from ages five (5) through seventeen (17) years with a 12-subtest standard battery. The 12-subtest battery includes assessments for: planning-matching numbers, planned codes, and planned connections; for simultaneous-non-verbal matrices, verbal-spatial relations, and figure memory; successive-word series, sentence repetition and questions, and speech rate; attention-expressive attention (EA), number detection (ND), and receptive attention (RA). For the purposes of this study, only the attention subtests were used.

The CAS was normed using a stratified sample of 2200 children ranging in age from 5.0 years to 17.11 years of age. Besides age, the subjects were further stratified according to gender, race, Hispanic origin, geographic region, parental educational attainment, and community setting. There were 1,100 females used in the study and 1,100 males, representing 50% each of the total population of subjects. Seventy-seven percent of the subjects were White, thirteen percent were Black, and ten percent were designated as other. Eleven percent of the subjects were Hispanic as compared to eighty-eight percent who were not. The geographic regions used in the study were the Midwest, Northeast, South, and West. Twenty-five percent of the test subjects were from the Midwest, nineteen percent were from the Northeast, thirty-four percent were from the South, and twenty-two percent were from the West. The majority of the subjects came from homes where the parents had at least a high school diploma, about
twelve-seven percent. Twenty percent had less than a high school diploma, twenty-nine percent had some college, and twenty-two percent were college graduates and above. About seventy-five percent of the subjects were from urban communities and twenty-five percent were from rural communities.

The average test-retest reliability for the attentional subtests of the CAS is .88. The initial examination of the validity of the CAS was illustrated through the confirmation and factor analysis of each subtest based on the following standardization age groups: five (5) to seven (7) years, eight (8) to ten (10) years, eleven (11) to thirteen (13) years, and fourteen (14) to seventeen (17) years. The confirmatory factor analyses results for the attentional subtests and age group for this investigation are: .580 for EA, .761 for ND, and .778 for RA (Naglieri & Das, 1997) indicating high positive relationships between the attentional subtests and the factors on which the subtests were specified. The raw score distributions for each one year interval range of the CAS subtests were used to obtain a cumulative frequency distribution. The distributions were normalized and scaled scores with a mean of 10 and a standard deviation of 3 were obtained. Each subtest raw score is a scaled score depending upon the age of the child. The standard/scaled scores were obtained from the Subtest Norms Table in Appendix A of the test booklet and are presented in Appendix B of this document. A CAS Subtest scoring protocol can be viewed in Appendix B.

To validate the use of the CAS subtests with children receiving special education services, children so identified were evaluated in a group of studies. In one of these studies, a sample of sixty-six children who met the DSM-IV (American Psychiatric
Association, 1994) criteria for attention deficit/hyperactivity disorder (ADHD) were identified. The subject group ranged in age from seven (7) to fourteen (14) years and was composed of white, non-Hispanic males. The mean scores of the ADHD students on the CAS attential subtests were 8.8 for Expressive Attention with a standard deviation of 2.1; 9.1 for Number Detection with a standard deviation of 2.8; and 8.0 for Receptive Attention with a standard deviation of 2.7. All of the subjects exhibited depressed attention scores as compared to the subtest standardization sample scores, which expressed a mean of 10 and a standard deviation of 3 (Naglieri & Das, 1997).

In a 2001 study, Perez-Alvarez and Timoneda-Gallart investigated the efficacy of the CAS in determining the early diagnoses and remediation of attentional deficits. Eighty children, fifty-five boys and twenty-five girls, ages six to twelve years were selected from the clientele of a neuropediatric clinic. The inclusion criteria for the study were inattention and inattention with hyperactivity symptoms. The treatment group was compared to a control group of 300 individuals with the same controls as the treatment group. Neuropediatric clinic clientele, boys and girls, ages six years were the population from which both samples were taken. The results were analyzed using cluster analysis and a t-test. The results identified three categories of attention deficit disorder: planning deficits; deficits in other processes (e.g. memory); and a few cases without cognitive processing deficits. Cognitive deficiencies in terms of mean scores (EA=9.1, ND=8.5, & RA=8.0) were found to be statistically significant as compared with the control group with a p=.001. This study gave positive indication of the efficacy of the CAS in determining the presence of attentional processing deficits.
The three attentional subtests of the CAS used in this investigation measure direct concentration, focus on essential details, focus on important information, resistance to distraction, selective attention, sustained attention over time, and sustained effort.

The Expressive Attention (EA) task is a subtest designed to measure selective attention and the ability to shift attention. The EA task involves three conditions as a measure of selective attention. The first and second pages of the test protocol contain the words red, blue, and green or colored rectangles in red, blue, or green, presented in varying order and arranged in eight rows, five to a row (Appendix B). The subject is first required to read all of the words on page one or say the names of the colors on page two as fast as possible to a maximum of 180 seconds. The selective attention component in this task is the last item of the subtest, on page three of the protocol, and contains the words red, blue, and green, printed in colors different from that of the word. The subject is instructed to name, as fast as possible, the color in which the word is printed. The subject’s raw score is the ratio of the total number of items correct and the time in seconds needed to complete each page. A Ratio Score is obtained using the Ratio Score Conversion Table (Appendix B) yielding a standard final score (Naglieri & Das, 1997).

Number Detection (ND) is designed to measure selective attention, the ability to shift attention and resistance to distraction (sustain attention). This subtest presents the test subject with the task of underlining numbers on a page that match target stimuli at the top of the page (Appendix B). Each item consists of rows of numbers that match the stimuli and distracter numbers that do not match the stimuli. The subject is instructed to
circle numbers 1, 2, and 3 when they appear in bold face (1, 2, 3) rather than regular face type and involves the examination of many numbers arranged in rows on each page. The child must complete the task row by row, from left to right, and from top to bottom within 150 seconds. Using the scoring template (Appendix B), the number of correct items and incorrect items are identified. An accuracy score is then obtained by subtracting the number of false items from the number correct. A raw score is derived by determining the ratio between the accuracy score and the time (in seconds) taken to complete each item summed across all items. A ratio score is then obtained from a Ratio Conversion Table (Appendix B). The final score is a standard score.

The Receptive Attention Task (RA) is a two-page paper-and-pencil test that measures sustained effort over time (Appendix B). The subject is to find and underline pairs of letters that are the same but might look different. Each item consists of rows of letter pairs, which contain pairs that match and pairs that do not match. The subject is instructed to underline the pairs of letters that are physically the same or have the same name (e.g. rR, RR, rr, rt Tr) within 180 seconds. To score, the time to complete each item is recorded. The number correct and the number of false detections are determined using the scoring template (Appendix B). The number of false detections is then subtracted from the number of correct detections to obtain an accuracy score. The ratio of the accuracy score to the total time in seconds to complete each item, summed across the items are used to obtain a ratio score from the Ratio Score Conversion Table (Appendix B) yielding a final standard score.
Figure 1. Diagram of the Independent and Dependent Variables

\[
\begin{array}{ccc}
O_1 & X & O_2 \\
\hline
\text{Pretest Dependent Variable} & \text{Independent Variable} & \text{Posttest Dependent Variable} \\
\text{CAS Attentional Subtests} & \text{Hierarchical Attention Training Plus} & \text{CAS Attentional Subtests} \\
\text{RA (Sustained Attention)} & \text{EA (Selective Attention)} & \text{RA (Sustained Attention)} \\
\text{EA (Selective Attention)} & \text{ND (Sustained & Selective)} & \text{EA (Selective Attention)} \\
\text{ND (Sustained & Selective)} & & \text{ND (Sustained & Selective)} \\
\end{array}
\]

Materials

The computer used for this study was a district issue, IBM PC clone with a high-resolution monitor, a color screen and a standard mouse. Additionally, an egg timer was used to time treatments and maintain structure during the sessions.

Study Research Design

Research designs are constructed arrangements for collecting data to help a researcher answer research questions and control for possible rival hypotheses or extraneous variables that might compete with the independent variable as an explanation for changes in the dependent variable (Bloom & Fischer, 1982; Grinnell, 1981; Huck, Cormier, & Bounds, 1974). There are four major types of designs used to illustrate these changes: hypothetical development designs, quantitative-descriptive designs, associational designs, and cause-effect designs (Grinnell, 1981).

This study used an associational or pretest-posttest research design. Pretest-posttest designs have been commonly used in early intervention research to determine, as with the current study, if a new intervention is worthy of further study, and their use is
reported in ADD treatment literature (Castro & Mastropieri, 1986).

In this design, observations are made before and after the independent or treatment variable is introduced to a group of test subjects. The strategy behind this is to determine if there is a significant difference between the dependent variable from pretest to posttest. Statistically significant differences between measures of a dependent variable constitute evidence of an empirical association between the independent variable, which is in this case the stimulus presentation of the Hierarchical Attention Training Plus (HATP) program and the dependent variable the measures of sustained and selective attention (CAS attentional subtest scores) (Grinnell, 1981).

There are three basic pretest-posttest designs: (1) the one shot case study, which involves a group exposed to an intervention and then observed; (2) the one-group pretest-posttest design; and (3) the static group comparison design, which has two groups and comparisons are made between one group exposed to a treatment and another group which is not. This study used the one-group pretest-posttest design. Though it is not the most robust of the three designs, it is often used in early studies of specific interventions (Huck, Cormier, & Bounds, 1974).

In one-group pretest-posttest designs, any observed changes in test subject condition at posttest as compared to pretest is attributed to the effectiveness of the intervention assuming the control of extraneous variables.

