The Use of Auditory and Visual Stimulation for the Treatment of Attention Deficit Hyperactivity Disorder in Children

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Abstract

The study evaluated the effectiveness of standard treatment for ADHD (Ritalin & Adderall) and the efficacy of the combination of medication and AVS treatment. The study of 99 children all had the diagnosis of ADHD. There were four separate groups that were compared: AVS group, AVS/Stimulant medication Group, Stimulant Medication Group, and Self-selected Comparison Group. Cognitive functioning levels were evaluated by IQ tests on the Wide Range Achievement Test (WRAT-R), Peabody Picture Vocabulary Test (PPVT), and Raven Progressive Matrices (Raven's) . Behavioral changes were noted by the use of Attention Deficit Disorder Evaluation Scale and the Intermediate Visual and Auditory Continuous Test. The study evaluated the effectiveness of standard treatment for ADHD (Ritalin & Adderall) and the efficacy of the combination of medication and AVS treatment. Both the AVS and AVS/Stimulant medication group indicated significant statistical cognitive and behavioral changes at $p < .05$, $p < .01$, and $p < .001$ level. The stimulant medication group showed less change when compared to the AVS and AVS/Stimulant groups. The self-selected comparison group indicated no change on cognitive or behavioral dependent measurements. Further study is indicated to explore and replicate the findings in this study. The clinical applications for social workers who are in a school setting, a research environment, or in private practice can possible have another intervention tool available to use.

Chapter 1

Introduction

The purpose of this study is to evaluate the effectiveness of a non-pharmacological treatment for individuals who suffer from Attention Deficit Hyperactivity Disorder. This evaluation will be conducted by means of comparing outcomes of four groups of subjects: the first group having been treated by a non-pharmacologic methods, the second group having been treated by a non-pharmacologic plus pharmacologic means, the third group having been treated by pharmacological means, and the fourth group with no treatment serving as a self-selected comparison group. The study will evaluate effectiveness by changes in IQ scores and behavioral rating scales. Past research has documented that individuals who suffer from attention deficit hyperactivity disorder (ADHD) have cognitive and behavioral deficits in three specific areas: (a) attention span, (b) hyperactivity, and (c) impulsivity (Barkley, 1990). The deficits are usually evident in lower scores on standardized IQ tests, poor school performance, and behavioral problems at school and home. Thus, the significance of the effects of ADHD is well established. However, throughout this century, the causes of and appropriate treatment for this disorder have undergone changes that are important to review. The evolution of society = s (both lay and scientific) understanding of causes, effects, and treatment of the ADHD individual underscores the rationale behind the choice of treatment protocols comparatively examined by this research study. For this reason, we will first review the historical development of the disorder known as ADHD.

Background and History of Attention Deficit Hyperactivity Disorder

To date, the treatment of ADHD has developed from characterizing the individual as morally weak to a more practical and less moralistic approach in dealing with the disorder. The two main treatment protocols have been a behavioral approach and a pharmacological approach (Barkley, 1990). The concept of altering the fundamental etiological factors or Acuring@ ADHD has not generated a great deal of research (Barkley, 1990; Swanson & Kinsbourne, 1978). The vast majority of past and current research has focused on symptom reduction techniques for the ADHD population (Barkley, 1990; Barkley, DuPaul, & McMury, 1990).

Prevalence of Learning Disabilities in the United States

Researchers have estimated that the prevalence of learning disabilities ranges from 1 to 30% of all school age children. In 1976-1977, shortly after the passage of Public Law 94-142 in 1975, the U.S. Department of Education = s Thirteenth Annual Report to Congress reported 797,212 students with a learning disability (Lerner, Lowenthal, & Lerner, 1995). In 1990, Public Law 101-476 (IDEA) was enacted and the U.S. Department of Education reported 2,064,892 students with a learning disability. The rapid and overwhelming increase in the number of students with learning disabilities between 1975 and 1990 can be attributed to the improved awareness of learning disabilities, improvements in diagnostic procedures, improvements in assessing learning disabilities, widening the age groups of learning

disabilities, and social acceptance and perception of learning disabilities (Lerner, Lowenthal, & Lerner, 1995).

Attention deficit hyperactivity disorder in the context of other learning disabilities

As noted in the research literature, many similarities exist among different learning disabilities. Common characteristics include inappropriate social behavior, mathematical difficulties, poor motor skills, perceptual and information processing problems, oral language difficulties, and problems with distractibility and/or poor concentration levels (Barkley, 1990; Barkley, DuPaul, & McMury, 1990; Lerner, Lowenthal, & Lerner, 1995; Waldon, 1995; Lubar, 1998; Biederman, Faraone, Spencer, Wilens, Norman, Lapey, Mick, Lehman, & Doyle, 1993). Attention Deficit Hyperactivity Disorder is distinguished from other learning disabilities as denoted by the following definition taken directly from the American Psychiatric Association = s 1994 *Diagnostic and Statistical Manual of Mental Disorders, 4 edition* (DSM-IV):

A. Either (1) or (2):

(1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Inattention

(a) often fails to give close attention to details or makes careless mistakes in school work, work, or other activities

(b) often has difficulty sustaining attention in tasks or other activities

(c) often does not seem to listen when spoken to directly

(d) often does not follow through on instructions and fails to finish school work, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)

(e) often has difficulty organizing tasks and activities

(f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)

(g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)

(h) is often easily distracted by extraneous stimuli

(i) is often forgetful in daily activities

(2) six or more of the following symptoms of hyperactivity-impulsivity which have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity

(a) often fidgets with hands or feet or squirms in seat

(b) often leaves seat in the classroom or in other situations in which remaining seated is expected

(c) often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)

(d) often has difficulty playing or engaging in leisure activities quietly

(e) is often Aon the go@ or often acts as if Adriven by a motor@

(f) often talks excessively

Impulsivity

(g) often blurts out answers before questions have been completed

(h) often has difficulty awaiting turn

(i) often interrupts or intrudes on others (e.g., butts into conversations or games)

B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before 7 years.

C. Some impairment from the symptoms is present in two or more settings (e.g., at school, work, and at home).

D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another developmental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).

Current research on ADHD has estimated that between 25 and 40% of all learning disabled children have an ADHD diagnosis (Barkley, 1990; Barkley, DuPaul, & McMury, 1990; Lerner, Lowenthal, & Lerner, 1995; Waldon, 1995). The DSM-IV states that 3% to 5% of the school age population have ADHD. Additionally, the DSM-IV and others report that ADHD is more predominant in males (one out of four) than in

females (one out of nine). Children with ADHD score 7 to 15 points, on average, below their counterparts on standardized intelligence tests (Barkley, 1991). Many of the children display associated features of ADHD that include low self-esteem, depressed moods, negative perception of life, and a greater exaggeration of mood lability (Barkley, DuPaul, & McMury, 1990; Biederman, Faraone, Keenan, Benjamin, Krifcher, Moore, Sprich-Buckminster, Ugaglia, Jellinek, Steingard, Spencer, Norman, Kolodny, Kraus, Perrin, Keller, & Tsuang, 1992; Biederman, et al., 1993). Additionally, Barkley (1991) reports that 40% of all children and approximately 60% of all adolescents can have a dual diagnosis of oppositional defiant disorder or conduct disorder as described in the DSM-IV. Barkley (1990) also states that more than 50% of all children who have ADHD have trouble with their peers and most display poor or inappropriate social skills.

As children with ADHD mature, they are more prone to antisocial behavior than non-ADHD children (Barkley, 1990; Barkley, DuPaul, & McMury (1990); Lerner, Lowenthal, & Lerner, (1995); Waldon, (1995). Barkley, DuPaul, & McMury, (1990) also reported that ADHD children are three times more likely to have oppositional defiant behavior and four times more likely to exhibit conduct disorder behavior when compared with their non-ADHD peer group. Hart, Lahey, Loeber, Applegate, & Frick (1995) reported in a four-year longitudinal study that those individuals who were diagnosed with ADHD as children tend to outgrow the hyperactivity component of the disorder. However, the poor attention span or inattention symptoms did not decline over time as they aged. Claude and Firestone (1995) completed a twelve-year follow-up study of ADHD children/adolescents and they concluded that individuals who have

ADHD symptoms in childhood and adolescence have a greater propensity to have adult psychiatric disorders. Goldstein (1997) concluded that 80% of all ADHD children and adolescents will enter into adulthood with deficits in attention span, hyperactivity, and/or problems with impulsivity. Although some children and adolescents show a marked decrease in problematic behavior, most enter adulthood with inattentiveness and disorganization as the residual symptoms (Barkley, 1990; Barkley, DuPaul & McMury, 1990; Biederman, et al., 1993; Lerner, Lowenthal, & Lerner, 1995). The combination of life experiences coupled with residual problematic behavior increases the likelihood of life problems that society and the adult ADHD will face (Barkley, 1990; Lerner, Lowenthal, & Lerner, 1995; Goldstein, 1997). The high concurrent rate of depression, antisocial behavior, substance abuse, and anxiety in the adult ADHD population is unparalleled in any other psychiatric disorder (Hodes, 1989; Barkley, 1990; Barkley, DuPaul, & McMury, 1990; Biederman, et al., 1993; Lerner, Lowenthal, & Lerner, 1995; Goldstein, 1997). Additionally, the United States Government in the Social Security Act (42 USC) recognizes ADHD as a lifelong problem and denotes, in Titles II and XVI, that disability payments are allowed to ADHD individuals (Goldstein, 1997). In the court case of Aviles v. Brown, the court decided that ADHD was considered a non-psychotic disorder (Goldstein, 1997). One can easily see that for ADHD individuals, not finishing high school (higher dropout rates), poor social skills, lower self-esteem, and a greater need for mental health services for themselves and for their families could be the beginning of lifelong problems (Barkley, 1990; Barkley, DuPaul, & McMury, 1990; Lerner, Lowenthal, & Lerner, 1995; Goldstein, 1997).

Historical development of the etiology of attention deficit hyperactivity disorder

Since the turn of the century, learning disabilities in children have gone through a theoretical evolution (see appendix A). Prior to the 1900s, few published papers focused on the problems of ADHD. The few that were printed dealt with medical aspects of ADHD and their relation to problems with the central nervous system. In 1902, G.F. Still, an English physician, began to hypothesize the first major theory in learning disabilities among children (1902). Still = s series of presentations to the Royal College of Physicians focused on the Ainhibitory volition, lawlessness, spitefulness, and cruelty@ of 20 pediatric patients in his clinical practice (Barkley, 1990, p.8). Still = s diagnostic procedure also noted that many of the children reported accidental injuries, a family history of alcoholism, criminality, affective disorders, depression, and high suicidal tendencies (Barkley, 1990). Still (1902) also described the comorbid diagnosis of Tourette = s Syndrome in some of the children. Still continued his research on one particular learning disability and, in his 1902 publication, he labeled as abnormal defects in control what the scientific and lay individual now identify as ADHD. He described common characteristics of such individuals as being mischievous, destructive, and morally weak (1902). Still formulated his theories from a 1890 publication by William James that described the disorder as biologically based, with the main culprit being an underlying neurological deficiency of the central nervous system.

However, in 1917-1918, after a severe influenza epidemic in the United States, physicians began to notice that pediatric and adolescent survivors of this viral epidemic suffered a decrease in attentiveness and an increase in antisocial behavior and impulsive behavior (Hohman, 1922). The group of children and adolescents who had exhibited

this impulsive behavior had not only contracted the influenza virus but their condition was further complicated by a form of viral encephalitis that attacks the brain and the central nervous system (Stryker, 1973). This group of children and adolescents also displayed an inability to remain still while performing different tasks and were labeled Ahyperactive@ (Hohman). Additional symptomology included oppositional defiant behavior, conduct problems, and generally delinquent behavior. In today = s DSM IV nomenclature, this group of individuals would likely have a dual diagnosis of oppositional defiant disorder and/or conduct disorder. At that time, however, their behavior was labeled Postencephalitic Behavior Disorder (Hohman). Due to the number of affected children and the severity of the problem, many children were forced to seek help and living arrangements outside of their home environment. These conditions contributed to the application of increased supervision and behavioral modification. It is important to note that both the scientific and lay communities appeared to notice that under these altered conditions, the behavior of many of the children and adolescents significantly improved (Barkley, 1990). This change from a pessimistic to a more optimistic prognosis directed the first major shift in the etiology and treatment of this disorder and seems to have spawned an increase in related research in the years that followed. Further, the social theory that had applied moral weakness to the affected individuals was challenged and the etiology of ADHD as a neurologically based disorder was begun (Kennedy, 1924).

As research continued in the 1930s, a great debate was initiated regarding the true causes of ADHD. In this period of philosophical development, the ADHD individual was labeled as having by the following: having a minimal brain dysfunction,

being mentally retarded, and/or having genetically based deficits (Bradley, 1937). Considerable research focused on the pathologies of the brain as well as how outside influences could affect the cognitive functioning of the individual. Shirley (1939) noted that children who experienced a traumatic birth or who were significantly premature exhibited many of the same characteristics noted in early research on ADHD. Other researchers attributed head injuries (Blau, 1936; Werner & Strauss, 1941; Werner & Lehtinen, 1947), epilepsy (Levin, 1938), and lead toxicities in children (Byers & Lord, 1943) as being the significant contributors to a damaged brain. Most of the researchers = subjects had related symptomatology including impaired attention span, poor regulation of activity, and poor impulse control.

In 1937, Bradley, a physician, decided to treat the ADHD problems with a pharmacological approach. Bradley administered to his ADHD patients the stimulant amphetamine sulfate, the use of which helped to change their brain wave characteristics (Bradley, 1937). Bradley reported that the amphetamines reduced oppositional behavior, improved academic functioning, and reduced the negative occurrence of disruptive behavior in more than 50% percent of the hospitalized children whom he treated. However, while with some children, Bradley achieved remarkable results, the degree of improvement (and amount of medication) varied significantly for each child and case (Bradley, 1937). Nevertheless, his research continued to indicate that the underlying cause of ADHD was neurological dysfunction and that effective treatment involved changing the EEG characteristics of the individual.

In 1938, Jasper, Solomon, and Bradley, well-known neurologists of their time, concluded in their studies that children who displayed ADHD had a slowing in their

electroencephalograph (EEG) waves when performing mental tasks. In 1947, Strauss and Lehtinen diagnosed their subjects, all of who had displayed ADHD symptomatology, as having Aminimal brain damage.@ At the time, many of the children and adolescents suffering from ADHD were hospitalized in psychiatric facilities, most having had a previous history of brain trauma, some type of infection to the brain, and/or pre/perinatal trauma (Barkley, 1990). Later in the 1950s and 1960s this label was changed to Aminimal brain dysfunction@ (Barkley, 1990). In 1953, Knott, Platt, Ashby, and Gottleib further postulated that the EEG characteristics of ADHD children were generally slower than their non-ADHD counterparts. Laufer, Denhoff, and Solomons, in 1957, proposed that children with ADHD were having Hyperkinetic impulse disorder.@

Significantly advancing the study of the disorder toward its present day position, Stella Chess published an article in 1960 that focused on the behavior (hyperactivity) of the disorder and on the concept of a dysfunctional brain. Chess = 1960 article is historically significant because a) it emphasized that focus of the disorder should most accurately be on the activity of the individual; b) it proposed objectivity as a measure of the disorder rather than the subjectivity of previous research; c) it shifted the blame of the disorder away from the child and parents; and d) it delineated the difference between the syndrome of hyperactivity and the brain damage syndrome.

Chess is also credited with establishing the connection between ADHD and impulsive aggressive behavior, and she also postulated that ADHD individuals are more prone to mental illnesses, such as schizophrenia, mental retardation, and organic brain disorders. Chess proposed a treatment approach that is still in use today. She believed

that a multi-modality treatment is the best way to address the ADHD individual. This approach included behavioral modification programs, psychotherapy, medication, and special education for the child at school. This period between 1960 and 1969 was so important to the development of modern treatment of ADHD that it has been named the "Golden Age of Hyperactivity" (Barkley, p.9, 1990).

By the 1970s, more than 2,000 publications and numerous clinical and scientific books were written on the subject of ADHD in children and adolescents (Barkley, 1990). In this decade, numerous text books were published with the sole purpose of educating, training, and assisting health professionals to more adequately deal with ADHD individuals (Barkley, 1990). The inclusion criteria for ADHD expanded to include not only the domain of hyperactivity, but also impulsivity, poor attention span, aggressiveness, distractibility, frustration levels, parent-child conflict, and other cognitive impairments (Barkley, 1990). One of the leading research institutions in this period was McGill University whose research team was headed by Virginia Douglas (Douglas & Peters, 1979; Douglas, 1980a, 1980b, & 1983). Douglas proposed four major deficit areas of ADHD in her research: A(1) deficits in the investment, organization, and maintenance of attention and effort; (2) inability to inhibit impulsive responding; (3) inability to modulate arousal levels to meet situational demands; and (4) an unusually strong inclination to seek immediate reinforcement@ (Barkley, 1990, p.14). Douglas and her colleagues so influenced the medical field that her research is one of the contributing factors that prompted the renaming of the disorder to Attention Deficit Disorder in the Diagnostic and Statistical Manual (DSM III) in 1980 (American Psychiatric Association, 1980).

During the 1980s, the expansion of research, textbooks, and diagnostic tools related to ADHD continued to increase at a dramatic rate. The American Psychiatric Association in its DSM-III reconceptualized the Hyperkinetic Reaction of Childhood to the more commonly used label of Attention Deficit Disorder (ADD). The new criteria for diagnosing ADHD included a greater emphasis on poor attention span and impulsivity (Barkley, 1990). In the DSM-III criteria, subtyping included ADD with Hyperactivity and ADD without hyperactivity. In 1987, the DSM-III was revised and ADD was renamed to ADHD. Additionally, ADHD was now under behavioral disorders (Oppositional Defiant Disorder and Conduct Disorder) which is a subcategory of Disruptive Behavioral Disorders (DSM-III).

The 1980s also demonstrated important advances in research results. Family aggregation studies revealed that ADHD individuals also had family members who displayed other psychiatric disturbances (Barkley, 1990). Other advances in research focused on the etiological factors of ADHD. Significant research included cerebral blood flow of underactive prefrontal areas of the brain (Lou, Henriksen, & Bruhn, 1984; Lou, Henriksen, Bruhn, Borner, & Nielsen, 1989; Amen & Carmichael, 1997). Additional research included quantitative EEGs of brain cortical electrical activity as another frontier for exploring the etiological factors of ADHD in this era (Barkley, 1990). Still other studies focused on neurotransmitters such as dopamine and norepinephrine to explain underactivity or deficits in brain functioning (Shaywitz,

Shaywitz, Cohen, & Young, 1983; Zametkin & Rapport, 1986; Hunt, Cohen, Anderson, & Minderaa, 1987; Rapport & Zametkin, 1988).

Another advance achieved in the 1980s was in the area of assessment (Barkley, 1990). Developed during this time were assessment scales, such as the Child Behavior Checklist (CBCL) (Achenbach & Edelbrock, 1983; Achenbach & Edelbrock, 1986; Barkley, 1990), Conners Rating Scales (Barkley, 1988; Barkley, 1990), ADD-H Comprehensive Teacher Rating Scale (ACTeRs) (Ullmann, Sleator, & Sprague, 1984), the Home and School Situations Questionnaires (Barkley & Edelbrock, 1987), and the ADHD Rating Scale (DuPaul, 1990). These assessment tools improved not only the diagnostic ability of health professionals but incorporated observations of home and school problems in the assessment process.

During the 1990s, ADHD has become the primary label used by most health care providers (DSM-IV). Most providers categorize four subtypes grouped under this one diagnosis (Sanford, 1995). The first subtype is labeled ADHD, predominately the inattentive type. This form of ADHD focuses on the poor attention span displayed by the individual. The second subtype is ADHD, predominately hyperactive type. When an individual is diagnosed with this form of ADHD, the primary problem is his or her hyperactivity. The third diagnosis of ADHD, the combined type, is characterized by both inattentiveness and hyperactivity. The fourth diagnosis of ADHD, not otherwise specified (NOS), is a catchall diagnosis (Sanford, 1995). In this diagnosis, the

individual does not fit into a clear category (DSM-IV). For the purpose of this study, ADHD will be used as a general label without distinction between the specific subtypes.

Strategy of Assessment and Intervention: the Biopsychosocial Model

For a social worker, it is extremely important to understand the etiological development of ADHD. However, when working with an ADHD individual, the social worker must also take into account the wide range of influences and developmental issues that the child with ADHD is experiencing. Without a sound understanding of these factors, social workers will limit their effectiveness. Moreover, social workers must also be critically aware of the numerous areas of potential intervention toward the ADHD

individual. Traditionally, social workers intervene at the individual or family level of functioning, performing such tasks as individual therapy, family therapy, and/or intervention at school to aid in the individual = s academic performance. To better understand the multiple levels of functioning as well as ranges of possible intervention, an important tool will be discussed the Biopsychosocial Model of Assessment and Functioning.

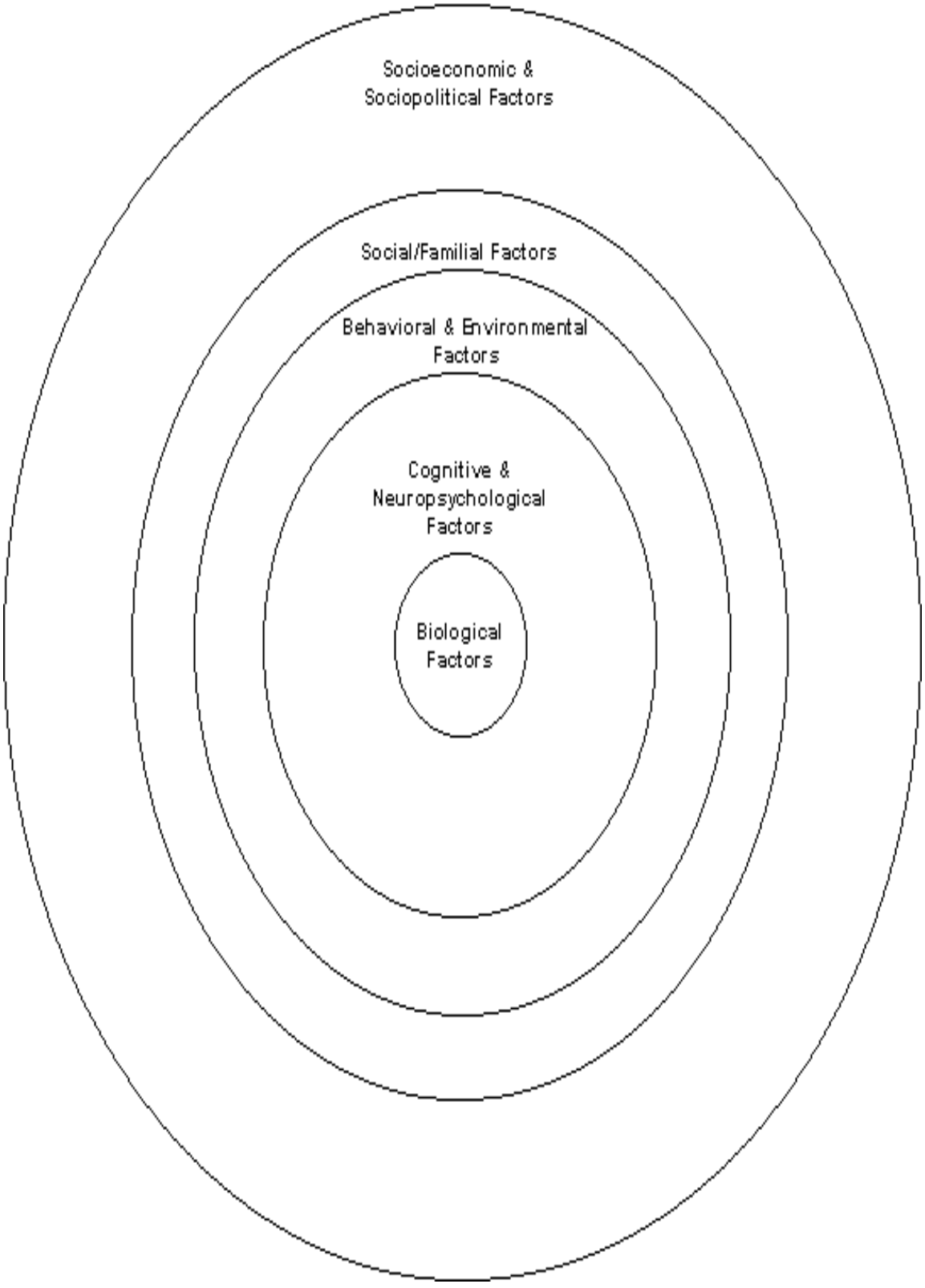
In the perspective of this Biopsychosocial Model, the levels of functioning are broken down into concentric circles (Barkley, 1990). The interaction between each level of assessment and functioning can radiate inward and outward affecting different levels of the individual = s life (see Figure1). This study focuses on two specific areas, as illustrated within the model: the individual = s biological factors and his/her cognitive and neuropsychological factors. These two levels of functioning are uncommon areas of focus in the social work field. However, with a basic understanding

of the Biopsychosocial Model of development, social workers can expand their areas of intervention by non-pharmacologic means, a significant enhancement to the more restricted intervention methods of the past.

Biological factors: the innermost circle

The innermost circle represents the biological level of functioning which includes “physical integrity, genetic predispositions toward various behavioral classes, such as depression, anxiety, or even ADHD” (Barkley, 1990). This level deals with the basic physical integrity of the individual = s central nervous system. The integrity of the central nervous system can be affected by genetic predispositions and outside environmental factors such as toxins (de al Brude & Choate, 1972; David, 1974; Gittelman & Eskinazi, 1983). Toxic factors such as maternal smoking (Denson, Nanson, & McWatters, 1975; Nichols & Chen, 1981), alcohol use during pregnancy (Jones, Smith, Ullenland, & Streissguth, 1973; Shaywitz, Cohen, & Shaywitz, 1980) and prenatal anoxia can all affect the physical integrity of the central nervous system (Barkley, 1990).

The Biopsychosocial Model of Assessment and Functioning



Within this innermost circle, fundamental areas that the social worker may address are: a) the neurological dysfunction of the cortical and subcortical regions of the brain, b) the role of neurotransmitters in the brain to control impulsivity and improve attention span, and c) a combination approach that embraces the neuroanatomical and neurotransmitter perspective. The above-mentioned areas are not commonly germane to intervention by social workers and further exemplify the strong neurological connection of ADHD (see Figure 1). Cognitive and neuropsychological factors: the second circle

The second concentric circle deals with cognitive or neuropsychological functioning related to the functioning level of the central nervous system (Castellanos et al., 1994). Within this framework, the social worker must ask whether the child is able to inhibit impulses (hyperactivity) and achieve goals at hand, or are there significant deficits that hinder obtainment. Some ADHD children may perform very well in particular academic subjects while having difficulty in others. This condition could be caused by numerous factors including the child = s temperament or mood. Additionally, the child could have deficits in visual-motor processing, central auditory processing, and/or fine and gross motor skill deficits (Castellanos et al., 1994). A combination of deficits in one or all of the areas can influence the child = s performance; the resulting manifestation and/or deficit is in the form of inappropriate behavior by the individual. Social workers and other mental health workers can realize the importance of multiple deficits and recognize how the combination of specific deficits can affect the ADHD individual = s everyday experiences. Thus, diagnosis and treatment can be adjusted

according to the level of functioning for each ADHD individual (Barkley, 1990). For the purpose of this study, cognitive functioning levels will be evaluated by the use of standardized IQ tests (dependent variables).

Behavioral and environmental factors: the third circle

The third circle within the Biopsychosocial model focuses on behavioral and environmental interactions of the ADHD individual. Specifically, the social worker addresses the question as to whether the child is able to meet the demands of teachers, parents, and other care givers. Additional information must be obtained with respect to how the child responds to different situations and environments and whether he or she can perform in one environment and display appropriate behavior while in other situations displaying impulsivity, distractibility, and other inappropriate behavior. The impact of different environments is best displayed in the academic setting. A child who has ADHD and is placed in an unstructured academic environment will display more impulsivity and distractibility (Barkley, 1990; Phelan, 1993; Lerner, Lowenthal, & Lerner, 1995). However, if this ADHD child = s academic environment is changed to include a structured classroom with clear expectations and demands, the reduction in negative behavior is fairly significant in most cases (Barkley, 1990; Phelan; Lerner, Lowenthal, & Lerner).

Another aspect of assessment in this level of functioning involves the child = s interactions with teachers, parents, and peers. Children with ADHD usually have problematic social interactions (Barkley, 1990; Phelan, 1993; Lerner, Lowenthal, & Lerner, 1995; Amen & Carmichael, 1997). They display difficulties in such social situations as taking turns, changing from one environment to another, and following the

rules of a game and other social norms. A non-ADHD child quickly obtains social skills enabling the child to perform in a more socially acceptable fashion than the ADHD child (Ross & Ross, 1976; Barkley, 1990; Lerner et al). Consequently, friends are hard to keep, and teachers along with parents find ADHD children hard to deal with on a day-to-day basis (Ross & Ross, 1976; Barkley, 1990; Lerner et al). Thus, for the purpose of this study, behavioral assessments will be measured using a standardized behavioral rating scale and a computerized continuous performance test (dependent variables).

Social/Familial factors: the fourth circle

The fourth circle in the Biopsychosocial Model of assessment is the social/familial functioning of the individual. In the social/familial circle, the question of parental/sibling psychological integrity is questioned and focus is placed on daily family interactions (Ross & Ross, 1976; Barkley, 1990; Lerner et al., 1995). Questions of previous psychological problems, status of the marriage, and other stressors that impact the everyday life of the family are also taken into consideration. Hence, the Aidentified patient@ is now expanded to the family setting. Familial factors like depression, alcoholism, and unemployment can drain time, energy, and patience from the parents that could be utilized on the ADHD individual (Ross & Ross; Barkley, 1990; Lerner et al., 1995). For the social worker/clinician, it becomes imperative to move from a micro individual level to a macro familial level. Thus, all interventions may not focus on the ADHD individual but may encompass family interventions along with social

interventions–interventions commonly within the skills and training of social workers (Barkley, 1990; Phelan, 1993; Lerner et al).

Socioeconomic and sociopolitical factors: the fifth circle

The last concentric circle of functioning involves the socioeconomic or sociopolitical level of functioning, involving such factors as parental education, socioeconomic level, and type of employment (Barkley, 1990), along with parental drug or alcohol use. Factors at one point of the circle radiate in and out toward other functioning levels (Ross & Ross, 1976; Barkley, 1990; Lerner et al, 1995). Sociopolitical factors, such as the city, state, or even country in which the child lives, can determine resources that could be available to him or her for assessment and treatment of ADHD (Ross & Ross; Barkley, 1990; Lerner et al). In one area of the United States, there can be more or fewer services available to the ADHD child than in another, the level of resources thereby directly influencing the prognosis of the child = s functioning level (Barkley, 1990).

In summation, this chapter has addressed the historical development of ADHD, the present DSM-IV criteria for ADHD and presented the Biopsychosocial Model of Assessment and Functioning. Chapter II will now focus on the pertinent research literature of non-pharmacological interventions for ADHD individuals. This chapter will also introduce the conceptual model for this study. Chapter III will then discuss the methodological aspects of the study including a discussion of the independent and dependent variables. This chapter will also address data collection and data analysis. Chapter IV will present the result of the current study. Chapter V will discuss the findings of current study with implications for social workers. In addition this chapter

will discuss strengths and limitations of current study and direction for future research.

Chapter II

Literature Review

Current study = s shift in treatment: From symptom reduction to etiology alteration

Standard treatment for Attention Deficit Hyperactivity Disorder (stimulant medication/behavioral modification).

Generally speaking, pharmacological intervention alone or coupled with behavioral modification have comprised the standard treatment for the ADHD individual. There are those physicians, mental health workers, and families of ADHD individuals who believe that pharmacological interventions coupled with some behavioral modification is the only effective intervention in treating ADHD (Barkley, 1977; Barkley & Cunningham, 1978; Barkley, 1990; Hunsucker, 1993; Goldstein, 1997).

With regard to pharmacological interventions, the most common to date include the use of methylphenidate (Ritalin), D-amphetamine (Dexedrine), Pemoline (Cylert), Adderall, and/or Imipramine (Tofinil). In 1978, Barkley published a pharmacological study reviewing stimulant drugs and how they effected the hyperactive child. Barkley (1978) study concluded that pharmacological interventions in the form of stimulants were the most effective tools to reduce hyperactivity (Knights & Bakker, 1976; Barkley & Cunningham, 1978; Pelham, 1986; Brown & Borden, 1989; Barkley, Anastopoulos, Guevremont, & Fletcher, 1991).

These pharmacologic procedures, even when coupled with behavioral modification treatments, are not, however, 100% effective. Many problems exist including: a) poor parental training, b) reluctance to place an individual on medication,

c) side effects due to the medications, d) poor compliance with medications, e) inability to afford a pharmacological intervention, f) the stigma placed on the individual who takes medication, g) the poor effectiveness of both behavioral and stimulant medications for some individuals, and h) poor compliance with behavioral modification programs.

With regard to treatments involving medication alone, further potential problems arise. For some, the use of methylphenidate (Ritalin) and/or Adderall can relieve some of the major symptoms of ADHD and provide an answer to some of the children and adolescents who display sociopathic behavior (Mattes, Boswell, & Oliver, 1984; Swanson, 1978). However, pharmacological intervention does not come without the possibility of negative side effects. Both Ritalin and Adderall have addictive qualities that one must consider. The Physician = s Desk Reference (PDR) (1998) clearly indicates that caution should be used when administering these types of drugs to individuals who have a history of drug or alcohol use and/or abuse. The prolonged use of the drugs can lead the ADHD individual to the point of abusing the drug by increasing the dosage without the physician = s consent. Additional side effects can range to palpitations, headaches, dyskinesia, drowsiness, blood pressure and pulse changes, tachycardia, angina, abdominal pain, weight loss, and insomnia. Individuals who use this form of pharmacological intervention for prolonged periods can also develop, in rare cases, Tourette syndrome (PDR, 1998). The possibility of an overdose is a major concern since it can result in overstimulation of the central nervous system. Additional overdose symptoms may include vomiting, agitation, tremors, muscle twitching, convulsions, possible coma, arrhythmia, and hypertension (PDR, 1998).

These conditions reflect just a few of the problems encountered by the social worker treating an ADHD individual with the standard methods.

Fortunately, as the understanding of ADHD improves over the years due to advances in technology, new forms of treatment are also emerging. These newer treatment methods are being explored by physicians, mental health workers, and lay individuals who are seeking less invasive forms of treatment. Their focus is directed toward the possibility of changing the neurological aspects of the ADHD individual with to regard to the specific EEG characteristics of ADHD individuals.

Etiological electroencephalographic differences in ADHD

At the University of Tennessee at Knoxville, Lubar's (1993) research is contradictory in several respects to Barkley's (1990) conclusion regarding the diagnosis and treatment of ADHD children and adolescents. In 1991, Lubar proposed that there are biological and physiological functions of the body that one can learn how to control. One of the biological functions under one = s control (with specialized equipment and training) is brain wave activity. This intervention modality is generally referred to as EEG or neurofeedback training. In order to understand this highly specialized intervention, one must define biofeedback. Biofeedback is the "use of nonpharmacological treatment that uses scientific instruments to measure, amplify, and feedback physiological information to the patient" (Shellenberger, Amar, Schneider, & Stewart, 1989, p. 2). Lubar (1991) gives the locus of control back to the individual and does not rely solely on pharmacological interventions. This approach is theoretically a cognitive/behavioral or learned approach. Lubar's research is congruent with others in the field, including Barkley, that an ADHD individual = s EEG characteristically

displays increased amounts of slow brain waves (theta) frequencies when compared with non-ADHD individuals who have greater amounts of faster EEG (beta) frequencies (Knights & Bakker, 1976; Lubar, 1991; Barkley, 1993; Rosenfeld, Cha, Blair, & Gotlib, 1995; Linden, Habib, & Radojevic, 1996; Sterman, 1996). Following the logic of self control, highly specialized treatments were developed from Lubar = s research.

As research and treatment in the field of ADHD continued to develop, many researchers and clinicians questioned the premise of biofeedback: Can an individual really learn how to control their own EEG activity? Is there a neurological difference between an ADHD individual versus a non-ADHD individual? Lubar research focused on the process of primarily analyzing four predominant EEG waves in the ADHD individual. The four brain waves are as follows: The delta brain wave, which is the slowest of all brain waves produced (0.5 to 4 cycles per second), is prominent when the individual is in deep sleep and not dreaming. A slightly faster brain wave, which is called theta activity (4 to 8 cycles per second), is related to both drowsiness and creativity and is present in the dream state of the individual = s sleep cycle. The alpha brain waves (8 to 13 cycles per second) are associated with relaxation, alertness, or shifting consciousness (Lawrence, 1972; Knights & Bakker, 1976; Duffy, Iyer, & Surwillo, 1989). This is the brain wave that is predominant in individuals who are trained in deep relaxation, as in the case of Zen monks and other Eastern mediators. The beta brain waves (13 to 32 cycles per second) are the fastest brain waves. Beta activity is associated with increased mental concentration, alertness, anxiety, and is evident when someone is in a problem-solving mode (Lawrence, 1972; Knights &

Bakker, 1976; Duffy, Iyer, & Surwillo, 1989). With regard to typical EEG activity, ADHD children have slower background or dominant EEG frequencies while the EEG frequencies of children who function on grade level did not indicate this slowness (Duffy, Iyer, & Surwillo, 1989). In 1985, Lubar, Bianchini, Calhoun, Lamert, Brody, and Shabsin proposed that individuals who exhibited ADHD characteristics also exhibited slow EEG patterns of activity. Lubar et al. (1985) continued to refine their research and specifically found that children who were ADHD exhibited theta (4-8hz) as a predominate EEG frequency. Lubar and his colleagues (1985) concluded that the most important factor is the theta (4-8hz) to beta (14-32hz) ratio in the individual EEG pattern, commonly referred to as EEG signature. Individuals who displayed ADHD characteristics were found to also display higher ratios of theta to beta activity (more slower than fast brain waves) than those who did not display ADHD behavior. In essence, the ADHD child produces more slow brain waves (4-8hz, theta) compared with children without ADHD who produce more faster (14-32hz, beta) brain waves (Lubar et al., 1985). All of this information and research was gathered by using quantitative EEGs (QEEG) that measure and analyze activity from multiple leads attached to the surface of the individual = s scalp (Lubar et al., 1985).