This investigation was divided into three phases. The first phase was the pretest phase, which employed the attentional subtests of the Cognitive Assessment System (CAS) (Das & Naglieri, 1993) to measure the current attentional functioning of the test
subjects. The attentional subtests of the CAS included: Expressive Attention (EA), Number Detection (ND), and Receptive Attention (RA). The resulting scores identified the present levels of sustained and selective attentional functioning for each of the four selected subjects, establishing the pretest level of the dependent variables.

The second phase of this study involved the administration of the intervention (independent variable) to improve sustained attention. This first intervention was administered in the form of the sustained attention-training portion of the Hierarchical Attention Training Plus (HATP) (Houston-Dillon & Werner, 2000) computer software program. As a process of the program, the progress of each subject was tracked daily at each session, resulting in a written report outlined as follows: (1) date of intervention; (2) attention training program; (3) stimuli used (e.g. digit or letter); (4) cue type (verbal/written); (5) memory requirement (not used in this investigation); (6) responses attempted; (7) number correct; (8) percent correct; and (9) average time in seconds to complete response. The ceiling for the response time was set at two seconds initially and then one second. Each subject's performance based upon the computer-generated reports as an evaluative measure was graphed. Following the sustained attention training intervention, each subject was re-tested using the Receptive Attention subtest of the CAS.

The third phase of this investigation involved the administration of the intervention (independent variable 2) to improve selective attention. This second intervention was administered in the form of the selective attention-training portion of the HATP computer software program. The daily progress of each subject was tracked in the same
manner as the sustained attention training, resulting in a written report, which was graphed by the investigator. Following the selective attention training intervention, each subject was re-tested using both the Expressive Attention and Number Detection subtests of the CAS, documenting changes since pretest administration.

Procedures

As required by University of Nevada, Las Vegas policies and procedures regarding research using human subjects, the researcher obtained the approval to conduct this investigation from the University Human Subjects Committee (Appendix A), the College of Education Committee on Educational Research and Planning (Appendix A), and the Clark County School District (Appendix A). To further facilitate the implementation of this study, the investigator discussed this study with the principal of the Center, remitted a copy of the research proposal, and obtained the principal's written permission Appendix A) to review the confidential folders of all the middle school males and conduct the research at the Center.

Phase I

Four subjects were identified for use in this investigation — subject 1-JJ; subject 2-PJ; subject 3- RJ; and subject 4-IJ. Written permission from the subject and parent (Appendix A) was obtained. All subjects were met individually for the pretest administration of the attentional subtests of the Cognitive Assessment System to determine current levels of sustained and selective attentional functioning. The testing
was completed on days one through four, one week before the beginning of the
intervention phase of the study. Each subject was asked about his ability to use a
computer. In addition to their exposure to computers as a part of the Center educational
program, all of the subjects reported having access to a computer at home and using
them regularly for schoolwork and recreation. Each student was then given instructions
from the researcher for accessing the Hierarchical Attention Training Plus program
using Windows 98. Once the student had accessed the program, the investigator had
each student log on to the program and complete two practice run sessions. After being
sure that each student was familiar with the computer and the software the next step was
to initiate the administration of the intervention.

Phase II

For each subject, the sustained attention-training portion of the HATP was
administered for two days each week for three weeks in 30-minute sessions for a total
of six sessions. Each session with the computer was randomly assigned by subject to a
treatment day and time by pulling names out of a box and constructing a treatment
schedule. The schedule was posted in the treatment area and shared with each student
and their parents.

The sustained attention training intervention was designed as follows: (1) the cues
given were combined (written and verbal); (2) there was a one second wait between the
time that the stimulus was presented and the expected response; (3) there was no
memory requirement (both the target stimulus and the response stimulus remained in
view on the computer screen the entire time); and (4) the stimulus type was alternated between three digits and three letters every 15-minutes of the 30-minute session. To use the program, the subject clicks the start button with the mouse. A “GO” button appears on the screen, and the subject clicks the “GO” button to initiate the lesson. An instruction bar appears at the bottom of the screen displaying the instructions for completing the task and the target stimulus (e.g., Click if 123 or a b c). The subject then clicks the “GO” button. In the next second a comparison stimulus is spoken and simultaneously appears in the touch box in the center of the screen. If the comparative stimulus displayed in the touch box matches the target stimulus presented in the instruction bar, the subject clicks in the touch box, which appears in the middle of the screen. The touch box holds a new comparative stimulus each time the “GO” button is pressed. If the target stimulus in the instruction bar and the comparison stimulus in the touch box do not match, the subject will make no response. After two seconds, the screen changes to a clear screen with the “GO” button in the middle. In order to continue the lesson, the subject must click the “GO” button to reinitiate the lesson and another stimulus is presented. The program records the correct and incorrect responses and the elapsed time between viewing the stimulus and clicking the mouse. If the student did not respond within the two-second time limit, the researcher re-directed the student. The program does not record delays between presenting the “GO” button and when the subject clicks on it. Hence, it was possible for students to lose significant training time from the thirty-minute session by failing to immediately press the “GO” button.
At the end of the sixth session, the researcher re-administered the Receptive Attention subtest of the Cognitive Assessment System to each subject to measure changes in sustained attention over time.

Phase III

The selective attention-training portion of the HATP program was administered to each student two days each week, for three weeks in 30-minute sessions for a total of six sessions. The sessions were again randomly assigned by subject to a treatment day and time generating a schedule in the exact manner as previously identified.

The selective attention training intervention was designed exactly as the sustained attention training intervention with one addition. When the stimulus button was clicked to initiate the lesson a series of distracting red squares annoyingly moved around the screen. To be successful, the user would ignore the red squares, selecting more relevant information and focusing on the task at hand. The subject would click the stimulus button if the series of digits or letters displayed were the same as the ones listed in the instruction bar. Otherwise, the subject would make no response. A bell reinforced all correct responses. Incorrect responses were negatively reinforced with a loud buzzer.

When the sixth session was completed, all subjects were re-administered the Expressive Attention and Number Detection subtest to determine any changes in selective attentional functioning over time.
When a subject was absent from school, his session was re-scheduled for his next day of attendance. Each student participated in the twelve 30-minute sessions, three hours per intervention, for a total of six hours. The stimulus type was intermittently alternated between letter series and number series by dividing each 30-minute session into 15-minute sub-sessions to offer variety and stimulation. Depending upon the subject and his level of distractibility, the amount of time it would take to continue the lesson after a response varied in the range between five and twenty seconds. Often one or more of the subjects were redirected to the task by the researcher.

Additionally, because this software was designed for subjects with more serious brain damage than those experienced by sufferers of ADD, the speed of the program was very slow. During the first day of the study, the researcher took steps to speed up the presentation of the stimulus in the program by contacting the distributor of the program who e-mailed slight changes to the program which were downloaded and implemented the next day before the start of that day’s sessions. All subjects were equally affected. An egg timer was used to start each session and would ring to signify the end of each 15-minute sub-session. All testing and interventions were monitored and administered by the researcher. Contact with students was limited to technical issues involving the computers used or the software.

Collection and Analysis of Data

From the ten, randomly selected, adolescent males treated with psychostimulant medication, parental permission was obtained for nine subjects. Four students were
chosen to be used in this investigation. The determination of eligibility was based upon demographic and psychological data derived from the criteria established by the researcher, review of the confidential folders of subjects (See Table 1) and attendance in summer school.

The four sets of scores on the attentional subtests of the CAS were analyzed. On the basis of these scores, the pretest/posttest and norming sample comparisons were made. There were three appropriate statistical analyses that could have been used for a one-group pretest-posttest design. Those analyses included the t-test for correlated samples, the Sign test, and the Wilcoxon matched pairs signed rank test (Huck, Cormier, & Bounds, 1974). For the purposes of this investigation, the t-test for correlated samples was used because it is the most robust of the three tests. Additionally, the CAS pretest and posttest attentional subtest scores were graphed and visually displayed for analysis.

This study evaluated the effectiveness of the attention process-training program by determining the degree of change in the CAS attentional subtest scores for each subject from pretest to posttest across phases.

The measuring instrument (the CAS) used to study this population of subjects was standardized and norm-referenced, thus, the experimental results can be compared to the norming sample of the test used (Scruggs & Mastropieri, 1994). Both visual inspection and data comparison of the CAS pretest-posttest scores was used in the data analysis. With all three subtests, the more accurate the subject was at detecting the target stimuli, avoiding the distracting stimuli, and selecting to focus on stimuli relevant to an assigned task, the higher the scores.
CHAPTER 4

RESULTS

This chapter presents findings pertinent to the major hypotheses of this study. Data are treated using statistical analysis, the visual inspection of individual and group findings, and are presented according to the research hypotheses. The general hypothesis postulated in this study stated that a process of computer-assisted cognitive rehabilitation in the form of an attention training software program (Hierarchical Attention Training Plus) designed to improve attention in adults with acquired brain injuries will also bring about an improvement in the sustained and selective attention of attention deficit disordered (ADD) adolescent male test subjects treated with psychostimulant medication.

For this investigation, a one-group pretest-posttest research design was selected as well as an experimental group versus CAS attentional subtests norming sample mean comparison. A correlated sample t-test was used as the vehicle of statistical analysis for the pretest-posttest differences and tabular and graphic representations were used to demonstrate experimental group and CAS norming sample mean differences. As a process of the Hierarchical Attention Training Plus (HATP) program, a report of the progress of each test subject was generated and presented in Tables 3 through 6. Additionally, as part of the intervention procedure, the presentation of the stimulus
alternately used either digits or letters. Figures 3, 4, 6, 7, 9, 10, 12, and 13 are a graphic representation of the digit versus letter stimulus responses attempted for the sustained and selective attention for each subject. The Statistical Package for the Social Sciences (SPSS) version 10.00 (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1999) was used for t-test calculations, which were recorded in Tables 7 through 9. Additionally, visual, graphic representations of subtest scores for each subject are represented in Figures 2, 5, 8, and 11.