Another study using advanced technology, specifically Single-Photon Emission Computed Tomography (SPECT) imaging, found that prefrontal cortical deactivation was evident in 65% of all children and adolescents who were diagnosed with ADHD (Amen & Carmichael, 1997). The study included 54 children and adolescents who had been diagnosed as having ADHD. The study measured cerebral blood flow to specific regions of the brain. The study indicated that deactivation of the frontal lobe begins

when the individual is asked to perform a mental task. Amen and his associates hypothesized that one of the causes for the ADHD child = s hyperactivity is that the child is seeking external stimulation. This deactivation hypothesis parallels Lubar = s 1985 findings, in that when Lubar asked an ADHD child or adolescent to perform a mental task, his or her EEG signature would slow down (4-8hz, theta) instead of increase (14-32hz, beta). Amen and his colleagues concluded that SPECT scan, PET (Positron Emission Tomography) and a quantitative EEG all had clinical applications in the diagnostic phase of intervention when dealing with the ADHD population (Amen & Carmichael, 1997).

With the understanding that ADHD individuals brain waves are not functioning at the same level as those of a non-ADHD individual, the possibility of changing the brain waves of the ADHD individual becomes a treatment goal to be reviewed without pharmacologic intervention. Through the use of special forms of biofeedback, it is now possible for some individuals to change their underlying EEG signatures. In the following sections, these specialized forms of EEG biofeedback will be explored.

EEG biofeedback treatment

With the knowledge at hand that ADHD individuals have EEG patterns that are different from those of non-ADHD individuals, new forms of treatment are being developed. The underlying assumption of EEG biofeedback training is that an individual can control specific brainwave frequencies. One of the leaders in EEG biofeedback has been J.F. Lubar. Lubar would train children to inhibit theta activity while increasing beta activity (Lubar & Shouse, 1976; Lubar, 1984; Lubar & Lubar, 1991). In 1976, Lubar and Shouse conducted a study using an ABA design. The EEG

biofeedback training involved the use of equipment that would give the child a tone when he or she would increase beta activity in the absence of theta activity. The increase in beta activity resulted in significant improvement in 8 of the 13 measures of hyperactivity and impulsivity. However, when the training was reversed so that the child would be rewarded for increasing slower EEG frequencies (theta) and inhibiting faster EEG frequencies (beta), a return to problematic behavior appeared in the classroom. Although the results of the study were intriguing, the number of subjects, though acceptable for this level of exploratory, was too low for a definitive study.

In 1979, Shouse and Lubar conducted another study using an ABA blind crossover design and a total of four subjects. Three of the four subjects were able to learn how to increase beta activity and decrease theta. The three that were able to increase beta showed a decrease in hyperactivity in the classroom. Reversal training of the three subjects returned their problematic behavior to the baseline reading. Once again, the study indicated promising results but the number of subjects was too small to achieve statistical significance.

In 1984, Tansey conducted a study through his private practice with six learning disabled boys (10 to 11 years old) using an ABA design. Tansey trained the subjects to increase 14 Hzs brainwave activity. The Wechsler = s (WISC-R) IQ test indicated increases in individual scores of more than 15 points. Additionally, the two individual = s with the lowest IQ scores gained a 60% increase over their baseline scores. Tansey concluded that EEG biofeedback can be an effective treatment to improve IQ scores. Tansey attributed the increase in IQ scores to the improvement of the brain = s functioning level by changing the individual = s EEG patterns.

In 1990, Tansey conducted an uncontrolled single group outcome study using EEG biofeedback as the treatment for ADHD children. His 24 subjects were generated from his private practice. The results were promising, with slower brainwave activity (theta) decreasing and faster brain waves (beta) increasing. The increase in the underlying EEG patterns was correlated with a significant increase in the Full Scale Verbal and Performance IQ scores of more than 15 points on the WISC-R test. Tansey attributed these post-treatment results to improved cognitive functioning of the brain. While the research outcomes described above have been positive, the number of subjects was consistently too low to draw reliable conclusions. Moreover, their lack of standardized, objective behavioral scales further reduces the external validity of their findings. Nevertheless, the studies do provide a foundation on which the theoretical assumptions of EEG biofeedback may be examined.

Theoretical justification for a non-pharmacological stimulation treatment for ADHD

At this time, a new form of treatment is emerging in the field to treat ADHD individuals. The treatment involves the use of auditory and visual stimulation (AVS) through the use of LEDs (light emitting diodes) in specially designed glasses that flash at predetermined frequencies coupled with binaural tones that are transmitted through headphones. The visual stimulation is synchronized with the auditory stimulation. Diamond (1988) concluded that different environments with different stimulations would increase or decrease growth of the individual = s dendrites on a neuronal level. Diamond hypothesized that nurturing or stimulation can actually enhance the brain = s functioning. The intensity of stimulation would increase dendrite growth which in turn increases the brain = s capability to carry more information than prior to stimulation

(Diamond, 1988; Kolb & Whishaw, 1990). These findings are well established in mammalian research. Rats were exposed to increased environmental stimulation, following which the density and weight of the rats = brains would increase; molecular, synaptic, and behavioral changes were noted. Postmortem human studies indicated that individuals who were exposed to a challenging environment show greater dendrite length and structural changes in the cortex (Diamond, 1988; Kolb & Whishaw, 1990). The increase in dendrite growth can be associated with increased ability to perform cognitive functions. In humans, the increased dendrite growth is represented by higher levels of educational and occupational functioning. Diamond concluded that if an individual were afforded a stimulating environment, he or she could develop changes in the structural anatomy of the brain, hence the possibility of improving cognitive functioning of the individual.

While stimulation theory has primarily been tested using rats or involving human postmortem subjects, some research has employed comatose patients. However, the procedures were particularly invasive wherein tiny electrodes were placed deeply within the brain to deliver electrical stimulation.

The results of these studies involving stimulation to alter brain activity have been promising in terms of possible ADHD advances. However, clearly the need exists for more advanced and statistically significant studies Thus, to test audiovisual stimulation as an independent variable becomes an important next step in the advancement of ADHD treatment.

Audio Visual Stimulation (independent variable)

Earlier studies conducted by W. Gray Walter, a British neuroscientist, focused on the ability of the brain to rhythmically match its frequencies to that of photic stimulation (Cook, 1994). This process was labeled the Aflicker phenomenon.@ (Adrian & Matthew, 1934; Walter & Walter, 1949; Van der Twill & Verduyn Lunel, 1965; Townsend, Lubin & Naitoh, 1975; Pigeau & Frame, 1992; Carter & Russell, 1993; Timmermann, Lubar, Rasey, & Frederick, 1998). Not only did the area of the brain associated with sight become synchronized with the external flickering lights, but the entire cortex of the brain showed changes that began to approach the same frequency of the flashing lights (Pribram, 1971; Kumano, Horie, Kuboki, Suematsu, Sato, Yasushi, Kamei & Masumura, 1997; Rosenfeld, Reinhart & Srivastava, 1997; Carter & Russell, 1993). This Aflicker phenomenon@ is also known as the Aentrainment process@ wherein brainwave pattern of the cortex synchronizes with the rhythmic frequency of external stimulation (Carter & Russell, 1993; Kumano, Horie, Kuboki, Suematsu, Sato, Yasushi, Kamei & Masumura, 1997; Rosenfeld, Reinhart & Srivastava, 1997).

In 1994, Cook performed an extensive review of not only visual entrainment literature but also that of auditory entrainment. The review revealed that external rhythmic sound waves, like flickering lights, would also produce brain wave changes. The brain wave pattern or EEG would match the frequency of the external auditory stimulus (Adrian & Matthew, 1934; Walter & Walter, 1949; Van der Twill & Verduyn Lunel, 1965; Townsend, Lubin & Naitoh, 1975; Pigeau & Frame, 1992; Carter & Russell, 1993; Timmermann, Lubar, Rasey, & Frederick, 1998). A consensus was thereby reached that auditory and/or visual stimulation could change EEG patterns

(Carter & Russell, 1993; Cook, 1994; Kumano, Horie, Kuboki, Suematsu, Sato, Yasushi, Kamei & Masumura, 1997; Rosenfeld, Reinhart & Srivastava, 1997). Carter & Russell (1993) also found that auditory entrainment could also be achieved when a subject would be given a pure tone in one ear and a slightly different pitch in the other ear; at this point, the brain would synthesize the difference between the two tones. This process has become best known as Abinaural tone or beat@ (The AVS Group Inc., 1992).

Other studies using some auditory and visual stimulation were conducted in Japan (Tsubokawa, et al., 1990). Chijiwiiana and his colleagues used auditory and visual stimulation to treat neurosis, major depression, dysthymia, bulimia nervosa, and anorexia nervosa with promising results (Chijiwiiana, Yasushi, Saito, Tsutsui, Jsuboi, & Maicino, 1993). Additionally, Rosenfeld, Reinhart, and Srivastava (1997) evaluated the predictability of the effects of an alpha (10-hertz) and beta (22-hertz) audiovisual stimulation on 26 college students. The entrainment stimulation of individuals with low-alpha production could increase, with some predictability, production of higher EEG frequency or beta activity. In some subjects, the results of the AVS stimulation would be relatively prolonged in the beta frequency which is indicative of increased cognitive functioning. However, if the individual = s EEG signature was relatively high in alpha at the baseline, the individual showed either no entrainment or relatively prolonged no entrainment with alpha stimulation. The study concluded that baseline alpha in individuals had predictable qualities for beta entrainment and beta enhancement.

In another study conducted by Kumano et al., (1997) the brain = s ability to match itself to an outside stimulus was evaluated. The study comprised a total of 16 subjects, 8 subjects in the treatment group and 8 subjects in the control group. The study employed a pre- and post-evaluation of specific changes in the individual. The study concluded that through the use of AVS, not only did the EEG of individuals change but additional change was noted in plasma cortisol and endorphin levels. This study provided clear evidence that the effects of AVS are far reaching and have direct affect not at the EEG level but also at the biochemical level, as others also came to discover (Carter & Russell, 1993; Cook, 1994; Kumano, Horie, Kuboki, Suematsu, Sato, Yasushi, Kamei & Masumura, 1997; Lubar, 1997; Rosenfeld, Reinhart & Srivastava, 1997).

As recently as 1998, Timmermann et al. submitted a study for publication evaluating the effects of AVS on 13 undergraduate subjects at the University of Tennessee at Knoxville. Baseline EEG readings were recorded with the subjects = s eyes closed. The subjects were exposed to AVS for 20 minutes at their dominant alpha frequency and then stimulated at twice their dominant alpha frequency in the same session. After completion of their training session, a thirty-minute post-training recording was also obtained. The EEG recordings were evaluated at 19 different locations on the scalp. The results coincided with previous studies (Adrian & Matthew, 1934; Walter & Walter, 1949; Van der Twill & Verduyn Lunel, 1965; Townsend, Lubin & Naitoh, 1975; Pigeau & Frame, 1992; Carter & Russell, 1993). Timmermann et al. reported that alpha stimulation in the form of lights and sound increased the output of the individual = s EEG in the delta and beta frequencies. At the second

stimulation period, the dominant alpha EEG reading of the individual was twice that of baseline recordings with increases of theta and beta power over the baseline of the individual. The increase in both theta and beta was also verified in the 30-minute post-training recording. The conclusion of the study was that AVS can increase the theta, alpha, and beta activity. The authors added that AVS may become an important adjunctive treatment for the ADHD individual.

Evidence has continued to grow that indicates that AVS stimulation can positively affect brain wave activity. Meanwhile, other researchers have been in the process of developing different forms of treatment. One of these forms of treatment that is based on AVS stimulation is electroencephalograph disentrainment feedback (EDF).

Electroencephalograph Disentrainment Feedback

Carter & Russell (1993) conducted a pilot study that employed AVS on a total of 26 boys. The study concluded that after 40 sessions of training at school followed by 40 sessions at home, the first group ($n = 14$) improved their cognitive functioning level with regard to four of the six variables. Using the Wide Range Achievement Test-Revised (WRAT-R), the areas that showed the greatest increase in functioning level included reading and spelling ($p < .01$) However, the Peabody Picture Vocabulary Test (PPVT) did not show a significant change in IQ level. The other group who received 18 training sessions ($n = 12$) generally improved their verbal performance scores while their spelling scores increased significantly ($p < .05$). The authors concluded that training improved cognitive functioning level in some individuals, and the number of training sessions affected the individual = s functioning level. The results from the pilot study spurred further research in this area of treatment.

This pilot study by Carter and Russell (1993) provided enough promising information to gain funding from the U.S. Department of Education (SBIR No. RA941300002) for a three-year study using AVS as the primary intervention technique to treat the ADHD individual. The total number of subjects of this study was 25, with 6 of the 25 comprising a control group. Binaural tomes and flashing lights were used as AVS. The study included pre- and post-AVS treatment measurements.

Carter and Russell (1993) based their study on previous research that indicated that the ADHD EEG signature is slower than that of non-ADHD. They worked with the premise that AVS would stimulate the brain to increase EEG frequencies. This process was labeled ADisentrainment.@ Carter and Russell used a form of EEG/AVS treatment that could be controlled by the individual = s own dominant EEG brainwaves. They hypothesized in this study that the brain, upon receipt of AVS higher stimulation, would attain synchronization and remain at a higher EEG frequency even after training, hence improving cognitive functioning levels. This disentrainment process or EDF/AVS was related to previous work by Diamond (1988) and Tsubokawa (1990). The EDF training would disrupt or disentrain the habituated slow EEG signatures of ADHD individuals, utilizing the individual = s dominant EEG frequency and slowly pushing or pulling the EEG frequency to different levels in response to the AVS. Specialized software manipulated the stimulation to bring about changes in EEG frequency to attain more normal levels.

The Carter and Russell (1995) study employed very strict quantitative measures. The researchers calculated two-way ANOVA on the groups. The three groups were composed of an experimental group, a no-treatment control group, and an attention

placebo group. In the experimental group, the individuals received 40 sessions of EDF training which consisted of 22 minutes of daily training for approximately eight weeks. The group = s performance was measured by pre- and post- Raven = s Progressive Matrices test, Peabody Picture Vocabulary Test-Revised (PPVT-R), Attention Deficit Disorder Evaluation Scale-School version (ADDES), and the Wide Range Achievement Test-Revised (Dunn & Dunn 1981; Jastak & Wilkinson, 1984; McCarney, 1995). The experimental group showed a 10.20 point gain in verbal IQ scores ($p < .0001$) (Carter & Russell, 1993) with a significant gain in the PPVT-R of 9.20. No significant change occurred in the placebo and no treatment control groups (1.70 and .40, respectively). The WRAT-R scores in all groups showed a slight and insignificant increase between pre- and post-test scores. In the experimental group, ADDES scores (School version) indicated a significant decrease in impulsivity and an increase in attention span. However, the hyperactive scale did not show any significant change. The Raven = s Progressive Matrices test did not show any significant differences pre- or post- between groups.

Dependent Variables Literature: Wide Range Achievement Test, Peabody Picture Vocabulary Test, Raven's Progressive Matrices, Intermediate Visual and Auditory Continuous Performance Test, and the Attention Deficit Disorder Evaluation Scale

There is always a concern in the mental health field that a proper diagnosis is obtained for an ADHD individual. The use of reliable and readily available tests becomes a factor for those who deal with the ADHD population (Barkley, 1990). Many children, adolescents, and adults are improperly diagnosed as having ADHD. The scientific community needs to develop a standardized neurological diagnostic test to

ascertain if the individual really has ADHD. However, the tests that are commonly used to evaluate cognitive functioning of possible ADHD individuals are the standard IQ tests, like the WRAT-R, Peabody Picture Vocabulary Test, Raven = s Progressive Matrices, behavioral rating scale (ADDES), and the computerized Intermediate Visual and Auditory (IVA) test would only increase the probability that an individual has ADHD. The use of the above tests is well established in the research literature as reliable tests to ascertain functioning levels of the individual who is being tested for the ADHD diagnosis (Barkley, 1990; Russell et al., 1995). For the purpose of this study, the above-mentioned tests will become the dependent variables. Although other tests are available to evaluate the functioning level of ADHD individuals, this study will use the same tests employed by Carter & Russell (1993) research to replicate the instrumentation protocol used in their study. Furthermore, the WRAT-R, Peabody Picture Vocabulary Test, Raven = s, ADDES, and the IVA are fast and reliable tools of evaluation to ascertain functioning levels of the ADHD individuals. However, the research to date has been used on a very small number of subjects. Prior research designs have ranged from single case analysis to weak methodological designs. An analysis of pertinent literature has revealed many of the methodological problems that need to be addressed in this study.

Past research has indicated that an ADHD individual displays abnormality in the EEG or brain waves(Shaywitz, Shaywitz, Cohen, & Young, 1983; Zametkin & Rapport, 1986; Hunt, Cohen, Anderson, & Minderaa, 1987; Rapport & Zametkin, 1988; Barkley, 1990; Carter & Russell, 1995; Lubar 1995; Lubar, 1997). It is well documented that ADHD is a neurologically based disorder (Barkley, 1990; Hallowel &

Ratey, 1994; Lubar, 1985,1995, 1997). The individuals who have ADHD display deficits in their behavior, social functioning, and cognitive functioning due to the brain moving slower than in the non ADHD individuals (Carter & Russell, 1993; Lubar, 1997). The primary treatment for ADHD individual has been the use of stimulant medication that changes the EEG patterns of the person. However, if the brain can be exposed to a challenging and stimulating environment (with no stimulant medication) cognitive changes can occur if EEG patterns change from an abnormally slow frequency to a faster more efficient frequency. Therefore, the use of AVS to entrain or disentrain slower EEGs to faster EEGs becomes a viable treatment. The AVS treatment will decrease the underlying slow EEG activity and a shift the EEG to a faster more productive EEG pattern. This stimulation (AVS) will improve both cognitive and behavioral functioning of the individual. Thus, the study will help verify the stimulation theory by exposing subjects to a challenging and stimulating environment through the use of AVS treatment (Diamond, 1988). In keeping with the above theory of providing a challenging and stimulating environment (stimulation theory) the following framework is proposed for this study.