The chapter has been divided into three sections. The first section presents the data collected from the daily treatment sessions, Phase 1 pretest/baseline results of the administration of the CAS attentional subtests, and the Phase 2 and Phase 3 post intervention test results from the CAS attentional subtests. The second section discusses and evaluates the pretest/posttest results of each of the test subjects on the sustained and selective attention subtest measures of the Cognitive Assessment System and section three presents the results of the pretest/posttest CAS score comparison to the CAS norming sample mean.

Daily Treatment Session Data

Subject 1: JJ

JJ's performance, as recorded in Table 2, was improved by one standard deviation (sd=3) from pretest to posttest on one of the CAS attentional subtests. He experienced
Table 2

Phase Results of CAS Attentional Subtest Administration

<table>
<thead>
<tr>
<th>Subject/Subtest</th>
<th>Phase 1 Pretest Scores</th>
<th>Phase 2 Posttest Scores</th>
<th>Phase 3 Posttest Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>JJ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive Attention</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Expressive Attention</td>
<td>5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Number Detection</td>
<td>9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>PJ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive Attention</td>
<td>9</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Expressive Attention</td>
<td>2</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Number Detection</td>
<td>1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td><strong>RJ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive Attention</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Expressive Attention</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Number Detection</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>IJ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive Attention</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Expressive Attention</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Number Detection</td>
<td>9</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
no improvement on one, and decreased on another from pretest to posttest. The Receptive Attention score showed no increase from pretest to posttest recording a score of 10 at both phases. There was a recorded decrease in the Number Detection score by one standard deviation from pretest to posttest with a score of 9 at pretest and a score of 6 at posttest. The Expressive Attention subtest was the only measure that recorded any positive change, with a pretest score of 5 and a posttest score of 10. Figure 2 graphically displays the patterns of data change in Receptive Attention, Expressive Attention, and Number Detection for subject JJ.

Table 3 shows a minimal increase in stimulus response attempts during the sustained attention intervention with a calculated average increase from 148 in the first half of the sustained attention training intervention to an average of 149 for the second half of the sustained attention training session. The average of the stimulus response attempts during the selective attention training intervention calculated at 170 during the first half of the session as compared to a score of 171 at the second half of the session. All attempts illustrated a high level of accuracy. During the session, each subject was exposed to alternating stimuli in the form of letters and digits. Figure 3 displays a comparison of the sustained attention response attempts for digits as compared to letters for this subject. The number of response attempts showed very little variation with only one exception during week 3. Figure 4 represents the selective attention digit-letter comparison for subject JJ. However, there were no significant variations in those responses as well. This indicated that the alternating between digits and letters portion of the intervention appeared to illustrate no confounding effects.
Figure 2. JJ's Pretest/Posttest Comparisons

Receptive Attention
Expressive Attention
Number Detection

CAS Attentional Subtest Scores

Pretest Postest

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Table 3

Subject “JJ” Progress Report

<table>
<thead>
<tr>
<th>Week</th>
<th>Treatment</th>
<th>Stimuli</th>
<th>Attempted</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Sustained</td>
<td>3 digit</td>
<td>137</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>122</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>178</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>148</td>
<td>97</td>
</tr>
<tr>
<td>Week 2</td>
<td>Sustained</td>
<td>3 digit</td>
<td>163</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>140</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>125</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>109</td>
<td>98</td>
</tr>
<tr>
<td>Week 3</td>
<td>Sustained</td>
<td>3 digit</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>214</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>175</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>181</td>
<td>91</td>
</tr>
<tr>
<td>Week 4</td>
<td>Selective</td>
<td>3 digit</td>
<td>150</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>170</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>208</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>170</td>
<td>97</td>
</tr>
<tr>
<td>Week 5</td>
<td>Selective</td>
<td>3 digit</td>
<td>175</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>115</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>139</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>168</td>
<td>96</td>
</tr>
<tr>
<td>Week 6</td>
<td>Selective</td>
<td>3 digit</td>
<td>131</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>160</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>145</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>170</td>
<td>98</td>
</tr>
</tbody>
</table>
Subject 2: PJ

PJ's attentional subtest scores increased from pretest to posttest on all three subtests as indicated in Table 2. His Receptive Attention scores increased from a pretest score of 9 to a post intervention score of 11. Expressive Attention scores increased from a 2 at pretest to a post intervention score of 10. Number Detection showed an increase from a score of 1 at pretest to a score of 9 at posttest. Figure 5 is a graphic representation of the CAS attentional subtest scores and the patterns of data change for subject PJ. This was done to make apparent the patterns indicated by the data and their implications. Table 4 documents an increase in the number of stimulus response attempts for both sustained and selective attention with a high level of accuracy. The calculated average responses attempted increased from 154 attempts during the first half of the sustained attention training session to 162 response attempted at the final half of the session. The stimulus responses attempted during the selective attention training session's first half, yielded a calculated average of 175 compared to 193 average responses attempted for the final half of the session. Figure 6 is a graphic representation of the subject's sustained attention digit versus letter response attempts. This figure indicates that this subject essentially made no more response attempts using digits as the stimulus than he did when letters were used as the stimulus. Figure 7 is a graphic representation of the subject's selective attention response attempts. Again, there was very little variability in digit versus letter response attempts with the exception of one point during week 6.
Figure 3. PJ's Pretest/Posttest Comparisons

- Receptive Attention
- Expressive Attention
- Number Detection

CAS Attentional Subtest Scores

Pretest

Posttest

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Table 4. Subject “PJ” Progress Report

<table>
<thead>
<tr>
<th>Week</th>
<th>Treatment</th>
<th>Stimuli</th>
<th>Attempted</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Sustained</td>
<td>3 digit</td>
<td>144</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>144</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>129</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>129</td>
<td>100</td>
</tr>
<tr>
<td>Week 2</td>
<td>Sustained</td>
<td>3 digit</td>
<td>196</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>180</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>168</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>156</td>
<td>97</td>
</tr>
<tr>
<td>Week 3</td>
<td>Sustained</td>
<td>3 digit</td>
<td>138</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>164</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>146</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>Week 4</td>
<td>Selective</td>
<td>3 digit</td>
<td>179</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>167</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>189</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>206</td>
<td>100</td>
</tr>
<tr>
<td>Week 5</td>
<td>Selective</td>
<td>3 digit</td>
<td>175</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>134</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>172</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>250</td>
<td>96</td>
</tr>
<tr>
<td>Week 6</td>
<td>Selective</td>
<td>3 digit</td>
<td>198</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>189</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>173</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>168</td>
<td>98</td>
</tr>
</tbody>
</table>
Subject 3: RJ

Figure 8 graphically displays information revealing that RJ made increases on two of the three CAS attentional subtests. Table 2 indicates RJ’s Receptive Attention scores increased from a low pretest score of 6 to a post intervention score of 11. The Expressive Attention subtest scores showed an increase from a pretest score of 4 to a posttest score of 7. The scores from the Number Detection subtest displayed no increase but maintained at a score of 6.

During the first half of RJ’s sustained attention training intervention, his stimulus response attempts generated a calculated average of 132 attempts, increasing to 193 attempts in the second half of the sustained attention intervention training session as indicated in Table 5. The selective attention intervention training sessions yielded an initial calculated average of 206 stimulus response attempts for the first half of the session as compared to the second half calculated average of 202 stimulus response attempts indicating a slight decrease. Figure 9 is the graphic representation of the digits stimulus versus letters stimulus responses attempted for sustained attention by subject RJ. The results indicated that there was an increase in the number of responses overall but basically very little difference in the stimulus response attempts using digits as the stimulus as compared to the attempts using letters as the stimulus. Figure 10 is the graphic representation of the selective attention digit versus letter stimulus responses for this subject. There appeared to be slightly more variability between the response attempts for digits as compared to letters.
Figure 8. RJ's Pretest/Posttest Comparisons

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Table 5. Subject RJ’s Progress Report

<table>
<thead>
<tr>
<th>Week</th>
<th>Treatment</th>
<th>Stimuli</th>
<th>Responses Attempted</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sustained</td>
<td>3 Digit</td>
<td>102</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 Digit</td>
<td>126</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>151</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Sustained</td>
<td>3 Digit</td>
<td>175</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>145</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 Digit</td>
<td>175</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>155</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Sustained</td>
<td>3 Digit</td>
<td>210</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>210</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 Digit</td>
<td>240</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>167</td>
<td>98</td>
</tr>
<tr>
<td>4</td>
<td>Selective</td>
<td>3 Digit</td>
<td>186</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>230</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 Digit</td>
<td>200</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>233</td>
<td>97</td>
</tr>
<tr>
<td>5</td>
<td>Selective</td>
<td>3 Digit</td>
<td>178</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>211</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 Digit</td>
<td>168</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>232</td>
<td>98</td>
</tr>
<tr>
<td>6</td>
<td>Selective</td>
<td>3 Digit</td>
<td>195</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>166</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 Digit</td>
<td>223</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Letter</td>
<td>230</td>
<td>98</td>
</tr>
</tbody>
</table>
Figure 9. RJ's Sustained Attention/Digit/Letter Comparisons

Figure 10. RJ's Selective Attention Comparisons

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Subject 4: IJ

IJ’s CAS attentional subtest results are displayed in Table 2 and graphically represented in Figure 11. He showed an increase in his Receptive Attention subtest scores from a pretest score of 5 to a post intervention score of 7. His Expressive Attention subtest scores also showed an increase, from a pretest score of 2 to a posttest score of 5. IJ’s Number Detection attentional subtest scores displayed a slight increase from a pretest score of 9 to a posttest score of 10. Table 6 represents a summary of IJ’s computer generated progress report. The table illustrates a pretest calculated average of 158 stimulus attempt responses during the first half of the sustained attention training intervention as opposed to a post intervention calculated average of 138. IJ’s stimulus response attempts during the first half of the selective attention training session generated a calculated average of 121 response attempts compared to a second half increase to 174 attempts with a high level of accuracy. Figure 12, a graphic representation of IJ’s sustained attention digit versus letter stimulus response attempts information, indicates that there was a great deal of variability in the number of stimulus responses attempted from week to week, but very little variability between the number of digits as compared to the number of letters. The information displayed in Figure 13 is the selective attention digit versus letter comparison of stimulus responses attempted for this subject. It also shows that there was very little difference in the number of responses when digits were used as the stimulus as compared to when letters were used as the stimulus.
Figure 11. U's Pretest/Posttest Comparisons

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### Table 6. Subject “IJ” Progress Report

<table>
<thead>
<tr>
<th>Week</th>
<th>Treatment</th>
<th>Stimuli</th>
<th>Response Attempts</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Sustained</td>
<td>3 digit</td>
<td>164</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>155</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>175</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>189</td>
<td>98</td>
</tr>
<tr>
<td>Week 2</td>
<td>Sustained</td>
<td>3 digit</td>
<td>131</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>132</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>132</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>116</td>
<td>93</td>
</tr>
<tr>
<td>Week 3</td>
<td>Sustained</td>
<td>3 digit</td>
<td>146</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>108</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 digit</td>
<td>139</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Sustained</td>
<td>3 letter</td>
<td>188</td>
<td>95</td>
</tr>
<tr>
<td>Week 4</td>
<td>Selective</td>
<td>3 digit</td>
<td>120</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>160</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>127</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>149</td>
<td>89</td>
</tr>
<tr>
<td>Week 5</td>
<td>Selective</td>
<td>3 digit</td>
<td>168</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>106</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>150</td>
<td>86</td>
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<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>174</td>
<td>89</td>
</tr>
<tr>
<td>Week 6</td>
<td>Selective</td>
<td>3 digit</td>
<td>187</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>160</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 digit</td>
<td>178</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Selective</td>
<td>3 letter</td>
<td>194</td>
<td>91</td>
</tr>
</tbody>
</table>

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One-Group Pretest/Posttest Analysis of Results

Hypothesis 1 of this study states that there is a significant difference between the pretest and posttest scores of subjects on the CAS attentional subtests subsequent to the presentation of the sustained and selective attention training software interventions. The most common statistical procedure for determining the level of significance when two means are compared is the t-test. The correlated sample t-test can be used when each of the data observations of one group is tied to a score in a second group and a single group of subjects is measured twice under two different treatment conditions of before and after a common experience as in the current investigation. For the purposes of this investigation, three correlated sample t-tests using the group scores of the four test subjects on the three CAS attentional subtests were computed. The generated results of the t-test as calculated using SPSS are presented in Tables 7 through 9 and Figures 14 through 16. The t-scores are compared to a critical value of 2.353 at a .05 level of significance.

Receptive Attention

The pretest scores were compared to the posttest scores of the Receptive Attention Subtest using the correlated sample t-test. A graphic representation of Receptive Attention subtest scores is presented in Figure 14. The t-test results are presented in Table 7. The resulting t-score was 2.183 at a .05 level of significance against a critical value of 2.353. Significant differences were not found.
Figure 14. Receptive Attention Group Results

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Table 7. Receptive Attention Correlated Samples T-Test

**Paired Samples Statistics**

<table>
<thead>
<tr>
<th>Pair</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST</td>
<td>9.7500</td>
<td>4</td>
<td>1.8930</td>
<td>.9465</td>
</tr>
<tr>
<td>PRETEST</td>
<td>7.5000</td>
<td>4</td>
<td>2.3805</td>
<td>1.1902</td>
</tr>
</tbody>
</table>

**Paired Samples Correlations**

<table>
<thead>
<tr>
<th>Pair</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST &amp; PRETEST</td>
<td>4</td>
<td>.555</td>
<td>.445</td>
</tr>
</tbody>
</table>

**Paired Samples Test**

<table>
<thead>
<tr>
<th>Pair</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST - PRETEST</td>
<td>2.2500</td>
<td>2.0616</td>
<td>1.0308</td>
<td>Lower: -1.0304, Upper: 5.5304</td>
<td>2.183</td>
</tr>
</tbody>
</table>

**Paired Samples Test**

<table>
<thead>
<tr>
<th>Pair</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST - PRETEST</td>
<td>3</td>
<td>.117</td>
</tr>
</tbody>
</table>
Expressive Attention

The t-test score was computed for the Expressive Attention pretest scores on the CAS attentional subtests as compared to posttest scores of the four subjects. A graphic representation of subtest scores for Expressive Attention is presented in Figure 15. The t-test results are presented in Table 8 and yielded a t-score 4.020 compared to the critical value of 2.353 at a .05 level of significance, indicating a significant difference.

Number Detection

Figure 16 is a graphic representation of the Number Detection subtest scores. Table 9 documents the correlated t-test comparison of the pretest scores and the posttest scores of the Number Detection subtest of the CAS. The resulting t-test score calculated at a .645 compared to a test value of 2.353 at a .05 level of significance, indicating that there were no significant differences. Significant group differences were only found for the Expressive Attention subtest.

CAS Posttest to Norming Sample Mean Comparisons

Hypothesis 2 for this study states that there is no significant difference between the posttest scores of test subjects on the CAS attentional subtests and the CAS attentional subtest norming sample mean scores subsequent to the presentation of the attention training software interventions. These differences were illustrated and the results displayed in Tables 10 through 13. The identified subtest mean score for the norming ample was 10 with a standard deviation of 3. Subject JJ's RA and EA posttest scores of
Figure 15. Expressive Attention Group Results

Pretest/Posttest Scores

Test Subjects

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Table 8 - Expressive Attention Correlated Samples T-Test

Paired Samples Statistics

<table>
<thead>
<tr>
<th>Pair</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST</td>
<td>8.0000</td>
<td>4</td>
<td>2.4495</td>
<td>1.2247</td>
</tr>
<tr>
<td>PRETEST</td>
<td>3.2500</td>
<td>4</td>
<td>1.5000</td>
<td>.7500</td>
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</table>

Paired Samples Correlations

<table>
<thead>
<tr>
<th>Pair</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST &amp; PRETEST</td>
<td>4</td>
<td>.363</td>
<td>.637</td>
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Paired Samples Test

<table>
<thead>
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<th>Paired Differences</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST - PRETEST</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error Mean</td>
</tr>
<tr>
<td>POSTTEST - PRETEST</td>
<td>4.7500</td>
<td>2.3629</td>
<td>1.1815</td>
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</tbody>
</table>

Paired Samples Test

<table>
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<tr>
<th>Pair</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST - PRETEST</td>
<td>3</td>
<td>.028</td>
</tr>
</tbody>
</table>
Figure 16. Nimber Detection Group Results
Table 9 - Number Detection Correlated Samples T-Test

Paired Samples Statistics

<table>
<thead>
<tr>
<th>Pair</th>
<th>POSTTEST</th>
<th>PRETEST</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.7500</td>
<td>6.2500</td>
<td>4</td>
<td>4</td>
<td>2.0616</td>
<td>1.0308</td>
</tr>
</tbody>
</table>

Paired Samples Correlations

<table>
<thead>
<tr>
<th>Pair</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST &amp; PRETEST</td>
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<td>.797</td>
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Paired Samples Test

<table>
<thead>
<tr>
<th>Pair</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST - PRETEST</td>
<td>1.5000</td>
<td>4.6547</td>
<td>2.3274</td>
<td>-5.9 - 8.91</td>
<td>.645</td>
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</tbody>
</table>

Paired Samples Test

<table>
<thead>
<tr>
<th>Pair</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTTEST - PRETEST</td>
<td>3</td>
<td>.565</td>
</tr>
</tbody>
</table>

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Table 10. Subject JJ’s Norming Sample Comparison Results

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pretest Score</th>
<th>Posttest Score</th>
<th>Norming Sample Mean</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>EA</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>ND</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>-4.0</td>
</tr>
</tbody>
</table>

Table 11. Subject PJ’s Posttest/Norming Sample Comparison Results

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pretest Score</th>
<th>Posttest Score</th>
<th>Norming Sample Mean</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>EA</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>ND</td>
<td>1</td>
<td>9</td>
<td>10</td>
<td>-1.0</td>
</tr>
</tbody>
</table>

Table 12. Subject RJ’s Posttest/Norming Sample Comparison Results

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pretest Score</th>
<th>Posttest Score</th>
<th>Norming Sample Mean</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>6</td>
<td>11</td>
<td>10</td>
<td>1.0</td>
</tr>
<tr>
<td>EA</td>
<td>4</td>
<td>7</td>
<td>10</td>
<td>-3.0</td>
</tr>
<tr>
<td>ND</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>-4.0</td>
</tr>
</tbody>
</table>

Table 13. Subject IJ’s Posttest/Norming Sample Comparison Results

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Pretest Score</th>
<th>Posttest Score</th>
<th>Norming Sample Mean</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>-3.0</td>
</tr>
<tr>
<td>EA</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>-5.0</td>
</tr>
<tr>
<td>ND</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>
10 were equal to the norming sample mean. His posttest ND score of 6 was one standard deviation below the norming sample mean and represented a decrease from a pretest score of 9. Subject PJ's posttest RA score of 11 was within one standard deviation above the CAS norming sample mean. His EA posttest score of 10 was recorded as equal to the norming sample mean and his ND score of 9, though indicating an increase in functioning from pretest, was below the norming sample mean. Subject RJ's posttest scores yielded a RA score of 11, and EA score of 7 and a ND score of 6. All indicated an increase in functioning but only the subject's RA score was recorded as above the norming sample mean score. IJ's data indicated an RA posttest score of 7, and EA score of 5 and a ND score of 10. Only the ND score was equal to the norming sample mean score.