Independent and Dependent Variables for testing the Stimulation Theory	
Independent Variables	***Dependent Variables***
Audio Visual Stimulation Treatment	WRAT-R1, Raven = s, PPVT, IVA, & ADDES
Audio Visual Stimulation Treatment with	WRAT-R1, Raven = s, PPVT, IVA, &

Independent and Dependent Variables for testing the Stimulation Theory	
medication	ADDES
Medication only, no treatment	WRAT-R1, Raven = s, PPVT, IVA, & ADDES

Note. Abbreviations: WRAT-R1 = Wide Range Achievement Test (revised); IVA = Intermediate Visual and Auditory Continuous Performance Test; PPVT = Peabody Picture Vocabulary Test; Ravens = Raven = s Progressive Matrices; ADDES = Home Behavioral Rating Scale.

The current study = s theoretical framework will examine and compare: (a) the independent variables of an AVS treatment only group; (b) an AVS treatment and stimulant medication group; (c) a medication group. In addition there will be an ADHD self-selected comparison group on no medication and no treatment for comparison. The study will evaluate the theoretical assumption that if an ADHD individual is exposed to an audio and visual stimulation that cognitive and behavioral changes will occur. Additionally, the study will expand the stimulation theory by providing a unique and non-pharmacological treatment or stimulation for the ADHD population.

In Chapter III methodological issues will be presented for the current study. In addition, goals will be discussed and hypotheses will be defined. Furthermore data collection and analysis for the current study will be discussed.

Chapter III

Methodology

Methodological Critique of Previous Studies

One of the most promising non-pharmacological approaches to ADHD treatment involves AVS (Carter & Russell, 1993). Studies related to this method of ADHD treatment, however, tended to provide incomplete data and thereby did not lead to reliable and conclusive results, nor did they provide explicit verification of the underlying theoretical assumptions, some of which were scarcely mentioned in previous research. The number of subjects in these previous studies was too small (less than 25 total subjects) to allow researchers to apply more stringent forms of statistical analysis (Barkley, 1990; Tabachnick & Fidell, 1989). Furthermore, the lack of a true control group reduced the significance of the findings (Russell & Carter, 1995). In addition, the studies attained almost no diversity in terms of sex and race of subjects, as the majority of the subject populations were white males. Moreover, little attention was focused on the development of a testable theoretical framework for AVS (Carter & Russell, 1993; Russell & Carter, 1995; Russell & Carter, 1997; Tansey, 1984; Tansey, 1990; Tansey, 1991). The current study has attempted to address these concerns.

Goals of Current Study

Broadly described, the goal of this research was to expand the understanding, diagnosis, and treatment of ADHD in a pre-adolescent and adolescent population. The study attempted to evaluate the theoretical assumption, described in depth in earlier sections, that if an ADHD individual is exposed to AVS, positive cognitive and

behavioral changes will occur. Specifically, the methodology of the study included the following components:

1) Independent variables:

a) AVS treatment group with no medication (AVS group)

b) AVS treatment group with stimulant medication (Ritalin & Adderall) (AVS + Stimulant Medication group)

c) Stimulant medication group with no AVS treatment

d) Self-Selected Comparison group with no medication and no AVS treatment

2) Dependent variables:

a) Wide Range Achievement Test, Revised (WRAT-R)

b) Raven = s Progressive Matrices (Raven = s)

c) Peabody Picture Vocabulary Test (PPVT)

d) Intermediate Visual and Auditory Continuous Performance Test (IVA)

e) Attention Deficit Disorder Evaluation Behavioral Rating Scale (ADDES)

The possibility of random assignment of subjects to the study groups was not feasible due to constraints and restrictions imposed by the nature of the ADHD population and the use of secondary data. Specific restraints include available time of the parents to supervise their child while training, commitment of time by the child and parents to engage in the training sessions, and the reluctance of parents to take their child on and off of medication for extended periods of time. Therefore, the researcher was not privy to group assignment. To control for the possibility of any biases in testing the majority of testing was completed by trained research assistants.

The multiple group, pre/post test with follow-up design graphic representation is illustrated as follows:

Group O X a O O

Group O X b O O

Group O X c O O

Group O O O

Note: Group A—ADHD with no medication and with AVS training, n=21.

Group B —ADHD with medication and AVS training, n=27.

Group C —ADHD with medication and no AVS training, n=20.

Group D —ADHD self-selected comparison group, n=31.

Hypotheses

The following hypotheses were proposed:

1) Upon completion of AVS training, there will be a significant difference among group's from baseline to post-testing periods in cognitive functioning, as demonstrated by IQ scores (WRAT-R, WRAT-S, WRAT-M, PPVT, and Raven = s);

a) The AVS + Stimulant Medication group will indicate significant changes on the WRAT-R, WRAT-S, WRAT-M, PPVT, and Raven = s between baseline and post-testing periods when compared to AVS, Stimulant Medication, and Self-Selected Comparison groups.

b) The AVS group will have significantly higher scores on the WRAT-R, WRAT-S, WRAT-M, PPVT, and Raven = s when compared to Stimulant Medication and Self-selected Comparison group;

c) The Stimulant Medication group will have significantly higher scores on the WRAT-R, WRAT-S, WRAT-M, PPVT, and Raven = s when compared to the Self-selected Comparison group.

d) The Self-Selected Comparison group will show no significant changes on the WRAT-R, WRAT-S, WRAT-M, PPVT, and Raven = s.

2. Upon completion of AVS training, there will be a significant difference among group's from baseline to posttesting periods in behavioral functioning as demonstrated by scores on the IVA and ADDES for those who complete the AVS training.

a) The AVS + Stimulant Medication group will have significantly higher scores on the IVA and ADDES when compared with AVS, Stimulant Medication, and Self-selected Comparison group.

b) The AVS group will have significantly higher scores on the IVA and ADDES when compared with Stimulant Medication and Self-selected Comparison group.

c) The Stimulant Medication group will have significantly higher scores on the IVA and ADDES when compared with the Self-selected Comparison group.

d) The Self-Selected Comparison group will show no significant changes on the IVA and ADDES.

Addition of Intermediate Visual and Auditory Test

The addition of the IVA computerized test was selected to enhance the ability to record small changes in the response control and attention span of the individual. The IVA can be used to quantify the changes of attention and response control to the test

which are considered a precursor to improved cognitive functioning (Sanford, 1995). Additionally, the IVA had not been used in this capacity and to the researchers = knowledge was the first extensive use of the instrument to measure response control and attention span changes in the individual after AVS treatment. However, it had been utilized to measure effectiveness of pharmacological and behavioral intervention (Sanford, 1995). Therefore, the IVA had important quantitative properties that were used in this study enabling it to become a unique tool for evaluating cognitive functioning of the individual.

Data collection Method

The original study and data collection were conducted by Carter and Russell (1995) and was funded by the U.S. Department of Education (SBIR No. RA941300002). The data were collected at the Behavioral Medicine Clinic which is part of The University of Texas Medical Branch at Galveston, a clinical resource whose clinical population averages more than 17,000 per year. Additionally, a small number of subjects were obtained from a private clinical population referred by pediatricians, psychiatrists, psychologists, and social workers. Beginning in the summer of 1997 and ending in the fall of 1998, data were collected on 25 subjects to satisfy the requirements of the grant. However, the Behavioral Medicine Clinic/Family Health Care Centers continued the data collection means to a total of 99 subjects to allow for further analysis in this study. Thus, this is considered a secondary analysis study.

Demographic data of age, sex, marital status of parents, and employment status were obtained for all subjects and retrieved from their medical records by the researcher. Additionally, the protocol was reviewed and approved by The University

of Texas Medical Branch (Galveston) Human Subject review committee (IRB # 96-047). Prior to participation in the study, informed consents were obtained from all participants in the study, either by the researcher or one of his assistants (see appendix B). Additional approval was obtained from the University of Houston committee for the Protection of Human Subjects for the purpose of analyzing secondary data (see appendix C). In addition any questions pertaining to the research protocol and training were referred to the primary researcher.

The possibility of random assignment of subjects to the study groups was not feasible due to constraints and restrictions imposed by the nature of the ADHD population and the use of secondary data. Specific restraints included available time of the parents to supervise their child while training, commitment of time by the child and parents to engage in the training sessions, and the reluctance of parents to take their child on and off of medication for extended periods of time. To control for the possibility of any biases in testing, the majority of testing was completed by trained research assistants.

Placing the subjects into the 4 subgroups allowed for the following study samples:

1) AVS only group: n = 21.

2) AVS + Stimulant Medication group: n = 27

3) Stimulant Medication only group: n = 20

4) Self-selected comparison group (no AVS, no Med): n = 31.

Self-selected comparison group assignment

One of the weaknesses noted in previous research literature in respect to design was the lack of a true comparison group (Lubar & Lubar, 1984; Lubar et al., 1985;

Lubar, 1993; Carter & Russell, 1995; Timmermann et al., 1998). For the purpose of this study a comparison group was obtained that consisted of individuals whose parents routinely discontinued the medication throughout the summer vacation period. Additionally, there were a small number of subjects that had the diagnosis of ADHD but whose parents decided not to address the problem at the time of data collection. The decision to discontinue medication was made by the parents and by the attending medical doctors' (not by the researcher).

Non-probability/purposive sampling

This study used a nonprobability form of sampling due to the clinical nature of the ADHD population. Specifically, a purposive sample was drawn to obtain a representative sample of the total population of ADHD individuals (Kerlinger, 1986). Subjects were placed in specific self-selected groups depending upon their commitment to engage in a non-pharmacological intervention, willingness to be off medications, and/or willingness to have a combination of medication and/or treatment.

Testing Periods

The first testing period for all groups was completed after the referral had been made and the subject deemed appropriate for the possibility of AVS training. This initial testing period was considered the baseline evaluation. All subjects in the study were tested off medication to obtain a true baseline for statistical comparison. The second period of testing occurred immediately after the 40th training session was completed by the individual. The third and final testing period was administered four weeks after the post-training evaluation period. The groups that did not receive AVS treatment (i.e., the medication group and the self-selected comparison group) were

tested 40 days after baseline measurement to approximate the same time frame as the two groups who received AVS treatment. Finally, the groups who did not receive AVS treatment had a third testing period one month after their second testing date.

More specifically, the self-selected comparison group was obtained and tested without medication, and subsequent testing was absence of intervention and medication. The medication/AVS treatment group was tested off medication at baseline and then was placed on their stimulant medication for the AVS treatment. This group remained on their medication for the post testing periods. The medication only group was tested off medication and then placed on their stimulant medication with a 4-week follow-up testing to approximate the same period of time as in the other three groups. Graphically, the testing periods are as follows:

1st Testing Period 2nd Testing Period 3rd Testing Period

X---------- > ----------X---------- > ----------X

Baseline (no medication) After training 1 month follow-up

Training Procedure

After receiving an ADHD child from one of the above-mentioned referral sources, the child and parent/s were instructed in detail about the procedures of the study and consent forms were completed and signed. The ADHD child was then tested (baseline) and assigned to the appropriate group. As stated above, consideration for optimal testing was employed and was provided for all subjects. Upon completion of

baseline testing those individuals who were assigned to either the AVS group or the AVS + Med group received specific instructions on how to use Carter = s and Russell = s AVS-130 training unit (AVS, 1992). The training consisted of 20 minute sessions five days a week up to a total of 40 sessions. The first training session was administered by the researcher or a research assistant who completed training in the use of this specialized form of treatment. The ADHD child sat in a comfortable office setting and was fully instructed on the procedure. The first training session was observed by the researcher or by a trained research assistant to ensure proper use and functioning of the AVS-130 training unit. The 39 subsequent training sessions were completed at home and were supervised and recorded by a parent or legal guardian. The ADHD individual wore a specialized pair of glasses that contained the LEDs. The subjects were also instructed to keep their eyes closed throughout the training session. At that time, the AVS unit 20-minute program was initiated by either a parent or by the child. The AVS unit was programed to begin with both auditory and visual stimulation at 10 hertz. This stimulation would last for a total of 2 minutes and at that time visual stimulation would cease and only auditory stimulation would continue for 1 minute. After the auditory only stimulation, the AVS unit would switch to both auditory and visual stimulation at 18 hertz for 2 minutes. Upon completion of this 2-minute cycle, the unit would automatically return to the beginning of the program. In essence the subject would experience 4 complete cycles (5 minutes per cycle) for the completion of a 20-minute training session. Subsequently, the subject used a pair of headphones to receive the auditory stimulation. Additional home AVS-130 units were issued after procedural training was completed and mastered by the parent and/or child. The

number of sessions were then monitored and tracked by the researcher and the parent's (see Appendix D). After the completion of 40 sessions, the child was to return to the office and complete the second battery of tests (post-test). The same tests and procedures at the baseline were employed and replicated for the second and subsequently the post-four weeks testing periods. The Medication group started their stimulant medication without further intervention from the researcher. The self-selected comparison group did not receive any further intervention other than the testing periods from the researcher. Upon completion of training and/or requirements for all four groups, appropriate statistical analysis was applied.

Internal validity and generalizability

The issue of internal validity was one problem that needed to be addressed in the research protocol. A specific consideration and concern was the testing or practice effect that could occur when an individual was tested repeatedly over time. The tests (measurements) were carefully selected for their high reliability and validity characteristics. In addition, by the design of the study, a significant period of time between testing periods reduced the possible occurrence of a practice effect by the subject.

Additionally, the research design addressed the question of generalizability (external validity) with all subjects. The baseline testing was completed without any medication which allowed the researcher to compare all groups equally. This was a major deviation from the original study. The original study did not have all subjects tested off medication, thus the possibility that the groups might have been inherently different from the beginning of the study was originally problematic. To the

researchers = knowledge, this has been the first study that had all groups tested off medication under the same conditions. This research design allowed for comparison of data from baseline to

post-testing. After baseline testing was completed, the subjects were placed in their respective groups. The researcher was aware of the subject = s group assignment. This process was considered a threat to the internal validity of the study, thus the majority of testing and training was completed by trained research assistants in an attempt to reduce this effect. In addition, the current study employed the largest number of individuals to date with regard to this field of investigation, thus helping to increase the generalizability of the findings. Finally, the current study was composed of individuals of different gender and race, a diversity that was lacking in previous research and in the original study.

Power Analysis

A power analysis was conducted to determine appropriate sample size. The power analysis indicated that an n = 20 in each group would be able to detect changes from the self-selected comparison group of at least 10% from the mean (Borenstein, Rothstein, & Cohen, 1997). Thus, this became the anticipated effect size. In addition, the alpha value was set at .05 level requiring a p-value of 0.05 or less to establish statistical significance (Borenstein, Rothstein, & Cohen, 1997). The power was set at the standard 80% level (Borenstein et al). There were two Factors used in the study. Factor I was *Treatment* and has four separate levels which included the treatment only group, treatment and medication group, medication only group, and a self-selected comparison group. Factor II was *Time* which contained three levels. The first level

was the baseline measurement or Time I. The second testing period (Time II) occurred after 40 daily training sessions on the AVS unit. The groups that did not receive AVS treatment (i.e., medication group and self-selected comparison group) were tested 40 days after baseline measurement to approximate the same time frame as the two groups who received AVS treatment. The third level of measurement was designed to occur one month after the second testing period for all four groups. Baseline testing for all four groups was conducted off medication to detect any differences at the beginning of the study. The combination of Factor I and Factor II was to allow the researcher to determine the interaction effect of *Treatment* and *Time* among the groups.

Data Analysis Plan

Data were analyzed using univariate and multivariate statistical procedures that included repeated measures Multivariate Analysis of Variance (MANOVA). In addition repeated measures ANOVA = s and post-hoc Bonferroni were used to determine mean differences (Tabachnick & Fidell, 1989).

Utilization of repeated measures Multivariate Analysis of Variance (MANOVA)

Mean differences among groups were evaluated by repeated measures MANOVAs. One advantage of the repeated measures MANOVA is its capability to measure group differences among groups with a combination of dependent variables. This form of statistical analysis creates a new dependent variable that maximizes group differences. This new dependent variable is generated from the set of dependent variables in the study. This process enhances the separation of groups differences to allow the researcher the assess different treatments and their interactions as measured by multiple dependent variables. Thus, the repeated measures MANOVA may allow

differences to be measured that would not be detected by ANOVA = s (Kinnear & Gray, 1997; Motulsky, 1995; Tabachnick & Fidell, 1989).

Utilization of Analysis of Variance (ANOVA)

To reliably assess differences among group means, ANOVA was used. Because ANOVA can test differences between two or more means, it becomes another tool to identify mean differences among groups. Thus, ANOVA was used to assess differences in the dependent variables. ANOVA is a comparison of estimates of variances. One of the estimates is the different mean scores within each group. These scores are considered random variance (error). The other estimate is the different group mean scores and delineates group differences (treatment effects plus error) (Tabachnick & Fidell, 1989). If group means differ significantly, the differences are assumed to be due to treatment effects (Kinnear & Gray, 1997; Motulsky, 1995; Tabachnick & Fidell, 1989).

Utilization of the Bonferronis Multiple Comparison Test

Bonferroni = s Multiple Comparison Test was used to assess multiple means differences among groups. These differences were generated from baseline testing to either second and/or third testing period. In addition, means differences can also be obtained from second and third testing periods. The difference in test scores (DVs) allow the researcher the ability to rule out that the change was generated by chance and was due to a specific intervention. Due to the small number of subjects and lack of equal number of cases in each group, Bonferroni = s test was a viable tool. In addition, Bonferroni = s post-hoc test is used to reduce the likelihood of committing a Type II error (Kinnear & Gray, 1997; Motulsky, 1995; Tabachnick & Fidell, 1989).

Chapter III focused on the methodological aspects of the study. In addition independent and dependent variables were introduced. Cognitive and behavioral hypotheses were also described in this chapter. Chapter IV will now describe the results of the current study. Demographics and statistical significant data will also be presented.

Chapter IV

Results

Overview

The results of the study will be presented in two sections. Part I will contain the results of descriptive statistics of the study population. In addition, statistical significance will also be presented in reference to the proposed study hypotheses. This includes the results of cognitive changes as measured by using the Wide Range Achievement Test (WRAT-S, WRAT-R, & WRAT-M), Peabody Picture Vocabulary Test (PPVT), and the Raven = s Progressive Matrices. The five tests listed above are the Dependent Variables and are considered IQ test to measure cognitive functioning of an individual. Higher scores on the five tests indicate improvement in generalized IQ performance. Part II will contain the results of descriptive statistics of the study sample. In addition, statistical significance will also be presented in reference to the proposed study hypotheses. Behavioral changes in the form of higher scores on the Intermediate Visual and Auditory Continuous Performance Test (IVA) and the Attention Deficit Disorder Evaluation Scale (ADDES). The IVA and the ADDES are the Dependent Variables.