Summary

The analysis of each subject's daily treatment session data indicated that the Receptive Attention subtest scores, as a measure of sustained attention, were improved for three test subjects and stayed the same for one subject (Table 2). As a measure of selective attention, the Expressive Attention subtests scores showed an improvement for all four subjects (Table 2). The Number Detection attentional subtest scores, which measure selective attention, the ability to shift attention, and resistance to distraction, only elicited a positive change in the test scores of two subjects — PJ and IJ. Subject JJ showed a decrease in Number Detection scores from pretest to posttest and RJ showed no change. The progress reports presented in Tables 3 through 6 recorded a high
degree of accuracy in the responses to training tasks and as each subject progressed, the overall average number of response attempts showed some variability but showed an increasing trend for three subjects and decreased for one subject. This indicated an increasing ability to sustain attention over time for three of the four (75%) test subjects.

The progress reports for selective attention revealed a high level of accuracy in response attempts at the selective attention training tasks. As each subject progressed, three out of the four subjects experienced an increase in the total number of response attempts. This indicated that their ability to select and attend to pertinent information also increased. Additionally, the progress appears cumulative. From the beginning of the sustained attention training intervention to the conclusion of the selective attention intervention, each subject's total number of response attempts increased. Because the stimulus provided alternated between digits and letters, a comparison of the digit versus letters response attempts was completed for sustained and selective attention and is displayed in Figures 3, 4, 6, 7, 9, 10, 12, and 13.

The results indicated that overall there were no significant differences between the number of digit versus the number of letter stimulus responses attempted. To determine the significance of the pretest/posttest comparisons of the test subjects by CAS attention subtests, three correlated sample t-tests were conducted and are presented in Tables 7 through 9 and Figures 14 through 16. Though all of the t-tests conducted recorded an improvement across the groups of subjects, only the results for Expressive Attention indicated any significance (EA - 4.020; RA - 2.183; ND - .645 compared to a critical value of 2.353, 3df).
The statistical findings of this investigation provide support for only one of the hypotheses of this study. Though the Receptive Attention subtest yielded a t-test score that indicated an increase in sustained attentional functioning, it was not significant. The t-test scores for Number Detection yielded an even smaller difference, again indicating no significance. Expressive Attention, which measured selective attention, yielded the only significant results.

The comparisons of the test subject's scores on the CAS attentional subtests and the CAS norming sample mean (mean = 10, sd = 3) revealed that all of the subjects performed near the normal range for subjects without deficits on at least one of the CAS attentional subtest measures for the group. Two of the test subject’s scores improved to exceed the mean on the Receptive Attention subtest, one subject’s scores did not improve and one subject’s scores improved but remained below the mean. Two subject’s scores increased to equal the mean on the Expressive Attention subtest and the other two subjects improved but their scores remained below the mean. Only one subject’s scores improved on the Number Detection subtest, two increased but did not equal or exceed the mean and one subject’s score decreased.

These analyses indicate that though the Receptive Attention and Number Detection subtest scores showed some slight to modest improvements in sustained attention and resistance to distraction, the attention training software for adults with acquired brain injuries and used with adolescents diagnosed with childhood attention deficit disorder only showed a significant improvement in the Expressive Attention subtest scores as a measure of selective attention. Thus, we cannot accept Hypothesis 1 for sustained...
attention: There was no significant difference between the pretest and posttest scores of subjects on the CAS attentional subtests subsequent to the presentation of the sustained attention software intervention. However, we can accept Hypothesis 1 for selective attention: There was a significant difference between the pretest and posttest scores of subjects on the CAS attentional subtests subsequent to the presentation of the selective attention software intervention.
DISCUSSION AND IMPLICATIONS

The purpose of this investigation was to explore the efficacy of training attention, specifically sustained and selective attention, using a method of cognitive rehabilitation developed for use with adults suffering acquired brain injury and modified for use with adolescents diagnosed with childhood attention deficit disorder. It was hypothesized that the scores of test subjects at the posttest administration of the attentional subtests of the Cognitive Assessment System (CAS) would show an improvement in attentional functioning as compared to their pretest scores pursuant to the training of sustained and selective attention using the Hierarchical Attention Training Plus (HATP) program. Four adolescent males with diagnosed attention deficit disorder (ADD) and being treated with psychostimulant medications were treated and tested.

Attention is a complex cognitive process that William James (1890) described as enabling us to choose the sort of a universe we will inhabit. As a cognitive process, attention is an integral part of a larger process that encompasses all of the mental processes, operations, and systems that are identified in the acquisition of knowledge (Flavell, Miller & Miller, 1993). LaBerge (1995) wrote that attention directs the process by which these brain functions can move to the center stage of the mind at any given moment.
The analysis of the literature relative to the purpose of this study presented the attributes of this complex attentional process that is a part of a larger even more complex cognitive process which, when deficits occur, produces an extremely heterogeneous population of learners. Attentional deficits can arise from a multitude of locations throughout the brain. Possible causes have included food allergies, environmental toxins, poor parenting practices, perinatal and birth injuries, and genetic defects. However, none of the possible causes that have been identified here can be said to be the single cause for ADD but have been identified as risk factors with the exception of genetic deficits. The research indicates that most ADD sufferers have a parent or first-degree relative who also has at some point been identified as an ADD sufferer, suggesting a genetic link.

The primary treatment for ADD the last four decades has been psychostimulant medications, which include: methylphenidate, dextroamphetamine, and pemoline. However, clinicians who regularly treat ADD sufferers generally recommend a multimodal treatment combining educational and behavioral interventions with medication management. These pharmacologic interventions have been effective for the majority of those so treated. However, there is a large population of ADD sufferers for whom neither of these interventions works — forty to forty-five percent, to be specific. This is the population for which this study was initiated.

Our brains have self-regulating, self-repairing, and reorganizing capabilities—plasticity. This is evidenced by the often swift rehabilitation of victims of stroke and the remediation of attentional deficits in CHI and TBI patients. The literature reviewed
indicated that attentional deficits experienced by TBI and CHI patients are among the most common cognitive dysfunctions observed in individuals following a serious acquired brain injury and are the first to be restored. Additionally, the damage incurred by patients with acquired brain injuries appears to be much more extensive than those diagnosed with childhood attention deficit disorder. While researching studies involving the rehabilitation of stroke victims, the process of cognitive rehabilitation, which uses computer software to retrain cognitive processes after stroke, was uncovered. This process is currently in frequent use and has as its goals the strengthening of serious weaknesses, training of compensatory strategies, and the improvement of practice skills. These practice skills include: attention, concentration, mental efficiency, memory, and other neuropsychological processes, that are a focus of rehabilitation in patients with brain injuries (Liberto, Tomlin, Lutz, Nash, & Shapiro, 1993).

A review of the current research literature indicated that cognitive rehabilitation is very effective in treating attentional deficits in those recovering from acquired brain injuries and is recognized by the National Institute of Mental Health (NIMH) as essential to the treatment of brain injuries. However, very few studies have used children and adolescents, and even fewer have used children diagnosed with ADD.

Computers programmed with cognitive process training software are the primary tools used in cognitive rehabilitation. They train and educate (Flick, 2000). Research also shows that ADD children, who require increased stimulation to maintain attention, derive great stimulation from working with computers because they are a constant source of amusement for them (Zentall, 1985). Children with ADD are highly stimulated by fast
moving computer programs that use a video game format to teach basic skills. Having worked with children diagnosed with ADD for several years, this researcher investigated possible educational methods for building attentional skills in children with attention processing problems and hypothesized that since this process was successful with TBI patients with the same manner of disability, that it could also be successfully used with childhood ADD sufferers.

A further review of the literature identified several approaches and models for cognitive rehabilitation. The model chosen for this investigation is based on the 1987 research of Sohlberg and Mateer, which used a theoretical approach for cognitive rehabilitation involving direct stimulation of the affected processes. Sohlberg and Mateer's model identifies five levels of attention: focused attention, selective attention, sustained attention, divided attention, and alternating attention. Hierarchies of treatment tasks specific to each of the five levels of attention were used, inclusive of computer programs, audiotapes, and timed paper and pencil exercises. For the purposes of this investigation, a single computer delivered intervention was administered to train only two levels of attention—sustained attention and selective attention.

The intervention used in this study specifically trained attentional processes using hierarchical tasks that progressed in difficulty from a lower level to a higher level, similar to hierarchical task specific exercises used by Sohlberg and Mateer (1987). This, it was postulated, would build new connections to unaffected areas of the brain, stimulating the growth of new synaptic pathways through exercises, much the way a newborn develops and extends his neural network through the experience of physical activity. It was further
hoped that this would facilitate the restoration of damaged attentional processes or expand that same neural network that facilitates newborn neural development. This study, obviously, does not attempt to assess whether or not changes in such neural processes actually take place. This study is only to determine if task specific stimulation directed at the processes governing such neural processes can result in improved attention for the test subjects.

Analysis of the data collected in this investigation provided evidence of mixed results supporting the use of cognitive rehabilitation in the form of attention process training as a treatment for attention deficit disorder in terms of specific levels of attention and the direct stimulation of cognitive areas of deficit. The findings of this investigation in relation to the hypotheses, which test the assumption that the practice of cognitive tasks using exercises specific to attentional processes will result in increased attentional functioning are discussed in this chapter.

Discussion and Implications

Effects of Intervention Within Subjects

The analysis of the individual data collected relative to the principal objectives of this study showed substantial and consistent individual gains for two of the four subjects on all three of the CAS attentional subtests, which included an Expressive Attention task, Receptive Attention task, and Number Detection task representing the processes of sustained and selective attention. Both of these subjects had strong and supportive families who encourage the student's willingness to change and making them slightly
more motivated to change than the other two students. Additionally, these two students spent large amounts of their relaxation time at home and at school playing video games on computer, generating a single-mindedness with respect to computer games and supporting a willingness to spend extended amounts of time engaged in computer activities. The remaining two of the test subjects maintained their pretest scores on Receptive Attention and Number Detection respectively. The subject who maintained his pretest score on the Receptive Attention task through posttest also exhibited a decrease on the CAS Number Detection subtest score from pretest to posttest. When the performance of these two children was viewed individually with respect to the variables under investigation in this study, the controls regarding age, level of development, age at time of diagnosis, medication used, level of intelligence, and educational classification did not appear to be a justification for their failure to show consistent gains on sustained and selective attention tasks.

Several factors may have affected the variability in the performances of these two test subjects, including their individual level of hyperactivity, which is different for each subject and difficult to control. The social dynamics of the test subjects in the form of negative peer/adult treatment staff interactions before the testing often caused problems for these two students. There were times when an altercation with a peer or staff member would keep the subjects from a treatment session and they would have to be rescheduled. Family environmental dynamics, which is seldom without turmoil for one or the other of these two students; and sparse family support as opposed to that of the more successful students might have also been a factor. Their relationship with researcher could have
caused a willingness to perform better on the part of some students as well as differences in their individual temperament. A parent of one of these two test subjects had a history of drug and alcohol abuse and incarceration was imminent, this resulted in some daily changes in the mood and affect of this student, which he had difficulty controlling. The daily treatment session data showed overall increases in the number of stimulus responses attempted and the percentage of correct responses from week one to week six, giving the appearance of an overall increase in the subject's ability to attend.

*Group Effects of Intervention*

The analysis of the group data collected relative to the principal objectives of this study indicated a significant positive difference between the pretest and posttest scores on only one of the three CAS attentional subtests pursuant to the presentation of the HATP program intervention, the Expression Attention subtest, which measured selective attention. While some improvement in sustained attention from pretest to posttest was shown, it was not significant. The presentation time for the intervention was only six weeks. Perhaps selective attention does not require the same amount of training time as sustained attention. The time needed to successfully train sustained attention may require a longer training period. Training sustained attention one whole school year might have yielded better results.

Only one of the subjects showed an improvement in his Number Detection scores, which measures a combination of sustained and selective attention. The daily treatment session data showed increases in the number of responses attempted and the number of
correct responses, giving the appearance of an increase in the subjects' ability to attend.

*Norming Sample Comparisons*

The CAS attentional subtest posttest scores of the four test subjects' were compared to the mean scores of the CAS attentional subtests, without attentional deficits, norming sample mean scores, which carried a mean of 10.0 and a standard deviation of 3.0. Two of the subjects exceeded the norming sample mean on the RA subtest measuring sustained attention. One subject made no change and the fourth subject scored within one standard deviation of the mean. On the EA subtest, two subjects scored at the mean, one subject scored within one standard deviation of the mean and the fourth subject improved but remained more than one standard deviation below the mean. Two of the four subjects improved on the Number Detection subtest. The other two subjects either made no change or decreased from pretest to posttest. None of these subjects had any known physical disabilities.

These results appear to indicate that the attention training intervention facilitated the test subjects' progress toward normal sustained and/or selective attentional functioning as compared to the mean of a norming sample of same aged children without attentional deficits. This could indicate that further study and perhaps a longer intervention period would render an experimental population even closer to normal attentional functioning.

All four of the test subjects exhibited some hyperactive behavior. However, there are degrees of hyperactivity based upon the effectiveness of the pharmacological treatment used. Two of the test subjects were excessively hyperactive. This brings up a question
regarding the effectiveness of a subject's medication or perhaps a problem with dosage. Further, if any subject was excessively distracted at the time instructions were given, this could have interfered with the subject's interpretation of the directions at test administration and affected motivation. There is also the question of whether one of the levels of attention being investigated in this study might have interfered with the assessment of the other level of attention being studied in this investigation. There are currently no instruments that measure attention specifically and the instrument used in this investigation is an assessment battery designed to evaluate overall cognitive processing. Only two of the subjects showed any improvement on the ND task, one subject significantly so. These subjects also demonstrated a pretest to posttest improvement on measures of both sustained and selective attention. Since the Number Detection task is a measure of both sustained and selective attention, it follows that perhaps only improvement by a subject in both of those levels of attention would culminate in an improvement in the performance on the Number Detection task.

This investigator's interpretation of these findings was consistent with those of other studies reviewed in that the results indicated that all of the subjects suffering acquired brain injuries exhibited some improvement at some level of attentional functioning that could be attributed to cognitive rehabilitation in the form of the computer-assisted attention process training intervention (Sohlberg & Mateer, 1987; Laatsch, 1998). Additionally, the findings in this study are also consistent with other reviewed studies regarding childhood attention deficit disordered subjects in that the results are positive for some of the subjects tested making further research promising and warranted (Sohlberg
Much of the literature reviewed earlier in this study supports the successful use of a computer-assisted cognitive rehabilitation technique with adults (Cicerone, Smith, & Elmo, 1996; Palmese & Raskin, 2000; Raichle, Fiez, & Videen, 1994; Raskin & Gordon, 1992; Sohlberg & Mateer, 1987). The current data has demonstrated the potential for the improvement of attentional deficits in adolescents with ADD using attention process training. These data further supports the general effectiveness of the theoretical concepts for the direct stimulation model of cognitive rehabilitation. Additionally, some of the studies reviewed illustrated successful results using cognitive rehabilitation techniques with younger children as well (La Rose, Gagnon, Ferlen, & Pepin, 1998; Williams, 1989). This would support further study using cognitive rehabilitation with children than 12 years.

Finally, the stimulating effects of computers typically fascinate children diagnosed with attention deficit disorder. They are, no matter the extent of their attentional disability, able to focus their attention as well as sustain that attention on information conveyed by computer. Additionally, computers are a convenient and unobtrusive part of a regular classroom environment, making them a practical and effective resource for training attentional deficits through practice.

Limitations of the Current Study

There were a number of limitations encountered in the process of implementing this investigation, which should be considered when interpreting these results and addressed.
with the replication of research in this area. First, the design of this investigation was only a simple initial step in determining whether cognitive rehabilitation could be used with a different population other than the one for which it was originally designed. However, it would not be adequate for showing the effects of such a treatment in the classroom environment with all of its distractions. Additionally, this design was unable to control for variables that might have had a much greater impact on the results of the investigation than the intervention.

ADD sufferers are an extremely heterogeneous group in that attentional processes have no particularly central location in the brain. The literature reviewed indicated that stations for information processing, which cannot process information appropriately without adequate attentional functioning, are located throughout the brain. It would be reasonable to assume that those attentional deficits, their severity, and extent would depend a great deal, upon which areas of the brain are affected. This would make it difficult to find a large enough group of ADD sufferers in any one place with characteristics similar enough to be called homogeneous. This would be problematic in accommodating a two-group comparison design due to the probability of increased error. Group designs function based upon what a group of subjects have in common and too much variability of subjects within a group can produce large error variances making the results unreliable and justifying the use of a research design that would be robust enough to accommodate a small or single subject sample size. Single subject research may be a reasonable path to follow for future research because it utilizes a comparison of the variability within individual subjects to show the effectiveness of an intervention.
Secondly, peer pressure in this population could be a motivational factor. At the stage of development for the test subjects, fitting in with same aged peers is important and involvement in any activity can be affected by positive and negative peer influences. Third, a sometimes turbulent and unsupportive home situation is a consistent issue with this population. The related issues are a daily distraction and can affect mood, motivation, and performance related to almost any task. Additionally, even though the test subjects were a pull-out group, the distractions of a classroom environment with little structure, also a daily issue in the district special school from which the subject sample was taken, were sufficiently disruptive to the subjects before pull-out that their effects might have had an uncontrolled/uncontrollable effect on the current investigation results.

The fourth problem encountered was the speed and appropriateness of the HATP because it was designed for adult subjects who are considerably lower functioning than the ADD test subjects. After seeing the frustrations of the test subjects on the first day of testing because of the slowness of the HATP program, the investigator lowered the response time allotment from 2-seconds to 1-second to accommodate the test subjects’ ability to respond more quickly than the typical user. Further, the investigator consulted with the designers of the program who e-mailed changes for the program the first day. The changes were promptly downloaded, added to the program, and implemented immediately before the following day’s sessions began, making it more appropriate to the ADD population being trained. These changes included speeding up the auditory stimulus voice commands and adjusting the voice vocabulary so that fewer words were used in the prompt. All of the subjects were similarly affected. However, this could have
positively influenced the results in that motivation could have been affected for that day because of the lowering of frustrations.