Descriptive Statistics of Study Participants

Initial univariate statistics were performed to describe the general demographics of the study sample (n = 99). As expected, the variable gender comprised of 88 males (88.9%) and 11 (11.1%) females which is a typical distribution of the ADHD population as described by DSM-IV. The variable ethnicity demographics was also typical of DSM-IV findings which included: White (n = 77; 77.8%), African-American

(n = 10; 10.1%), Hispanic (n = 8; 8.1%), Other (n = 4; 4.0%). The age distribution was: 6 (n = 1; 1%), 7 (n = 16; 16.2%), 8 (n = 15; 15.2%), 9 (n = 19; 19.2), 10 (n = 16; 16.2%), 11 (19; 19.2), 12 (n = 9; 9.0%), 13 (n = 4; 4.0%) with a mean of 10.069. The study groups were divided into: AVS treatment only group (n = 21; 21.2%), AVS & Medication group (n = 27; 27.3%), Medication group (n = 20; 20.2%), Self-Selected Comparison group (n = 31; 31.3%). See Table 1 for summary.

Table 1

Demographic Variables (n = 99)

	N	%
GENDER		
Male	88	88.9
Female	11	11.1
ETHNICITY		
White	77	77.8
African-American	10	10.1
Hispanic	8	8.1
Other	4	4
AGE		
6	1	1
7	16	16.2
8	15	15.2
9	19	19.2
10	16	16.2
11	19	19.2
12	9	9
13	4	4
Mean age (10.069)		
TREATMENT GROUP		
AVS	21	21.2
AVS + Medication	27	27.3
Medication Only	20	20.2
Self-Selected Comparison Group	31	31.3

Note: AVS = Audio Visual Stimulation

Hypothesis 1: Univariate statistics of Cognitive Dependent Variables

The first hypothesis stated that upon completion of AVS training there will be a significant difference among groups from baseline to posttesting periods in cognitive functioning as demonstrated by IQ scores Wide Range Achievement Test-Revised (WRAT-R, WRAT-S, & WRAT-M), Peabody Picture Vocabulary Test (PPVT) and the Raven = s Progressive Matrices for those who complete the AVS training. The results below represent mean changes in the cognitive variables. See Table 2 for mean score changes across time for the cognitive dependent variables scores.

AVS group Cognitive mean scores across time

The AVS group mean scores are as follows: The WRAT-R (reading) mean score was 99.48 at baseline (n = 99; SD 17.49; range 73-136); second testing period mean score was 103.1 (n = 99; SD 16.97; range 74-135); the third testing period mean score was 106.8 (n = 99; SD 16.49; range 76-136). The WRAT-S (spelling) mean score was 90.62 at baseline (n = 99; SD 14.31; range 69-126); second testing period mean score was 97.48 (n = 99; SD 17.41; range 71-136); the third testing period mean score was 98.81 (n = 99; SD 16.62; range 73-133). The WRAT-M (math) mean score was 100.2 at baseline (n = 99; SD 18.4568-146); second testing period mean score was 101.2 (n = 99; SD 20.24; range 74-154); the third testing period mean score was 100.4 (n = 99; SD 21.14; range 73-154).

The PPVT mean score at baseline was 110.8 (n = 99; SD 19.48; range 75-141); second testing period mean score was 110.1 (n = 99; SD 15.57; range 85-150); the third testing period mean score was 114.0 (n = 99; SD 17.65; range 87-148).

The Raven = s mean score at baseline was 113.4 (n = 99; SD 12.36; range 90-125); second testing period mean score was 118.5 (n = 99; SD 10.23; range 99-125); the third testing period mean score was 120.6 (n = 99; SD 8.369; range 100-125). See Table 2 for summary.

TABLE 2

AVS Group Cognitive Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
WRAT-R				
	1	99.48	17.49	73-136
	2	103.1	16.97	74-135
	3	106.8	16.94	76-136
WRAT-S				
	1	90.62	14.31	69-126
	2	97.48	17.41	71-136
	3	98.81	16.62	73-133
WRAT-M				
	1	100.2	18.45	68-146
	2	101.2	20.24	74-154
	3	100.4	21.14	73-154
PPVT				
	1	110.8	19.48	75-141
	2	110.1	17.57	85-150
	3	114.0	17.65	87-148
RAVEN = S				
	1	113.4	12.36	90-125
	2	118.5	10.23	99-125
	3	120.6	8.369	100-125

Note. WRAT-* = Wide Range Achievement Test-Revised, R(Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, RAVEN = s = Raven = s Progressive Matrices

AVS + Stimulant Medication Cognitive group mean scores across time

The AVS + Stimulant Medication group mean scores are as follows: The WRAT-R (reading) mean score was 97.67 at baseline (n = 99; SD 22.05; range 55-136); second testing period mean score was 105.5 (n = 99; SD 20.07; range 63-136); the third testing period mean score was 110.8 (n = 99; SD 20.54; range 68-142). The WRAT-S (spelling) mean score was 94.22 at baseline (n = 99; SD 18.93; range 57-128); second testing period mean score was 98.78 (n = 99; SD 23.44; range 62-143); the third testing period mean score was 100.9 (n = 99; SD 22.35; range 70.140). The WRAT-M (math) mean score was 94.93 at baseline (n = 99; SD 15.24; range 61-124); second testing period mean score was 99.15 (n = 99; SD 17.80; range 54-133); the third testing period mean score was 100.8 (n = 99; SD 15.74; range 61-132).

The PPVT mean score at baseline was 113.8 (n = 99; SD 17.83; range 75-146); second testing period mean score was 114.9 (n = 99; SD 16.62; range 86-145); the third testing period mean score was 118.8 (n = 99; SD 17.65; range 81-146).

The Raven = s mean score at baseline was 104.6 (n = 99; SD 23.71; range 29-125); second testing period mean score was 108.4 (n = 99; SD 24.90; range 32-125); the third testing period mean score was 110.4 (n = 99; SD 24.7; range 33-127). See Table 3.

Table 3

AVS and Stimulant Medication Group Cognitive Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
WRAT-R				
	1	99.67	22.05	55-136
	2	105.5	20.07	63-136
	3	110.8	20.54	68-142
WRAT-S				
	1	94.22	18.93	57-128
	2	98.78	23.44	62-143
	3	100.9	22.35	70-140
WRAT-M				
	1	94.93	15.24	61-124
	2	99.15	17.80	54-133
	3	100.8	15.74	61-132
PPVT				
	1	113.8	17.83	75-146
	2	114.9	16.62	86-145
	3	118.8	17.65	81-146
RAVEN = S				
	1	104.6	23.71	29-125
	2	108.4	24.90	32-125
	3	110.4	24.7	33-127

Note. WRAT-* = Wide Range Achievement Test-Revised, (Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, RAVEN = s = Raven = s Progressive Matrices

Stimulant Medication Cognitive group mean scores across time

The Stimulant Medication group mean scores are as follows: The WRAT-R (reading) mean score was 107.8 at baseline (n = 99; SD 24.74; range 56-154); second testing period mean score was 110.3 (n = 99; SD 24.03; range 61-146); the third testing period mean score was 111.9 (n = 99; SD 24.90; range 58-157). The WRAT-S (spelling) mean score was 103.2 at baseline (n = 99; SD 22.43; range 68-155); second testing period mean score was 102.2 (n = 99; SD 19.27; range 70.140); the third testing period mean score was 103.5 (n = 99; SD 21.59; range 70.147). The WRAT-M (math) mean score was 100.2 at baseline (n = 99; SD 19.67; range 61-154); second testing period mean score was 99.60 (n = 99; SD 18.48; range 55-142); the third testing period mean score was 98.5 (n = 99; SD 16.10; range 55-128).

The PPVT mean score at baseline was 116.0 (n = 99; SD 16.28; range 95-145); second testing period mean score was 121.0 (n = 99; SD 14.49; range 94-147); the third testing period mean score was 117.7 (n = 99; SD 14.77; range 95-145).

The Raven = s mean score at baseline was 113.3 (n = 99; SD 12.94; range 90-125); second testing period mean score was 115.4 (n = 99; SD 9.605; range 95-125); the third testing period mean score was 117.8 (n = 99; SD 9.094; range 100-125). See Table 4.

Table 4
Stimulant Medication Group Cognitive Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
WRAT-R				
	1	107.8	24.74	56-154
	2	110.3	24.03	61-146
	3	111.9	24.90	58-157
WRAT-S				
	1	103.2	22.43	68-155
	2	102.2	19.27	70-140
	3	103.5	21.59	70-147
WRAT-M				
	1	100.2	19.67	61-154
	2	99.60	18.48	55-142
	3	98.5	16.10	55-128
PPVT				
	1	116.0	16.28	95-145
	2	121.0	14.49	94-147
	3	117.7	14.77	95-145
RAVEN'S				
	1	113.3	12.94	90-125
	2	115.4	9.605	95-125
	3	117.8	9.094	100-125

Note. WRAT-* = Wide Range Achievement Test-Revised, R(Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, RAVEN's = Raven's Progressive Matrices

Self Selected Comparison Group Cognitive mean scores across time

The Self-selected Comparison group mean scores are as follows: The WRAT-R (reading) mean score was 102.6 at baseline (n = 99; SD 17.61; range 72-138); second testing period mean score was 102.3 (n = 99; SD 19.41; range 60-141); the third testing period mean score was 102.9 (n = 99; SD 18.89; range 69-143). The WRAT-S (spelling) mean score was 95.03 at baseline (n = 99; SD 15.98; range 69-127); second testing period mean score was 93.65 (n = 99; SD 18.46; range 53-127); the third testing period mean score was 94.03 (n = 99; SD 17.84; range 60.126). The WRAT-M (math) mean score was 92.19 at baseline (n = 99; SD 18.18; range 24-126); second testing period mean score was 92.16 (n = 99; SD 11.66; range 68-115); the third testing period mean score was 92.65 (n = 99; SD 13.43; range 57-126).

The PPVT mean score at baseline was 105.5 (n = 99; SD 19.09; range 60-145); second testing period mean score was 108.1 (n = 99; SD 20.43; range 60-150); the third testing period mean score was 106.9 (n = 99; SD 17.81; range 77-145).

The Raven = s mean score at baseline was 112.9 (n = 99; SD 14.01; range 77-125); second testing period mean score was 114.9 (n = 99; SD 13.18; range 77-125); the third testing period mean score was 111.9 (n = 99; SD 18.74; range 35-125). See Table 5.

Table 5

Self Selected Comparison Group Cognitive Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
WRAT-R	1	102.6	17.61	72-138
	2	102.3	19.41	60-141
	3	102.9	18.89	69-143
WRAT-S	1	95.03	15.98	69-127
	2	93.65	18.46	53-127
	3	94.03	17.84	60-126
WRAT-M				
	1	92.19	18.18	24-126
	2	92.16	11.66	68-115
	3	92.65	13.43	57-126
PPVT				
	1	105.5	19.09	60-145
	2	108.1	20.43	60-150
	3	106.9	17.81	77-145
RAVEN = S				
	1	112.9	14.01	75-125
	2	114.9	13.18	77-125
	3	111.9	18.74	35-125

Note. WRAT-* = Wide Range Achievement Test- Revised, (Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, RAVEN = s = Raven = s Progressive Matrices

Cronbach's Alpha Reliability Analysis of Dependent Cognitive Variables

Reliability of the dependent variables were tested using Cronbach's alpha to determine consistency of each variable (Kinner & Gray, 1997). Scores closer to 1.0 indicated good reliability of the dependent variables. Scores below .60 indicate poor reliability in the dependent variables. Internal consistency or reliability of the dependent variables indicated Cronbach's alpha of .9718 for the WRAT-R (reading). The WRAT-S (spelling) indicated a Cronbach's alpha of .9626. The WRAT-M (math) Cronbach's alpha was .9035. The Peabody Picture Vocabulary test indicated a Cronbach's alpha of .9429. The Ravens Progressive Matrices indicated a Cronbach's alpha of .9269. All of the dependent measures had alpha readings in the acceptable range. See Table 6.

Table 6

Cronbach's Alpha for Cognitive Test Scores

TEST	CRONBACH'S ALPHA	N
WRAT-R	.9718	99
WRAT-S	.9626	99
WRAT-M	.9035	99
PPVT	.9429	99
RAVEN'S	.9269	99

Note. WRAT-* = Wide Range Achievement Test, R(Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, Raven's Progressive Matrices

Hypothesis 2: Univariate Statistics of Behavioral Dependent Variables

The second hypothesis stated that upon completion of AVS training there will be a significant difference among groups from baseline to posttesting periods in behavioral functioning as demonstrated by scores on the IVA and ADDES for those who complete the AVS training. The results below indicate mean changes in the dependent variables. See following tables of changes in means scores by group.

AVS Group Behavioral mean scores across time

The AVS group mean scores are as follows: The ADDES-HYP (hyperactivity) mean score was 7.190 at baseline (n = 99; SD 3.250; range 2-13); second testing period mean score was 9.19 (n = 99; SD 2.892; range 0-14); the third testing period mean score was 9.476 (n = 99; SD 3.061; range 3-15). The ADDES-INT (inattentiveness) mean score was 4.476 at baseline (n = 99; SD 2.768; range 0-10); second testing period mean score was 7.143 (n = 99; SD 2.762; range 1-11); the third testing period mean score was 7.762 (n = 99; SD 2.682; range 2-12).

The IVAA (attention span) mean score was 87.90 at baseline (n = 99; SD 18.79; range 56-124); second testing period mean score was 93.43 (n = 99; SD 13.79; range 63-110); the third testing period mean score was 96.81 (n = 99; SD 12.78; range 70-112). The IVAR (response control) mean score at baseline was 95.67 (n = 99; SD 12.42; range 75-118); second testing period mean score was 98.14 (n = 99; SD 11.41; range 75-118); the third testing period mean score was 99.67 (n = 99; SD 9.789; range 87-122). See Table 7.

Table 7

AVS Group Behavior Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
ADDES-HYP				
	1	7.190	3.250	2-13
	2	9.190	2.892	0-14
	3	9.476	3.061	3-15
ADDES-INT				
	1	4.476	2.768	0-10
	2	7.143	2.762	1-11
	3	7.762	2.682	2-12
IVAA				
	1	87.90	18.79	56-124
	2	93.43	13.79	63-110
	3	96.81	12.78	70-112
IVAR				
	1	95.67	12.42	75-118
	2	98.14	11.41	75-118
	3	99.67	9.789	87-122

Note. ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test , A(Attention), R(Response Control)

AVS + Stimulant Medication Group Behavioral mean scores across time

The AVS + Stimulant Medication group mean scores are as follows: The ADDES-HYP (hyperactivity) mean score was 5.556 at baseline (n = 99; SD 2.547; range 0.10); second testing period mean score was 7.481 (n = 99; SD 2.833; range 0-13); the third testing period mean score was 7.778 (n = 99; SD 2.778; range 1-15). The ADDES-INT (inattentiveness) mean score was 4.704 at baseline (n = 99; SD 2.181; range 0-9); second testing period mean score was 6.185 (n = 99; SD 2.746; range 0-11); the third testing period mean score was 6.481 (n = 99; SD 2.651; range 1-12).

The IVAA (attention span) mean score was 79.19 at baseline (n = 99; SD 23.38; range 19-115); second testing period mean score was 88.52 (n = 99; SD 25.49; range 36-121); the third testing period mean score was 89.89 (n = 99; SD 26.87; range 21-129). The IVAR (response control)mean score at baseline was 82.44 (n = 99; SD 30.1; range 11-130); second testing period mean score was 99.44 (n = 99; SD 15.23; range 63-133); the third testing period mean score was 102.7 (n = 99; SD 13.79; range 69-126). See Table 8.

Table 8

AVS and Stimulant Medication Group Behavior Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
ADDES-HYP				
	1	5.556	2.547	0-10
	2	7.481	2.833	0-13
	3	7.778	2.778	1-15
ADDES-INT				
	1	4.704	2.181	0-9
	2	6.185	2.746	0-11
	3	6.481	2.651	1-12
IVAA				
	1	79.19	23.38	19-115
	2	88.52	25.49	36-121
	3	89.89	26.87	21-129
IVAR				
	1	82.44	30.12	11-130
	2	99.44	15.23	63-133
	3	102.7	13.79	69-126

Note. ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test , A(Attention), R(Response Control)

Stimulant Medication Group Behavioral mean scores across time

The Stimulant Medication group mean scores are as follows: The ADDES-HYP (hyperactivity) mean score was 6.600 at baseline (n = 99; SD 3.633; range 0.11); second testing period mean score was 7.200 (n = 99; SD 2.783; range 2-13); the third testing period mean score was 6.600 (n = 99; SD 3.169; range 1-13). The ADDES-INT (inattentiveness) mean score was 4.90 at baseline (n = 99; SD 2.337; range 0-8); second testing period mean score was 6.350 (n = 99; SD 3.167; range 0-13; the third testing period mean score was 6.950 (n = 99; SD 3.395; range 1-13).

The IVAA (attention span) mean score was 82.80 at baseline (n = 99; SD 28.99; range 11-130); second testing period mean score was 86.65 (n = 99; SD 27.25; range 12-125); the third testing period mean score was 79.95 (n = 99; SD 28.82; range 14-120). The IVAR (response control)mean score at baseline was 97.20 (n = 99; SD 20.59; range 38-135); second testing period mean score was 101.7 (n = 99; SD 20.72; range 35-132); the third testing period mean score was 95.35 (n = 99; SD 23.91; range 32.130). See Table 9 for summary.

Table 9

Stimulant Medication Group Behavior Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
ADDES-HYP				
	1	6.600	3.633	0-11
	2	7.200	2.783	2-13
	3	6.600	3.169	1-13
ADDES-INT				
	1	4.90	2.337	0-8
	2	6.350	3.167	0-13
	3	5.950	3.395	1-13
IVAA				
	1	82.80	28.99	11-130
	2	86.65	27.25	12-125
	3	79.95	28.82	14-120
IVAR				
	1	97.20	20.59	38-135
	2	101.7	20.72	35-132
	3	95.35	23.91	32-130

Note. ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test , A(Attention), R(Response Control)

Self-selected Comparison Group Behavioral mean scores across time

The Self-selected comparison group mean scores are as follows: The ADDES-HYP (hyperactivity) mean score was 5.710 at baseline (n = 99; SD 3.589; range 0-13); second testing period mean score was 5.935 (n = 99; SD 3.530; range 0-13); the third testing period mean score was 6.065 (n = 99; SD 3.356; range 1-13). The ADDES-INT (inattentiveness) mean score was 4.452 at baseline (n = 99; SD 3.129; range 0-13); second testing period mean score was 4.871 (n = 99; SD 3.212; range 0-13); the third testing period mean score was 5.097 (n = 99; SD 2.982; range 0-13).