Additionally, an important measure of student performance had to be deleted from this study. The computer program was designed to collect reaction time data for each item and calculate an average score for each session. A glitch was found in that part of the computer software program that generated the progress report for each subject. That data proved unreliable and could not be used as a measure of daily performance as originally planned. The researcher was forced to calculate the percentage of correct responses based upon the information that was given. This had no effect on the test subjects or the results. In the next phase of research in this area, an attempt should be made to find or design a computer program, which takes into account the speed with which ADD subjects process information, making it more suitable to their specific needs.

The measuring instrument used in this study was not designed to measure attentional functioning specifically. It was designed to assess intellectual functioning as a product of overall cognitive ability. There is currently no paper and pencil test designed to measure attention directly. What has been shown to be valid and reliable assessment tools are expensive neuropsychological tests such as MRI's, CAT Scans, and PET Scans (Flick, 2000). Most of the tests that are used to measure attention are rating scales that involve indirect measurement of emotional status or the direct measurement of behavior. Such instruments include the Attention Deficit Disorders Evaluating Scale (McCarney, 1989), the ADD-H Comprehensive Teacher’s Rating Scale (Ullman, Sleator, & Sprague, 1991), Attention Deficit/Hyperactivity Disorder Test (Gilliam, 1995).
The Children’s Attention and Adjustment Survey (Lambert, Hartsough, & Sandoval, 1990), and the Connors Rating Scales (Connors, 1997). These tests rely on the second-hand information and the observations of others, which include the teacher, the parent, a minister, a principal or anyone who is part of that child’s system. This information may not be as accurate as one would like because of its subjectivity. A direct measure of attention would be a more objective measure. The attentional subtests of the CAS battery of tests is designed to determine the competence of an individual and levels of overall cognitive functioning, to inform about cognitive strengths and weaknesses, processing abilities as compared to peers, achievement, and implications for the individual. Though not a direct measure of attention, the attention scales of the CAS evaluate how well the individual is able to process information through the determination of an individual’s ability to selectively attend, detect relevant stimuli among irrelevant ones, and resist distracters (Das & Naglieri, 1997).

A further limitation of this investigation was the fact that the investigator, attempting to avoid practice effects with the measuring instrument, only administered the subtest used to measure sustained attention after the sustained attention-training task and only used the subtests that measured selective attention after the selective attention-training task. This brings up the possibility of an interaction or cumulative affect that was not intended, between the intervention used to train sustained attention and the intervention used to train selective attention. Though the results of the sustained and selective attention-training tasks indicated that all subjects experienced some improvement, there is no way of telling whether selective attention was improved because of the selective
attention-training task or the combination of both training tasks. A complete
administration of the CAS attentional subtests in the middle phase of treatment and in the
final stage might have given more of an indication that it was the selective intervention,
which caused the changes in the subjects’ selective attention.

A final issue that should be addressed concerns the familiarity of the researcher with
the subjects used in the investigation and the possibility of a “white coat effect”. The
investigator’s position at the school where all of the subjects attend is one where building
a trusting relationship, advocating for student needs with other educators and with
parents, and direct counseling in crisis situations is part of the job. Wanting to please the
investigator might have been an issue. To avoid this, the research might have been
conducted by an outside, dispassionate and objective experimenter unknown to the
subjects.

Suggestions for Future Research

The first suggestion for future research would be to determine if after 6-months, the
demonstrated levels of attention remain at their post intervention levels. Next, because
the complex issues surrounding attentional process are difficult and slow to change,
进一步研究应涉及干预期的延长。这将
开始于实施干预整个学年，测量其
有效性在学年末，然后在学年开始时
重新评估，以确定是否保持变化。
Further, research with a younger population would also be beneficial. To date, even research with brain-injured patients does not document many studies with children. A controlled study with a large population of attention disordered children diagnosed using a separate control group, neurophysiological testing, with and without medication, in a classroom environment might produce a clearer picture of the attentional process, how it functions, and how deficits can be improved.

Much of the research conducted in education has, unfortunately, very limited practical application for the classroom. Many of the research issues in education are not issues that are conducive to a laboratory-testing environment separate from the classroom environment. Although the current investigation was not conducted in a regular classroom environment, there were several conclusions that can be derived from this study that may have very practical implications for those who are directly involved with educating children with ADD. First, this research study shows that attention process training using computers is viable and can be an effective intervention for improving attentional deficits in ADD children. The use of computers in the classroom has become an indispensable part of the teacher’s direct instruction program. Additionally, exercises that practice skills are a necessary component of direct instruction and allows for the student’s gradual fading from teacher directed activities toward independent work. Adding inexpensive software that is easy to use in the classroom; that can be used as a reward for appropriate behavior; and can be used as a method of teaching new skills and supporting old skills in a very difficult population would be a welcomed resource for any classroom. Further, this software could support the same skills at home as well, allowing
the ADD student to spend even more time practicing and exercising attention, thereby reinforcing the same skills taught at school. While it is important to be able to deliver the intervention in the classroom, an additional area for research is to study whether the training makes a practical difference in the student’s attention during instruction.

In summary, the results of this study were mixed regarding the improvements in the sustained and selective attention of subjects exposed to a computer-assisted, task specific, attention-training program as measured by the Cognitive Assessment System Attentional Subtests. Though only the selective attention results yielded significant posttest scores as compared to the pretest scores, individually, all of the subjects showed some improvement at some level of sustained or selective attention at posttest as compared to the pretest on the attentional subtests. This intervention has, for the most part, only been used with adults. These data indicate that this intervention can also be used effectively with adolescents. Further, it is logical to assume that, with some modifications for age and developmental stage, it could probably work with younger children as well.

The current study does have some limitations, but the clinical implications of this investigation are that therapy directed toward remediation of the underlying information processing deficits in attention with this population holds promise. As the body of knowledge grows in this area and the scientific research involving the human genome project and the mapping of our genes progresses, there may come a time in the near future when scientists will learn how to prevent or at least to more effectively treat those with ADD. However, until that time comes we will need to find an effective method of treating more members of this population.
APPENDIX A

PERMISSION FORMS AND LETTERS TO PARTICIPANTS
I, ______________________, as the principal of Miley Achievement Center,
Clark County School District, have received an explanation of the procedures and
methods to be used in the research study, Cognitive Rehabilitative Software: A Method
of Remediating Sustained and Selective Attention in Children with Attention Deficits. It
is an important and worthwhile endeavor and I consent to Mrs. Bullock, the investigator,
conducting her research at Miley Achievement Center. As an employee of Clark County
School District, Mrs. Bullock is bound by the rules of confidentiality subscribed to by all
Clark County School District employees.

Signature of Principal ______________________ Date ______________________

Signature of Investigator ______________________ Date ______________________
INFORMED CONSENT FOR PARTICIPATION IN A RESEARCH PROJECT INVOLVING HUMAN SUBJECTS

PARENT CONSENT FORM

University of Nevada, Las Vegas
Department of Special Education
4505 S. Maryland Parkway
Box 543014
Las Vegas, Nevada 89154

Dear Parent/Guardian of __________________________,

My name is Glinda Bullock. I am the Clinical Social Worker assigned to Miley Achievement Center and a Doctoral candidate in Special Education at the University of Nevada, Las Vegas (UNLV). This is my final year and as a research project, I will be studying the effects of training attention on male middle-school students identified as having Attention Deficit Disorder using an attention training computer program. The training tool to be used is a computer program constructed like a video game.

The entire project will last for only eight (8) weeks. During those eight weeks, the students will be tested three times and trained on the computer three days each week for 30-minutes each day. The training will be supervised and fun for the students.

The risk to your child is minimal and if this program performs as expected, many children like your son will be helped by making improvements in their ability to pay attention, resulting in better school performance.

All information collected will be confidential and no names will be used. Information will be maintained in a locked cabinet at an undisclosed location for three years and will then be destroyed. Participation is strictly voluntary and if at any time you decide or your son decides that you no longer wish to participate, he will be released from the study.

Dr. Beatrice Babbitt, PhD., is supervising me in this research; she can be contacted at 895-1106. I can be contacted at Miley Achievement Center, 799-5631 or at 647-5665, if you have further questions. If you have questions about the rights of research subjects, please contact the UNLV Office for the Protection of Research Subjects at 895-2794. I humbly ask that you allow your child to participate. By signing below, you are acknowledging receipt of the information regarding this study and agree to permit your child, __________________________ to participate. You will be given a copy of this form to keep.

Sincerely,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Glinda R. Bullock, LCSW
Special Education Doctoral Candidate

Signature of Parent/Guardian ___________________________ Date ____________
I am Glinda Bullock, a student at the University of Nevada, Las Vegas (UNLV). I am doing a research project with students who have attention deficits. As part of the project, you will be asked to take three tests and complete some special work on the computer to help improve your attention. I hope that by being a part of this project you, and other students like you, will be helped.

I have sent a letter home to your parents telling them about the project and asking them if you can participate. Feel free to discuss it with them. The activities in which you will participate will be fun. Participation is voluntary and if at any time you decide not to participate in the project you will be excused.

I will be happy to answer any and all questions you may have regarding the project. Please sign below if agree to participate.

Sincerely,

Glinda Bullock

Student Signature ___________________________ Date ________________
DATE: April 24, 2001

TO: Glinda Bullock
Special Education
M/S 3014

FROM: Dr. Fred Preston, Chair
UNLV Social/Behavioral Sciences Institutional Review Board

RE: Status of Human Subject Protocol Entitled:
"Cognitive Rehabilitative Software: A Method of Remediating Sustained and
Selective Attention in Children with Attentional Deficits"

OPRS# 3050401-005

This memorandum is official notification that the UNLV Social/Behavioral Sciences Institutional
Review Board approved the protocol for the project listed above and work on the project may
proceed. This approval is effective from the date of this notification and will continue through
April 19, 2002, a period of one year from the initial review.

Should the use of human subjects described in this protocol continue beyond a one-year period, it
will be necessary to request an extension.

If you have any questions or require any assistance, please contact the Office for the Protection of
Research Subjects at 895-2794.

cc: OPRS file
April 26, 2001

Glinda Bullock
2055 Cardigan Ave
North Las Vegas, NV 89032

Dear Ms. Bullock,

Members of the Center for Educational Research and Planning (CERP) have met and approved your research proposal. It meets the criteria established by the College of Education for ethical research. The proposal also should be forwarded to the UNLV IRB committee for their approval, if you have not done so already. The IRB will make a separate decision from CERP, then contact you regarding the status of your proposal. A copy of the CERP letter of approval should be forwarded to the Clark County School District as well.

If you have any questions, please contact me at your convenience, or contact Tina Wininger at the UNLV Institutional Review Board (895-2794).

Sincerely,

Gregory Schraw, Ph.D.
Acting Director of CERP
Department of Educational Psychology
235 Carlson Education Building
UNLV
89154-3003
(702)895-2606

cc: Beatrice Babbitt
May 23, 2001

Glinda Bullock
2055 Cardigan Ave.
North Las Vegas, NV 89032

Dear Glinda:

The Clark County School District’s Committee to Review Cooperative Research Requests has reviewed your proposal entitled “Cognitive Rehabilitative Software: A Method of Remediating Sustained and Selective Attention in Children with Attention Deficits.” I am pleased to inform you that the committee approved your proposal, with the proviso that you obtain the consent of the principal at the school you wish to use in your study.

Thank you for inviting the Clark County School District to participate in your research, and good luck on your project.

Sincerely,

Judith S. Costa, Ed. D.
Chairman
Committee to Review Cooperative Research Requests

cc: Beatrice Babbitt, Kevin Crehan, Bill Hoffman, Craig Kadlub, Lauren Kubat-Rust, Connie Kraiky, Charles Rasmussen, Michael Robison
APPENDIX B

TEST MATERIAL
<table>
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<tr>
<th>Subtest</th>
<th>Variables Assessed</th>
<th>Conversion #1</th>
<th>Conversion #2</th>
<th>Conversion #3</th>
<th>Conversion #4</th>
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</thead>
<tbody>
<tr>
<td>Expressive</td>
<td>Selective Attention</td>
<td>Ratio/Raw Score - Ratio Conversion Table (Ratio Of Time to Complete Item and Number Correct)</td>
<td>Raw Score to Scaled Score (Scaled Score Equivalents Of Raw Scores Table)</td>
<td>Obtain Raw Ratio - Ratio Conversion Table (Ratio of Time to Complete Item and Accuracy Score)</td>
<td>Raw Scores to Scaled Scores by Age and Subtest (Scaled Score Equivalents of Raw Scores Table)</td>
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<td>Attention Shifting</td>
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<td>Receptive</td>
<td>Sustained Attention</td>
<td>Obtain Accuracy Score (Using Scoring Template) Subtract Number Correct from Number Incorrect</td>
<td>Obtain Raw Score by Summing Ratio Scores of Items</td>
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</tr>
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<td>Effort Over Time</td>
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<td>Number Detection</td>
<td>Selective Attention</td>
<td>Obtain Accuracy Score (Using Scoring Template) Subtract Number Correct from Number Incorrect</td>
<td>Obtain Raw Score by Summing Ratio Scores of Items</td>
<td>Raw Scores to Scaled Scores by Age and Subtest (Scaled Score Equivalents of Raw Scores Table)</td>
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<td>Attention Shifting</td>
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<td>Attention</td>
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</table>
# Expressive Attention

**Materials**  
Administration and Scoring Manual, pages 51-58  
Stimulus Book, pages 241-253 (ages 5-7) or 255-265 (ages 8-17)  
Stopwatch

**Administer**  
Ages 5-7: Demonstration, Samples A-C, Items 1-3  
Ages 8-17: Samples D-F, Items 4-6

**Time Limit**  
180 seconds per item

**Record**  
Time in seconds  
Number correct

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<tr>
<th>Item</th>
<th>Time Limit</th>
<th>Time in seconds</th>
<th>Accuracy Score (Number Correct)</th>
<th>Ratio Score (see pp. 14-16)</th>
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<tr>
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<tr>
<td>Demo</td>
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<td>3.</td>
<td>180&quot;(5:00)</td>
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<td>Sample B</td>
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<td><strong>8-17 Years</strong></td>
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Demonstration

Sample A

Item 1

Sample B

Item 2

Sample C

Item 3

Sample D

Item 4

Sample E

Item 5

Sample F

Item 6

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## Receptive Attention

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</table>
Number Detection

Find the numbers that look like this: 1 2 3

<p>| | | | | | |</p>
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Find the numbers that look like this: 1 2 3

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</table>
Find the numbers that look like this: 1 2 3 4 5 6

\[
\begin{array}{cccccc}
4 & 2 & 2 & 5 & 3 & 6 \\
1 & 4 & 3 & 5 & 4 & 1 \\
\end{array}
\]
Find the numbers that look like this: 1 2 3 4 5 6

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Accuracy Score: Number Correct (MN, PCd, EA) or Number Correct Minus False Detections (ND, RA)
## Ratio Score Conversion Table (continued)

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<tr>
<th>TIME [seconds]</th>
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APPENDIX C

USING THE HIERARCHICAL ATTENTION TRAINING PLUS PROGRAM
## The Program Screen

Following is a description of the objects on the opening screen as displayed in Figure 1.

<table>
<thead>
<tr>
<th>Object</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go Button</td>
<td>This button is Clicked to start a lesson. It will then disappear from view.</td>
</tr>
<tr>
<td>Instruction Bar</td>
<td>This is the bar below the Go Button. The instruction bar displays the task required of the client.</td>
</tr>
<tr>
<td>Stimulus Button</td>
<td>This is the square box in the middle of the screen. Stimuli are displayed on the face of this button. If the stimulus displayed matches the one mentioned in the instructions, click this button (Enter).</td>
</tr>
<tr>
<td>Touch Bar</td>
<td>This is the large bar at the bottom of the screen. This bar is clicked (Enter) to move to the next problem.</td>
</tr>
<tr>
<td>Problem Box</td>
<td>This box, in the lower left corner, displays the number of items attempted.</td>
</tr>
<tr>
<td>Timer Box</td>
<td>This box displays the time required to respond.</td>
</tr>
</tbody>
</table>
Using the Program

Click the Start button to initiate a lesson.

You will see a screen similar to the following:

![Treatment Screen](image)

Figure 6. Treatment Screen.

Following is a description of the objects that appear in this view:

**Go Button**: This button is clicked to start a lesson. It will then disappear from view.

**Instruction Bar**: This is the bar below the Go Button. The instruction bar displays the task required of the client.

**Stimulus Button**: This is the square box in the middle of the screen. Stimuli are displayed on the face of this button. If the stimulus displayed matches the one mentioned in the instructions, click this button (Enter).

**Large Button**: This is the large bar at the bottom of the screen. This bar is clicked (Enter) to move to the next problem.

**Problem Box**: This box, in the lower left corner, displays the number of items attempted.

**Timer Box**: This box displays the time required to respond.
Focused Attention

In the first example we used the Lesson Design window to set: written cues, a 2 second wait time, no required memory, *focused attention*, and single digits.

The opening screen for this lesson looks like the one in Figure 7.

*Figure 7. The opening screen for Focused Attention.*

This screen is similar to the one you will see after pressing the Go Button.

- The instruction appears in the instruction bar.
- Click the Touch Bar (Enter) to start the lesson. You will then see a screen similar to the one in Figure 8.
Figure 8. The Focused attention screen showing stimulus presentation:

- If the single digit displayed in the Stimulus Box matches the instruction displayed on the Instruction Bar Click the Stimulus Box (Enter). Otherwise, wait.
- Responses are appropriately reinforced and the program continues until it is stopped by clicking End Lesson in the File Menu.
Selective Attention

The second example is for Selective Attention. Use the setup menu to configure for Selective Attention. In this example, we selected: written cues, a wait time of 2 seconds, no required memory, *selective attention*, and single letters from the Lesson Design Window.

The opening screen for this lesson looks like the one in Figure 9.

![Figure 9. The opening screen for a selective attention exercise.](image)

- The instruction appears on the instruction bar.
- Click the Touch Bar (Enter) to start the lesson. You will then see a screen similar to the one displayed in Figure 10.
Figure 10. The program screen for a sample selective attention lesson.

Notice that this lesson is the same as focused attention except that a distracting red square annoyingly moves around the screen. To be successful, the user must ignore the red square and focus on the task at hand.

- Click the Stimulus Button (Enter) if the letter displayed is the one listed in the instruction bar. Otherwise wait.
- Responses are reinforced and the program ends when the user closes the lesson by selecting End Lesson from the File Menu.
REFERENCES


Connors, C. (1980). *Continuous Performance Test Program*. Washington, DC: Laboratory of Behavioral Medicine, Department of Psychiatry, and Children's Hospital National Medical Center.


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Dissertation Examination Committee:
Chairperson, Dr. Beatrice Babbitt, Ph. D.
Committee Member, Dr. Nasim Dil, Ph. D.
Committee Member, Dr. Susan Miller, Ph. D.
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