The IVA-A (attention span) mean score was 87.77 at baseline (n = 99; SD 16.38; range 38-110); second testing period mean score was 84.87 (n = 99; SD 15.91; range 47-105); the third testing period mean score was 83.45 (n = 99; SD 19.41; range 39-111). The IVA-R (response control) mean score at baseline was 99.68 (n = 99; SD 16.35; range 58133); second testing period mean score was 96.87 (n = 99; SD 17.20; range 41-126); the third testing period mean score was 97.61 (n = 99; SD 17.27; range 60-130). See Table 10.

Table 10

Self Selected Comparison Group Behavior Test Summary Statistics

TEST	TEST PERIOD	MEAN	STANDARD DEVIATION	RANGE
ADDES-HYP				
	1	5.710	3.589	0-13
	2	5.935	3.530	0-13
	3	6.065	3.356	1-13
ADDES-INT				
	1	4.452	3.129	0-13
	2	4.871	3.212	0-13
	3	5.097	2.982	0-13
IVAA				
	1	87.77	16.38	38-110
	2	84.87	15.91	47-105
	3	83.45	19.41	39-111
IVAR				
	1	99.68	16.35	58-133
	2	96.87	17.20	41-126
	3	97.61	17.27	60-130

Note. ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test, A(Attention), R(Response Control)

Cronbach's Alpha Reliability Analysis of Dependent Behavioral Variables

Additionally, Cronbach's alpha was also completed on all the behavioral dependent variables. The ADDES-HYP dependent variable indicated a Cronbach's alpha of .9102. The ADDES-INT dependent variable indicated a Cronbach's alpha of .8604. The IVA-A alpha was .8302 while the IVA-R alpha indicated .7406. All of the dependent behavioral measure alphas were in the acceptable range. See Table 11

Table 11

Cronbach's Alpha for Behavior Test Scores

TEST	CRONBACH'S ALPHA	N
HAW-INT	.8604	99
HAW-HYP	.9102	99
IVA-R	.7406	99
IVA-A	.8302	99

Note. ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test, A(Attention), R(Response Control)

Part I: Results based on Major Cognitive Hypotheses

In the following pages the repeated measures MANOVA results will be presented to address the proposed cognitive hypotheses. In addition, ANOVA results will also be presented by group. Finally, Bonferroni's multiple comparison test results will also be presented by group and by testing period.

Repeated Measures MANOVA Results for Changes in Cognitive Functioning by AGroup@x ACognitive@

The major cognitive hypothesis (Hypothesis 1) stated that upon completion of AVS training there would be a significant difference among groups from baseline to posttesting periods in cognitive functioning as demonstrated by IQ scores (WRAT-R WRAT-S, WRAT-M, PPVT, and Raven = s) for those who complete the AVS training. The results of the repeated measures MANOVA procedure for specific groups across baseline and posttesting periods as measured by changes in IQ scores indicated that time and group involvement made a significant difference. The repeated measures MANOVA results indicated that at baseline there was not a significant difference between the groups [F(12,272) = 1.06011,NS]. The Hotelling = s trace criterion did not indicate that the group = s cognitive functioning levels were significantly different at baseline if time was not in the equation. Thus, ATime@ is an important factor in the model. The Hotelling = s trace criterion for the collective variable Acognition@ was [F(8,88) = 1.786,NS]. This supports the main hypothesis that across time cognitive functioning did change significantly in some groups. Table 12 presents the multivariate analysis of the effects of AGroup@. The eta-square effect was .046.

Repeated Measures MANOVA model with ATime@ as a Factor

The next factor that the repeated measures MANOVA model evaluated was variable of "Time". The five variables of cognition were added into the model as one dependent variable to determine if across time did the four groups change in their cognitive functioning level as measured by changes in their IQ test scores. The repeated measures MANOVA results indicated that the four groups did indicate change in their functioning levels across time. "Time" showed a Hotellings trace criterion significant effect of [$F(2,94) = 18.15806, p < .000$] for the collective dependent variable of IQ scores at the posttests evaluation. The eta-squared was .202. However, if ATime@ is taken out of the equation the group = s cognitive functioning level does not differ significantly across groups in cognitive functioning levels. Thus, ATime@ is an important factor in the model. This supports the main hypothesis that across time cognitive functioning would change significantly in some groups. Table 12 presents the multivariate analysis of the effects of ATime@ in this model.

Repeated measures MANOVA model with AGroup@ and ATime@ as Factors

The Repeated measures MANOVA model also evaluated the effects of group assignment and time as the two collective factors to evaluate changes in cognitive function levels. The results for AGroup@ by ATime@ showed a Hotellings trace criterion effect of [$F(6,186) = 5.107$, $p < .000$]. These results indicate that across time some groups improved their cognitive functioning levels as compared to other group/s who did not improve.

The summary of the repeated measures MANOVA results are as follows. The factor of "Group" x "Time" indicated [$F\ 5.107\ (6,186)$, $p < 0.000$]. The eta-squared

was .145. The factor of “Time” was [F 18.158 (2,94), $p < 0.000$]. The eta-squared was .202. The factor of “Cognitive” was [F 35.771 (4,92), $p < 0.000$]. The eta-squared was .238. The factor of “Cognitive” x “Time” was [F 1.786 (8,88), $p = 0.090$]. The eta-squared was .017. The factor of “Group” x “Cognitive” was [F 1.061 (12,272), $p = 0.394$]. The eta-squared .035. The factor of “Group” x “Time” x “Cognitive” was [F 1.38 (24,260), $p = 0.116$]. The eta-squared was .039. See Table 12 for summary.

Table 12
MULTIVARIATE ANALYSIS OF VARIANCE FOR COGNITIVE TEST SCORES

Factor	F value	Significance of F	Eta- square
Group x Time	5.107 (6,186)	$p < 0.000$	.145
Time	18.158 (2,94)	$p < 0.000$	.202
Cognitive	35.771 (4,92)	$p < 0.000$	.238
Cognitive x Time	1.786 (8,88)	$p = 0.090$	.017
Group x Cognitive	1.061 (12,272)	$p = 0.394$	.035
Group x Time x Cognitive	1.38 (24, 260)	$p = 0.116$	.039

Repeated Measures Analysis of Variance (ANOVA) Across Time for Individual Groups Dependent Variables Cognitive Scores

The first hypothesis stated that upon completion of AVS training there will be a significant difference among groups from baseline to posttesting periods in cognitive functioning as demonstrated by IQ scores (Wide Range Achievement Test (WRAT-R, WRAT-S, WRAT-M), Peabody Picture Vocabulary Test (PPVT) and the Raven's Progressive Matrices for those who complete the AVS training. The results below support Hypothesis 1 that AVS training did improve the functioning levels of the groups. See Table 5 for Repeated measures Analysis of Variance (ANOVA) statistics of cognitive dependent variables scores. The results are presented by group:

1) AVS Group (AVS only group)

a) The WRAT-R (reading) dependent variable was $p < 0.0001$. Significant at the 0.001 level.

b) The WRAT-S (spelling) dependent variable was $p = 0.0073$. Significant at the 0.01 level.

c) The WRAT-M (math) dependent variable was $p = 0.8718$, NS.

d) The PPVT dependent variable was $p = 0.1498$, NS.

e) The Raven's dependent variable was $p = 0.0002$. Significant at the 0.001 level.

2) AVS + Medication Group (AVS and stimulant group)

a) The WRAT-R (reading) dependent variable was $p < 0.0001$. Significant at the 0.001 level.

b)The WRAT-S (spelling) dependent variable was $p = 0.0030$. Significant at the 0.01 level.

c) The WRAT-M (math) dependent variable was $p = 0.1166$, NS.

d) The PPVT dependent variable was p = 0.0469. Significant at the 0.05 level.

e) The Raven's dependent variable was p = 0.0059. Significant at the 0.01 level.

3) Stimulant Medication Group (Medication only group)

a) The WRAT-R (reading) dependent variable was $p < 0.0244$. Significant at the 0.05 level.

b) The WRAT-S (spelling) dependent variable was p = 0.5309, NS.

c) The WRAT-M (math) dependent variable was p = 0.7556, NS.

d) The PPVT dependent variable was $p = 0.1958$, NS.

e) The Raven's dependent variable was p = 0.0062. Significant at the 0.01 level.

4) Control Group (Self-selected Comparison Group)

a) The WRAT-R (reading) dependent variable was $p < 0.7780$, NS.

b) The WRAT-S (spelling) dependent variable was $p = 0.2910$, NS.

c) The WRAT-M (math) dependent variable was $p = 0.9685$, NS.

d) The PPVT dependent variable was 0.1734, NS.

e) The Raven's dependent variable was p = 0.05128, NS.

The summary of the ANOVA's results are presented by group and changes in cognitive scores (see Table 13 for summary).

Table 13

REPEATED MEASURES ANALYSIS OF VARIANCE OF TIME FOR INDIVIDUAL GROUPS COGNITIVE SCORES

Test	p Value	Significance Level
AVS (Group A)		
WRAT-R	$p < 0.001$	0.001
WRAT-S	0.0073	0.01
WRAT-M	0.8718	ns
PPVT	0.1498	ns
RAVEN's	0.0002	0.001
AVS + Medication(Group B)		
WRAT-R	$p < 0.0001$	0.001
WRAT-S	0.0030	0.01
WRAT-M	0.1166	ns
PPVT	0.0469	0.05
RAVEN's	0.0059	0.01
Medication(Group C)		
WRAT-R	0.0244	0.05
WRAT-S	0.5309	ns
WRAT-M	0.7556	ns
PPVT	0.1958	ns
RAVEN's	0.0062	0.01
Self Selected Comparison Group(Group D)		
WRAT-R	0.7780	ns
WRAT-S	0.2910	ns
WRAT-M	0.9685	ns
PPVT	0.1734	ns
RAVEN's	0.5128	ns

Note: WRAT-* = Wide Range Achievement Test-Revised, R(Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, RAVEN's = Raven's Progressive Matrices,

The Bonferroni's Multiple Comparison test results of Cognitive Scores:

1) AVS Group results by testing period

a) WRAT-R (reading) Test Results by Testing Period

The WRAT-R (reading) was significant at $p < 0.05$ level from Test 1 (baseline mean score 99.48) to Test 2 (after training mean score 103.1). In addition, the WRAT-R was also significant from Test 2 to Test 3 (1 month follow-up mean score 106.94). Additionally, Test 1 (baseline mean score 99.48) to Test 3 (1month follow-up mean score 106.94) was also significant at $p < 0.001$ level.

b)WRAT-S (spelling) Test Results by Testing Period

The WRAT-S (spelling) was significant at $p < 0.05$ level from Test 1 (baseline mean score 90.62) to Test 2 (after training mean score 97.48) at the $p < 0.05$ level. In addition, Test 1 (baseline mean score 90.62) to Test 3 (1 month follow-up indicated significant changes at $p < 0.05$ level. No significant change was noted between Test 2 (mean score 97.48) and Test 3 (mean score 98.81).

c) WRAT-M (math) Test Results by Testing Period

The AVS Group did not change on the WRAT-M (math) at any testing period.

2) The AVS + Stimulant Medication Group results by testing period

a) WRAT-R (reading) Test Results by Testing Period

The WRAT-R (reading) was significant at $p < 0.05$ level from Test 1 (baseline mean score 99.67) to Test 2 (after training mean score 105.5). In addition, the WRAT-R was also significant from Test 2 to Test 3 (1 month follow-up mean score 110.8). Additionally, Test 1 (baseline mean score 99.67) to Test 3 (1 month follow-up mean score 110.8) was also significant at $p < 0.001$ level.

b) WRAT-S (spelling) Test Results by Testing Period

The WRAT-S (spelling) was not significantly different from Test 1 (baseline mean score 94.22) to Test 2 (after training mean score 98.78). However, Test 1 (baseline mean score 94.22) to Test 3 (1 month follow-up mean score 100.9) indicated significant changes at $p < 0.01$ level. No significant change was noted between Test 2 and Test 3.

c) WRAT-M (math) Test Results by Testing Period

The AVS group (Group B) did not change on the WRAT-M (math) at any testing period.

3) Stimulant Medication Group results by testing period

a) WRAT-R (reading) Test Results by Testing Period

The WRAT-R (reading) was not significant at $p < 0.05$ level from Test 1 (baseline mean score 107.8) to Test 2 (after training mean score 110.3). In addition, the WRAT-R was not significant from Test 2 to Test 3 (1 month follow-up mean score was 111.9). However, Test 1 (baseline mean score 107.8) to Test 3 (1month follow-up mean score was 111.9) was also significantly different at $p < 0.05$ level.

b) WRAT-S (spelling) Test Results by Testing Period

The WRAT-S (spelling) was not significantly different from Test 1 (baseline mean score was 103.2) to Test 2 (after training mean score was 102.2). No significant change was noted between Test 2 and Test 3 and from Test 1 (baseline mean score 103.2) to Test 3 (1 month follow-up mean score was 103.5).

c) WRAT-M (math) Test Results by Testing Period

The Stimulant medication group (Group C) did not change significantly on the WRAT-M (math) in any testing period.

4) Self-Selected Comparison Group results by testing period

At no time did the Self-selected Comparison Group reach statistically significant changes on the WRAT-R, WRAT-S, or WRAT-M.

5) PPVT Test Results by Testing Period

a) AVS Group results on the PPVT by testing period

At no time did the AVS Group reach statistically significant changes.

b) AVS + Med Group results on the PPVT by testing period

At no time did Group B reach statistically significant changes.

c) Med Group results on the PPVT by testing period

At no time did Group C reach statistically significant changes.

d) Control Group results on the PPVT by testing period

At no time did Group D reach statistically significant changes.

6) Ravens Results by Testing Period

a) AVS Group results on the Raven's by testing period

The Raven's was significant at $p < 0.01$ level from Test 1 (baseline mean score 113.4) to Test 2 (after training mean score 118.5) at the $p < 0.05$ level. In addition, Test 1 (baseline mean score 113.4) to Test 3 (1 month follow-up mean score 120.6) indicated significant changes at $p < 0.001$ level. No significant change was noted between Test 2 and Test 3.

b) AVS + Stimulant Medication Group results on the Raven's by testing period At no time

c) Stimulant Medication Group results on the Raven's by testing period

The Raven's test scores indicated that Test 1 (baseline mean score 113.3) to Test 3 (1 month follow-up mean score 117.8) indicated significant changes at $p < 0.05$ level. No other changes were noted.

d) Self-selected Comparison Group results on the PPVT by testing period

At no time did Control Group reach statistically significant changes.

The results of the Bonferroni's multiple comparison test results are presented by groups. Testing periods will also be presented in the table to allow for the evaluation of when change occurred by group (see Table 14 for summary).

Table 14

BONFERONNI POST TEST RESULTS FOR REPEATED MEASURES ANOVA COGNITIVE SCORES

Condition	Test 1 vs Test 2	Test 2 vs Test 3	Test 1 vs Test 3
WRAT-R			
AVS	$p < 0.05$	$p < 0.05$	$p < 0.001$
AVS + Medications	$p < 0.05$	$p < 0.05$	$p < 0.001$
Medication	ns	ns	$p < 0.05$
Self Selected Comparison Group	ns	ns	ns
WRAT-S			
AVS	$p < 0.05$	ns	$p < 0.05$
AVS + Medications	ns	ns	$p < 0.01$
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns
WRAT-M			
AVS	ns	ns	ns
AVS + Medications	ns	ns	ns
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns
PPVT			
AVS	ns	ns	ns
AVS + Medications	ns	ns	ns
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns
RAVEN'S			
AVS	$p < 0.01$	ns	$p < 0.001$
AVS + Medications	ns	ns	ns
Medication	ns	ns	$p < 0.05$
Self Selected Comparison Group	ns	ns	ns

ns = Not Significant at the 0.05 Level

Note: WRAT-* = Wide Range Achievement Test-Revised, R(Reading), S(Spelling), M(Math); PPVT = Peabody Picture Vocabulary Test, RAVEN's = Raven's Progressive Matrices

Part II: Results based on Major Behavioral Hypotheses

Repeated Measures MANOVA Results for changes in Behavioral functioning by AGroup@x ABehavior@

In the following pages the repeated measures MANOVA results will be presented address the proposed behavioral hypotheses. In addition, ANOVA results will also be presented by group. Finally, Bonferroni's multiple comparison test results will also be presented by group and by testing period.

The major behavioral hypothesis stated that upon completion of AVS training there will be a significant difference among groups from baseline to posttesting periods in behavioral functioning as demonstrated by scores on the IVA and ADDES for those who complete the AVS training. The results of the repeated measures MANOVA procedure for specific AGroups@ x ABehavior@ across baseline as measured by changes in increased scores on the IVA and ADDES behavioral rating scale indicated that the groups did not differ significantly at baseline. The Hotellings trace criterion effect was [F (9,275) = 1.220, p = 0.282]. The eta-squared was .025. However, at posttesting periods the groups were significantly different in their scores on the IVA and ADDES. "Group" showed a Hotellings trace criterion effect [$F(3,93) = 1208.78040, p < .001$] for the collective variable of group. The eta-squared effect was .957. These results indicated that groups were significantly different when compared to baseline readings. The repeated measures MANOVA findings become an important factor that all groups at baseline were statistically equivalent however, cognitive changes were observed after baseline readings. Table 15 presents the repeated measures MANOVA results for behavioral changes.

Repeated measures Results with “Time” as a Factor

The repeated measures MANOVA model evaluated what effect time had on the group means. The repeated measures MANOVA results indicated that ATime@ made an impact on the groups. These findings are an important factor due to the intervention after baseline. If changes were not noted the intervention would not have a significant effect to change groups means. The Hotelling = s trace criterion for ATime@ showed a [$F(2,94) = 6.207, p < .000$. The eta-square effect was .083. Table 15 presents the repeated measures MANOVA results for behavioral changes.

Repeated Measures MANOVA Results with “Group” and “Time” as Factors

The Repeated measures MANOVA model then evaluated the interaction between AGroup@ and ATime@ to determine if the collective means of the two factors made significant changes from baseline to posttesting periods. The results of the repeated measures MANOVA procedure for AGroup@ and ATime@ showed a significant change on the collective scores from baseline to posttesting periods. The Hotelling = s trace criterion indicated a significant effect [$F(6,186) = 4.526, p < .000$] for the two collective domains. Table 15 presents the repeated measures MANOVA results for behavioral changes.

The factor of “Group” x “Time” was [F 4.526 (6,186), $p < 0.000$]. The eta-squared was .153. The factor of “Time” was [F 6.207 (2,94), $p < 0.000$]. The eta-squared was .083. The factor of “Behavior” was [F 1208.780 (3,93), $p < 0.000$]. The eta-squared was .957. The factor of “Behavior” x “Time” was [F 2.328 (6,90), $p = 0.030$]. The eta-squared was .017. The factor of “Group” x “Behavior” was [F

1.220 (9,275), p = 0.282]. The eta-squared was .025. The factor of “Group” x “Time” x “Behavior” was [F 1.827 (18,266), p = 0.022]. The eta-squared was .087.

Table 15

REPEATED MEASURES MULTIVARIATE ANALYSIS OF VARIANCE FOR BEHAVIOR TEST SCORES

Factor	F value	Significance of F	Eta-squared
Group x Time	4.526 (6,186)	$p < 0.000$	.153
Time	6.207 (2,94)	$p < 0.000$	.083
Behavior	1208.780 (3,93)	$p < 0.000$	.957
Behavior x Time	2.328 (6,90)	$p = 0.039$	.017
Group x Behavior	1.220 (9,275)	$p = 0.282$	.025
Group x Time x Behavior	1.827 (18, 266)	$p = 0.022$	.087

ANOVA Results of Behavioral Functioning Levels

The second hypothesis stated that upon completion of AVS training there would be a significant difference among groups from baseline to posttesting periods in behavioral functioning as demonstrated by scores on the IVA and ADDES for those who complete the AVS training. The results below support Hypothesis 2 that AVS training did improve the functioning levels of the groups. See Table 16 for Analysis of Variance (ANOVA) statistics of behavioral dependent variables scores by Group.

Group A (AVS group)

The ADDES-HYP (hyperactivity) dependent variable was $p < 0.001$. Significant at the 0.001 level. The ADDES-INT (inattentiveness) dependent variable was $p < 0.001$. Significant at the 0.001 level. The IVAA (attention span) dependent variable was $p = 0.0587$, NS. The IVAR (response control) dependent variable was $p = 0.51666$, NS.

Group B (AVS & stimulant medication group)

The ADDES-HYP (hyperactivity) dependent variable was $p < 0.001$. Significant at the 0.001 level. The ADDES-INT (inattentiveness) dependent variable was $p < 0.002$. Significant at the 0.01 level. The IVAA (attention span) dependent variable was $p = 0.0405$. Significant at the 0.05 level. The IVAR (response control) dependent variable was $p < 0.001$. Significant at the 0.001 level.

Group C (Medication Only Group)

The ADDES-HYP (hyperactivity) dependent variable was $p = 0.3613$, NS. The ADDES-INT (inattentiveness) dependent variable was $p < 0.0273$. Significant at the 0.05 level. The IVAA (attention span) dependent variable was $p = 0.3076$, NS. The IVAR (response control) dependent variable was $p = 0.2783$, NS.

Group D (Self-selected Comparison Group)

The ADDES-HYP (hyperactivity) dependent variable was $p = 0.5786$, NS. The ADDES-INT (inattentiveness) dependent variable was $p < 0.1793$, NS. The IVAA (attention span) dependent variable was $p = 0.2767$, NS. The IVAR (response control) dependent variable was $p = 0.4029$, NS.

Table 16

REPEATED MEASURES ANALYSIS OF VARIANCE FOR INDIVIDUAL GROUPS BEHAVIORAL SCORES

Test	p Value	Significance Level
AVS (Group A)		
ADDES-HYP	$p < 0.0001$	0.001
ADDES-INT	$p < 0.0001$	0.001
IVAA	0.0587	ns
IVAR	0.51666	ns
AVS + Medication(Group B)		
ADDES-HYP	$p < 0.001$	0.001
ADDES-INT	$p < 0.002$	0.01
IVAA	0.0405	0.05
IVAR	$p < 0.0001$	0.001
Medication(Group C)		
ADDES-HYP	0.3613	ns
ADDES-INT	0.0273	0.05
IVAA	0.3076	ns
IVAR	0.2783	ns
Self Selected Comparison Group(Group D)		
ADDES-HYP	0.5786	ns
ADDES-INT	0.1793	ns
IVAA	0.2767	ns
IVAR	0.4029	ns

Note: ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test , A(Attention), R(Response Control)

The Bonferroni = s Multiple Comparison test results of Behavioral Scores are as follows.

Group A AVS group results by testing period

ADDES-HYP (Hyperactivity) Test Results by Testing Period

The ADDES-HYP (hyperactivity) was significant at $p < 0.001$ level from Test 1 (baseline mean score 7.190) to Test 2 (after training mean score 9.190). In addition, the ADDES-HYP was not significant from Test 2 to Test 3 (1 month follow-up mean score 9.476). However, Test 1 (baseline mean score 7.190) to Test 3 (1month follow-up mean score 9.476) was also significant at $p < 0.001$ level. See Table 17 for summary of the results..

ADDES-INT (Inattentiveness) Test Results by Testing Period

The ADDES-INT (inattentiveness) was significant at $p < 0.001$ level from Test 1 (baseline mean score 4.476) to Test 2 (after training mean score 7.143) at the $p < 0.05$ level. In addition, Test 1 (baseline mean score 4.476) to Test 3 (1 month follow-up mean score 7.762) indicated significant changes at $p < 0.001$ level. No significant change was noted between Test 2 and Test 3.

IVAA (attention span) Test Results by Testing Period

The AVS group (Group A) did not change on the IVAA) at any testing period.

IVAR (response control) test Results by Testing Period

The AVS group (Group A) did not change on the IVAR at any testing period.

Group B AVS & Stimulant medication group results by testing period

ADDES-HYP (Hyperactivity) Test Results by Testing Period

The ADDES-HYP (hyperactivity) was significant at $p < 0.001$ level from Test 1 (baseline mean score 5.556) to Test 2 (after training mean score 7.481). In addition, the ADDES-HYP was not significant from Test 2 to Test 3 (1 month follow-up mean score 7.778). However, Test 1 (baseline mean score 5.556) to Test 3 (1month follow-up mean score 7.778) was also significant at $p < 0.001$ level.

ADDES-INT (Inattentiveness) Test Results by Testing Period

The ADDES-INT (inattentiveness) was significant at $p < 0.05$ level from Test 1 (baseline mean score 4.704) to Test 2 (after training mean score 6.185) at the $p < 0.05$ level. In addition, Test 1 (baseline mean score 4.704) to Test 3 (1 month follow-up mean score 6.481) indicated significant changes at $p < 0.001$ level. No significant change was noted between Test 2 and Test 3.

IVAA (attention span) Test Results by Testing Period

The AVS group (Group A) did not change on the IVAA at any testing period.

IVAR (response control) test Results by Testing Period

The IVAR (response control) was significant at $p < 0.01$ level from Test 1 (baseline mean score 95.67) to Test 2 (after training mean score 98.14) at the $p < 0.05$ level. In addition, Test 1 (baseline mean score 95.67) to Test 3 (1 month follow-up mean score 99.67) indicated significant changes at $p < 0.001$ level. No significant change was noted between Test 2 and Test 3.

Group C Stimulant medication group results by testing period

ADDES-HYP (Hyperactivity) Test Results by Testing Period

Group C (stimulant medication) did not show statistical significant improvement at any testing period.

ADDES-INT (Inattentiveness) Test Results by Testing Period

Group C (stimulant medication) did not show statistical significant improvement at any testing period.

IVAA (attention span) Test Results by Testing Period

Group C (stimulant medication) did not show statistical improvement at any testing period.

IVAR (response control) test Results by Testing Period

Group C (stimulant medication) did not show statistical improvement at any testing period.

Group D Self-Selected Comparison group results by testing period

ADDES-HYP (Hyperactivity) Test Results by Testing Period

Group D (Self-selected comparison group) did not show statistical significant improvement at any testing period.

ADDES-INT (Inattentiveness) Test Results by Testing Period

Group D (Self-selected comparison group) did not show statistical significant improvement at any testing period.

IVAA (attention span) Test Results by Testing Period

Group D (Self-selected comparisons groups) did not show statistical significant improvement at any testing period.

IVAR (response control) test Results by Testing Period

Group D (Self-selected comparisons groups) did not show statistical significant improvement at any testing period.

The results of the Bonferroni's multiple comparison test results are presented by groups. Testing periods will also be presented in the table to allow for the evaluation of when change occurred by group (see Table 17 for summary).

In Chapter V discussion of the results will be in two parts. Part I will discuss the findings of the cognitive hypotheses. Part II will focus on the findings of behavioral hypotheses. In addition, strengths and limitations of the current study will be addressed. Finally, implications for social workers will be discussed with suggestions for future research.

Table 17

BONFERONNI POST TEST RESULTS FOR REPEATED MEASURES ANOVA BEHAVIOR SCORES

Condition	Test 1 vs Test 2	Test 2 vs Test 3	Test 1 vs Test 3
ADDES-HYP			
AVS	$p < 0.001$	ns	$p < 0.001$
AVS + Medications	$p < 0.001$	ns	$p < 0.001$
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns
ADDES-INT			
AVS	$p < 0.001$	ns	$p < 0.001$
AVS + Medications	$p < 0.05$	ns	$p < 0.001$
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns
IVAA			
AVS	ns	ns	ns
AVS + Medications	ns	ns	ns
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns
IVAR			
AVS	ns	ns	ns
AVS + Medications	$p < 0.01$	ns	$p < 0.001$
Medication	ns	ns	ns
Self Selected Comparison Group	ns	ns	ns

ns = Not Significant at the 0.05 Level
Note: ADDES-* = Attention Deficit Disorder Evaluation Scale, HYP(Hyperactivity), INT(Inattentiveness), IVA* = Intermediate Visual and Auditory Continuous Performance Test , A(Attention), R(Response Control)

Chapter V

DISCUSSION

As the health care field continues to change with the primary focus on reducing the access to mental health workers due to the escalating cost for therapy the research community is compelled to find more effective and cost saving techniques to treat ADHD. The primary focus and treatment for ADHD is symptom reduction. This approach of symptom reduction uses primarily two forms of intervention. The primary and first intervention in many cases is a pharmacological approach specifically the use of drugs (stimulants) such as Ritalin and Adderall (Barkley, 1990). The second approach or intervention commonly used in therapy is the use of behavioral therapy to reduce negative characteristics and increase appropriate behaviors for the ADHD individual (Barkley, 1990). However, pharmacological treatment for ADHD individuals is not always effective and can have significant side effects that may cause some individuals and parents to decide not to choose this form of treatment and/or discontinue treatment. In addition, many of the behavioral approaches require extensive parental and teacher involvement. Due to the overcrowding in schools and with ever greater demands on parents this form of intervention lacks the consistency that is the hallmark for positive change and outcomes. Those individuals who do not receive treatment for their ADHD problems have a greater risk of poor school performance, higher drop-out rates, anti-social behaviors, and an overall lower

functioning capacity when compared to those individuals who seek appropriate and effective treatment (Swanson & Kinsbourne, 1978; Barkley, 1990; Lerner, Lowenthal, & Lerner, 1995).

The purpose of the study is to evaluate the effectiveness of a non-pharmacological treatment for ADHD. In addition the current study was to explore and test the Stimulation Theory that previous research has not thoroughly addressed in an empirical fashion (Diamond, 1988). Although the use of AVS intervention has been tested to improve cognitive and behavioral functioning to some degree, AVS has not been thoroughly tested with significant numbers to generalizable efficacy. Most of the previous studies to test efficacy of AVS treatment has included case studies or small sample size i.e., ($n < 25$) (Tansey, 1984; Tsubokawa, et al., 1990;Carter & Russell, 1993; Kumano, et al., 1997; Timmermann et al., 1998). The use of AVS treatment may become a viable non-pharmacological intervention if proven effective with a more representative ADHD population. Due to the relatively low cost of training and use of the equipment insurance companies are more likely to approve reimbursement and treatment. In addition, for those individuals who do not have mental health coverage, AVS treatment can be a very affordable way to treat ADHD individuals.

The current study is unique due to several factors. The current study has employed the largest number of individuals to date ($n = 99$). In addition, the current study has a self-selected comparison group ($n = 31$) that is lacking in previous research. Another unique factor is that this study not only employs standard IQ test and behavioral rating scales to measure improve functioning levels of the individual; it is

the first study, known to this researcher that also uses a computerized ADHD test that measure changes in both auditory and visual performance levels in the individual. Another unique factor is the use of the Biopsychosocial Model as the conceptual framework for the current study allows a social worker to intervene in the cognitive and neuropsychological circle of functioning of the individual. This form of intervention is not commonly employed in a social worker = s approach to ADHD clients. Theoretically, a social worker can intervene with a non-pharmacological intervention (Stimulation Theory) that will possibly change the EEG patterns in a individual = s brain that could conceivably result in cognitive and behavioral changes (Adrian & Matthew, 1934;Diamond, 1988; Carter & Russell, 1993; Timmermann, et al., 1998).

Hypothesis I

Part I Major Cognitive Hypotheses Results

Repeated measures MANOVA results for changes in Cognitive Functioning Levels by "Group@

The major cognitive hypothesis stated that upon completion of AVS training there will be a significant difference among groups from baseline to posttesting periods in cognitive functioning as demonstrated by IQ scores (Wide Range Achievement Test (WRAT-R, WRAT-S, WRAT-M), Peabody Picture Vocabulary Test (PPVT) and the Raven = s Progressive Matrices for those who complete the AVS training. The results of the repeated measures MANOVA procedure for specific groups across baseline and posttesting periods as measured by changes in IQ scores indicated that time and group involvement did make a statistically significant difference. The repeated measures MANOVA test compiles the five (5) dependent variables of WRAT-S, WRAT-M,

WRAT-R, PPVT, and the Raven = s and creates one (1) dependent variable. The independent variable can be determined by the researcher. The independent variables that were pertinent to this particular study were “Time” and “Group”. Although the repeated measures MANOVA = s are not particularly sensitive to allow the researcher the ability to determine specific changes it is a valuable tool to assess changes in groups across time. One major concern in the present study was that all groups at baseline were equivalent. The repeated measures MANOVA results indicated that the groups IQ scores were not significantly different at baseline. The repeated measures MANOVA results confirmed that at baseline there was not a statistically significant difference in cognitive scores between the groups. The Hotelling = s trace criterion for the collective variable of group was [F(12,272) = 1.061,NS]. The eta-squared effect was .035. The results of statistically equivalent baseline groups allows the repeated measures MANOVA to analyze other factors that may be producing change in scores among groups. The Hotelling = s trace criterion did not indicate that the group = s cognitive functioning levels were significantly different if time was not in the equation. Thus, ATime@ is an important factor in the Repeated measures model [F (2,94) = 18.158, p < .000]. If ATime@ becomes the important factor in the model further interpretation can now focus on each group and discuss statistical changes across the variable time. In addition, the major hypothesis that cognitive changes would occur in the groups who participated in AVS training is a distinct possibility however, the repeated measures MANOVA limitations will not allow for further interpretation. The next set of statistical procedures will allow for a more direct interpretation of the data.

<u>One-way ANOVAs discussion of Cognitive changes among Groups</u>

The one-way analysis of variance (ANOVA) was used to compare group means across time (Motulsky, 1995). This statistical procedure will allow interpretation of each group across time. Additionally, Post-hoc Bonferroni = s Multiple Comparison Test was used to determine specific changes between testing periods. In addition, each groups changes can now be discussed in terms of baseline readings, second testing period results and finally the third testing period results. In addition, comparisons can be made between testing periods when the post-hoc Bonferrioni = s are employed.

Group A (AVS group) Hypotheses 2B Discussion One-way ANOVA results

Hypotheses 2B stated that the AVS group will have changes in their IQ scores as measured by the WRAT-S, WRAT-R, WRAT-M, PPVT, and Ravens when compared to Group C, and Group D. The one-way ANOVA for WRAT-S (spelling) indicated that group means did change across time $p = .0073$. The WRAT-R (reading) also indicated significant change across time with $p < .0001$. The Raven = s one-way ANOVA indicated that significant changes were also detected for the AVS group $p = .0002$. However, WRAT-M and the PPVT did not indicate statistically significant changes over time.

Post-hoc Bonferroni = s Multiple Comparison Test of Cognitive Changes Between Testing Periods

The first cognitive IQ test post-hoc Bonferroni = s Multiple Comparison Test that was interpreted is the WRAT which has three specific areas of measuring cognitive functioning levels. The three areas are the Spelling, Reading, and Math. The results of the WRAT-S (spelling) indicated that Group A showed significant changes between

baseline and the second testing period ($p < .05$). Group A also showed significant changes from baseline to the third testing period ($p < .05$). No statistically significant change was noted between the second and third testing period. Group A results support the hypotheses and indicated that this group = s mean scores improved significantly after the AVS training. This finding is important to show that after AVS treatment the individual = s scores increased which indicates a statistical significant improvement in their ability to spell.

The WRAT-R IQ score indicates the ability of the individual to read. The higher the scores the greater the reading ability of the individual. The WRAT-R Group A results also indicated that from baseline to second testing period after AVS treatment there was significant change ($p < .05$). In addition, IQ scores significantly changed from baseline to the third testing period ($p < .001$). Additionally, Group A mean scores also increased from the second testing period to the third testing period ($p < .05$). These findings once again support hypothesis 2A. This fundamental skill of reading can greatly enhance one = s ability to perform in school and is considered to be a foundation of cognitive ability.

The WRAT-M (math) Group A results were not as impressive. At no time did

statistically significant changes occur. The lack of significant change may be attributed to poor sensitivity of the test itself or that changes in mathematical computations may take longer to develop. However, only one month follow-up testing (i.e. third testing period) was explored.

The PPVT is designed to estimate verbal intelligence through the process of

hearing vocabulary from the examiner (Dunn, 1965). However, Group A had no significant changes after AVS treatment. With a longer posttesting period and follow-up testing there may be improved cognitive functioning over time. However, due to time constraints in this study it was not possible to obtain data beyond 1 month following treatment.

The Raven = s Progressive Matrices test was used as an estimate of Performance IQ. The Raven = s is considered a Aculturally free@ test and is designed to measure the Aobservation of clear thinking@ (Raven, 1974). The test by itself is not an IQ test of general intelligence but a test of productive thinking and reproductive thinking or the replication of a specific matrices. The Bonferroni = s Multiple Comparison Test indicated that from baseline (Group A) to the second testing period significant changes did occur in scores

($p < .01$). In addition, Group A scores also significantly increased from baseline to third testing period ($p < .001$). Additional, statistical changes were noted from the second testing period after AVS training to the 1 month follow-up testing period ($p < .05$). The changes in the Raven = s scores (Group A) supports hypothesis 1B.

Group B (AVS & medication) Hypotheses 1A One-way ANOVA Discussion

Hypotheses 1A stated that the AVS and medication group will have positive changes in there IQ scores as measured by the WRAT-S, WRAT-R, WRAT-M, PPVT, and Ravens when compared to Group A, Group C, and Group D. The one-way ANOVA for WRAT-S (spelling) indicated that group means did change across time $p = .0030$. The WRAT-R (reading) also indicated significant change across time with $p < .0001$. The Raven = s one-way ANOVA indicated that significant changes were also

detected for the AVS & medication group p = .0059. The PPVT also indicated significant change across time with the p = .0469. However, WRAT-M did not indicate significant changes over time.

Post-hoc Bonferroni = s Multiple Comparison Test of Group B Cognitive Functioning

The first cognitive post-hoc IQ test used the Bonferroni = s Multiple Comparison Test to interpret if the WRAT which has three specific areas of measuring cognitive functioning levels, significantly changed. The three areas are spelling, reading, and math. The results of the WRAT-S (spelling) indicated that Group B showed significant changes between baseline and the third testing period ($p < .01$). Group B results supports the hypothesis as indicated that the group = s mean scores improved significantly after the AVS training. The findings are important in that after AVS treatment the individual = s scores increased which indicates an statistical improvement in the subjects ability to spell.

The WRAT-R (reading) IQ score indicates the ability of the individual to read. The higher the scores the greater ability of the individual to read. The WRAT-R Group B results also indicated that from baseline to second testing period after AVS treatment indicated a significant change ($p < .05$). In addition, IQ scores significantly changed from baseline to the third testing period ($p < .001$). Additionally, Group B mean scores also increased from the second testing period to the third testing period ($p < .05$). These findings once again support hypothesis 1A.

The WRAT-M (math) Group B results were not as impressive. At no time did

statistically significant changes occur. The lack of changes may be attributed to poor sensitivity of the test itself or that changes in mathematical computations may develop over a longer period of time. However, only one month follow-up testing (i.e. third testing period) was explored.

The PPVT is designed to estimate verbal intelligence through the process of hearing vocabulary from the examiner (Dunn, 1965). However, Group B had no significant changes after AVS treatment although the one-way ANOVA did detect a change (see above statistics). The lack of longer posttesting periods and follow-up testing may indicate improved cognitive functioning. However, due to time constraints it was not possible to obtain data beyond 1 month following treatment.

The Raven = s Progressive Matrices test was used as an estimate of Performance IQ. The Raven = s is considered a Aculturally free@ test and is designed to test for the Aobservation of clear thinking@ (Raven, 1974). The test by itself is not an IQ test of general intelligence but a test of productive thinking and reproductive thinking or the replication of a specific matrices. The Bonferroni = s Multiple Comparison Test indicated that from baseline (Group B) to the third testing period indicated significant changes in scores ($p < .01$). The changes in the Raven = s scores (Group B) support hypothesis 1A.

Group C (medication only) Hypotheses 1C One-way ANOVA Discussion

As analysis continues Hypothesis 1C stated that the Medication Group (Group C) would have significantly higher scores on the WRAT-S, WRAT-R, WRAT-M, PPVT, and Raven = s when compared to the self-selected comparison group. A one-

way ANOVA was completed and the medication group had significant changes on only two out of five cognitive indices. The first change occurred on the WRAT-R or reading ($p = .0244$). The second change occurred on the Raven's with a $p = .0062$. These results are expected and helps to verify hypothesis 1C.

Post-hoc Bonferroni's Multiple Comparison Test of Group C Cognitive Functioning

The post-hoc Bonferroni's test of Group C noted from baseline to the third testing period on the WRAT reading scores increased at $p = .01$. This indicated that medication did in fact help the individual performance on the reading portion of the WRAT. In addition, the Raven's scores in the Medication Group also increased at the third testing period ($p < .01$). It is interesting to note that the only significant changes in Group C test scores were at the third testing period and not immediately following ingestion of stimulant medication. The findings of Group C begin to illustrate that stimulant medication is not directly related to improved cognitive functioning as one might believe. However, the lack of improvement in the Medication Group is not discouraging due to the positive findings that were obtained in Group A and Group B. This further exemplifies that Groups A & B intervention of a non-pharmacological AVS training did in fact change cognitive functioning. In addition, the above findings may help verify the Stimulation Theory of Diamond (1988).

Group D (self-selected comparison group) Hypotheses 1D One-way ANOVA & Post-hoc Test Discussion

The one-way ANOVA of Group D did not indicate significant change over time. In addition, no post-hoc test were calculated for this group. The findings of Group D support hypothesis 1D that there would not be significant changes in this group.

Hypothesis II

Part II Major Behavioral Hypotheses Results

Repeated measures MANOVA Results for changes in Behavioral Functioning Levels by "Group"

The major behavioral hypothesis stated that upon completion of AVS training there will be a significant difference among groups from baseline to posttesting periods in behavioral functioning as demonstrated by scores on the IVA and ADDES for those who complete the AVS training. The results of the repeated measures MANOVA procedure for specific groups across baseline and posttesting periods as measured by changes in behavioral scores indicated that time and group involvement made a significant difference. The repeated measures MANOVA test compiles the four (4) dependent variables of ADDES-hyp, ADDES-int, IVVA, and IVAR and creates one (1) dependent variable. The independent variable can be determined by the researcher. Thus independent variables that were pertinent to this particular study were "Time" and "Group". Although the repeated measures MANOVA are not particularly sensitive to allow the researcher the ability to determine specific changes it is a valuable tool to assess overall changes and trends in groups. One major concern in the present study was that all groups at baseline were equivalent. Another important finding that the repeated measures MANOVA indicated was the aspect that group behavioral scores were not significantly different at baseline. The repeated measures MANOVA results

indicated that at baseline there was not a significant difference between the groups. The Hotelling = s trace criterion for the collective variable of group was [F(9,275) = 1.220,NS]. The eta-squared effect was .025. The results of statistically equivalent baseline groups allows the repeated measures MANOVA to analyze other factors that may be producing change in scores among groups. The Hotelling = s trace criterion did not indicate that the group = s behavioral functioning levels were significantly different if time was not in the equation. Thus, ATime@ is an important factor in the model [F (2,94) = 6.207, p < .000]. If time becomes the important factor in the model the researcher can now interpret each group and discuss changes over time. In addition, the major hypothesis that behavioral changes would occur in the groups who participated in AVS training was verified by the results of the repeated measures MANOVA. However, the repeated measures MANOVA limitations will not allow further interpretation. The next set of statistical procedures will allow for a more direct interpretation of the data.

One-way ANOVAs discussion of Behavioral Changes Among Groups

The one-way analysis of variance (ANOVA) was used to compare group means across time (Motulsky, 1995). This statistical procedure will allow interpretation of each group across time. Additionally, Post-hoc Bonferrroni = s Multiple Comparison Test will also be used to determine specific changes between testing periods. In addition, each groups changes can now be discussed in terms of baseline readings, second testing period results and finally the third testing period results.

Group A (AVS group) Hypotheses 2B Discussion One-way ANOVA Behavioral

Results

Hypotheses 2B stated that the AVS group will have significantly higher scores on the IVA and ADDES when compared to Group C and Group D. The one-way ANOVA for ADDES-hyp (hyperactivity) indicated that group means did change across time $p < .0001$. The ADDES-int (inattentiveness) also indicated significant changes across time with $p < .0001$. The IVAA (attention span) one-way ANOVA did not indicate significant changes at the .05 level however, the AVS group approached significance at $p = .0587$. However, IVAR (response control) did not indicate significant changes over time.

Post-hoc Bonferroni's Multiple Comparison Test of Behavioral Changes of Group A Between Testing Periods

To further access changes in specific time periods a post-hoc test was completed. The first behavioral post-hoc test employed the Bonferroni = s Multiple Comparison Test. The Bonferroni = s Multiple Comparison test is well established in research literature and was chosen as a suitable post-hoc evaluation of the ANOVAs. The ADDES behavioral rating scale will be the first test discussed. The ADDES behavioral rating scales were completed by the parents of the child. The ADDES scale was completed at baseline off medication, after training (second testing period), and finally at the 1 month follow-up (third testing period). The ADDES has two specific domains. The ADDES-hyp is the measure of the individuals hyperactivity component of their ADHD diagnosis. The second domain of the ADDES behavioral rating scale is the inattentiveness and is denoted as ADDES-int. The results of the ADDES-hyp (hyperactivity) indicated that Group A (AVS group) showed significant changes

between baseline and the second testing period ($p < .001$). Group A (AVS group) also indicated significant changes from baseline to the third testing period ($p < .001$). No significant change was noted between the second and third testing period. Group A results support the hypotheses as indicated that the group = s mean scores improved significantly after the AVS training. This finding is important in that after AVS treatment the individual = s scores increase which indicates statistical improvement in their ability to reduce the hyperactivity component of their personality. If the use of AVS training can in fact reduce this major problem of hyperactivity in many of the ADHD individuals without the use of medication one must consider this non-pharmacological intervention as a viable tool.

The ADDES-int (inattentiveness) scores indicates the ability of the individual to maintain focus on a specific stimuli. The higher the scores the greater ability of the individual to maintain focus and reduce the domain of inattentiveness. The ADDES-int Group A results also indicated that from baseline to second testing period after AVS treatment was a significant change ($p < .001$). In addition, behavioral rating scale scores significantly changed from baseline to the third testing period ($p < .001$). However, no significant change was noted from second testing period to the third testing period. The above findings once again support hypothesis 2B. This fundamental skill of maintaining focus on a desired stimuli can greatly enhance one = s ability to perform in school and is considered a foundation of not only behavioral improvement but possible improved cognitive functioning.

The IVAA (measure of attention span) and the IVAR (response control) were not as impressive. At no time did statistically significant changes occur. Although, the

IVAA did approach significance at the .05 level in the ANOVA no post-hoc test were completed due to the fact that significance was not obtained in the general ANOVA run. The lack of longer posttesting periods and follow-up testing may yield positive changes and improvement in IVAA and the IVAR. However, due to time constraints it was not possible to obtain data beyond 1 month following treatment. Overall, the changes in Group A (AVS group) were significant and help verify the hypothesis that behavioral changes occur after AVS training.

Group B (AVS & medication) Hypotheses 2A One-way ANOVA Discussion of Behavioral Changes

Hypotheses 2A stated that the AVS and medication group (group B) will have significantly higher scores on the ADDES and IVA when compared to Group A, Group C, and Group D. The one-way ANOVA for ADDES-hyp (hyperactivity) indicated that group means did change across time $p < .0001$. The ADDES-int (inattentiveness) also indicated significant changes across time with $p < .0002$. The IVAA (attention span) one-way ANOVA did indicate significant changes at $p = .05$ level. However, the AVS & medication group scores on the IVAR (response control) did indicate change at the $p < .0001$. The findings in the ANOVA are supportive of hypothesis 2A. In addition, to the positive findings in the ANOVA = s, post-hoc tests were completed to further understand the significant changes in Group B.

Post-hoc Bonferronis Multiple Comparison Test of Group B (AVS & medication) Behavioral Changes

To further access specific changes in Groups a post-hoc Bonferroni = s test was completed. The ADDES behavioral rating scale will be the first test discussed. Once

again the ADDES behavioral rating scales were completed by the parents of the child to obtain behavioral information. The ADDES scale was completed at baseline off medication, after training (second testing period), and finally at the 1 month follow-up (third testing period). The ADDES has two specific domains. The ADDES-hyp is the measure of the individuals hyperactivity component of their ADHD diagnosis. The second domain of the ADDES behavioral rating scale is the inattentiveness and is denoted as ADDES-int. The results of the ADDES-hyp (hyperactivity) indicated that Group B (AVS & medication group) showed significant changes between baseline and the second testing period ($p < .001$). Group B (AVS & medication group) also indicated significant changes from baseline to the third testing period ($p < .001$). No significant change was noted between the second and third testing period. Group B results supports hypotheses 2A as indicated that the group = s mean scores improved significantly after the AVS training. These findings are important in that after AVS treatment the individual = s scores increase which indicates a statistical improvement in their ability to reduce the hyperactivity component of their personality. If the use of AVS training can in fact reduce this major problem of hyperactivity in many of the ADHD individuals without the use of medication one must consider this non-pharmacological intervention as a viable tool.

The ADDES-int (inattentiveness) scores indicates the ability of the individual to maintain focus on a specific stimuli. The higher the scores the greater ability of the individual to maintain focus and reduce the domain of inattentiveness. The results of the ADDES-int (inattentiveness) indicated that Group B (AVS & medication group) showed significant changes between baseline and the second testing period ($p < .05$).

Group B (AVS & medication group) also indicated significant changes from baseline to the third testing period ($p < .01$). No significant change was noted between the second and third testing period. Group B results support hypotheses 2A an indicated that the group = s mean scores improved significantly after the AVS training. These findings are important in that after AVS treatment the individual = s scores increased which indicates a statistical improvement in their ability to reduce the inattentiveness. If the use of AVS training can in fact reduce this major problem of poor attention span which is the hallmark of many ADHD individuals without the use of medication one must consider this non-pharmacological intervention as a viable tool. It becomes a logical assumption that the fundamental skill of improved focus will greatly enhance one = s ability to perform at a higher level of functioning than compared to an individual who has profound ADHD symptoms.

The IVAA (measure of attention span) scores were not as impressive. At no time did statistically significant changes occur. Although, the IVAA did approach significance at the .05 level in the ANOVA no post-hoc test were completed due to that significance was not obtained in the general ANOVA run. However, the IVAR (response control) Bonferroni = s post-hoc test did indicate that Group B (AVS & medication) did change from baseline testing to the second testing period after treatment and medication was used. The Bonferroni = s test indicated a change in behavioral scores at the $p < .01$ level. In addition, the baseline to third testing period also indicated a significant change in behavioral functioning level at $p < .001$. Overall, the changes in Group B (AVS & medication group) were significant and help verify the hypothesis that behavioral changes occurred after AVS training.

Group C (medication only) Hypotheses 2C One-way ANOVA Discussion

Hypothesis 2C stated that the Medication Group (Group C) will have significantly higher scores on the IVA and ADDES when compared to the control group. A one-way ANOVA was completed and the medication group had significant changes on only 1 out of 5 behavioral indices. The only change occurred on ADDES-int (inattentiveness) behavioral rating scale with p = .0273). No other changes were noted in the AVOVA runs.

Post-hoc Bonferroni = s Multiple Comparison Test of Group C

The post-hoc Bonferroni = s test of Group C noted from baseline to the second testing period on the ADDES-int scores p = .05. This indicated that medication did in fact help the individual behavioral performance improve in regards to increasing attention span. The findings of Group C reflect the research literature that stimulant medication can improve one = s attention span. However, the lack of overall improvement in the Medication Group is not discouraging due to the positive findings that were obtained in Group A and Group B. This further exemplifies that Groups A & B intervention of a non-pharmacological AVS training did in fact change behavioral functioning. In addition, the use of medication did not improve the participants overall functioning level when compared to the AVS group and the AVS & medication group. The use of stimulant medication may indicate that symptoms may be reduced or controlled however, the use of medication does not seem to improve cognitive or behavioral functioning levels of the individuals as with the group who receive treatment.

Group D (self-selected comparison group) Hypotheses 2D One-way ANOVA &

Post-hoc Test Discussion

The one-way ANOVA of Group D did not indicate significant change over time.

In addition, no post-hoc tests were calculated for this group. The findings of Group D support hypothesis 2D that there would not be significant changes in this group.

Summation of Changes by Groups Across Time

The overall changes among the treatment groups were impressive. In Group A (AVS training group) statistical changes occurred on 5 out of 9 tests or 55.6% of the time. In addition, Group B (AVS & Stimulant medication group) indicated changes on 8 out of 9 tests or 88.9% of the time. Group C which was the stimulant medication group only changed on 3 out of 9 test or 33.0% of the time. Finally, the self-selected comparison group had no statistical changes across time.

Strengths and Limitations of the Study

The dependent variables used in the study are well known in the educational research literature. Even though the current study is an evaluation of secondary data analysis the outcome measurements are well tested for their validity and reliability in measuring IQ functioning levels. The WRAT-R is a valuable tool to determine specific changes in Reading, Spelling, and Arithmetic (Jastak & Wilkinson, 1984). The three domains in the WRAT-R represent the development and foundation of good school performance. The WRAT-R also demonstrated high internal consistency which ranged from .96-.99 on the Reading, .97-.99 on the Spelling, and .98-.99 on the Arithmetic. The WRAT-R also demonstrates favorable validity. In addition, the WRAT-R when compared to the Stanford-Binet Intelligence Test correlated very well in the .60-.80

range. The Raven = s also demonstrates very good internal consistency from .69 to .97 range in the age group of 6.5 years of age to 12.5 years old. Test-retest reliabilities ranged from .85 to .98 for the same age group. Inter-test correlations ranged from .63 to .90. The PPVT reliability coefficients were also calculated using the Pearson product moment correlations on the raw scores. Correlation ranged from 0.67 to 0.84 with a median of 0.77 (Dunn, 1965). Validity of the PPVT was calculated for both individual items and for the total test. The validity scores were calculated and compared to the Stanford-Binet mental age scores. The range of mental age correlations on the Stanford-Binet test was from 0.82 to 0.86 with a median of 0.83.

In addition, the use of the ADDES behavioral rating scale and the IVA have been well tested and are considered reliable instruments to measure behavioral changes in the functioning level of an individual. The use of behavioral rating scales are a standard in determining functioning levels of an individual. In addition, the ADDES was completed by the same parent on each testing period. Since the evaluation was completed by the parent of the child, the researcher could not influence the scores. In addition, the use of the IVA that quantifies Response Control and Attention Span allows for another non-biased observation on the individual = s performance. The performance levels of the individual can be monitored both auditory and visually. This adds a uniqueness to the study that has not been throughly tested in past research.

Another strength of this study is the relatively large sample size. To date most of the prior literature employed a small number of individuals ($n < 25$) or used

individual case studies. With the larger number of individuals used in the current study it became feasible to employ more rigorous statistical evaluation procedures.

Another strength to the current study is the use of multiple group research design with a self-selected comparison group. In previous research single group studies of small numbers has been a disadvantage to determine the efficacy of AVS treatment.

One limitation of the current study was the lack of a true control group. This limitation is not only a weakness to this study but is germane to past research that lack randomly assigned control groups. This weakness is partly due to the nature of the ADHD population in that withholding treatment would be unethical in many instances. Although to date the current study employs the largest number of individuals ($n = 99$) the lack of equal gender representation (females < 11) falls short of the researcher = s expectation. However, this can be explained by the fact that ADHD is predominantly a male disorder. In addition, the current study used secondary data and equal representation of sexes was beyond the researcher = s control.

Another limitation of the current study was the lack of sensitivity inherent in the IQ test used and the follow-up time period available. Although a 1 month follow-up measurement was obtained it is possible that further changes might have occurred in a 3 or 6 month follow-up measurement period. However, this particular limitation can be addressed in future research. It is recommended in future research that a longitudinal study be employed to evaluate both cognitive and behavioral changes in the ADHD individual. A longitudinal design would allow for trends that were noted in the current study to be further evaluated and verified.

A final limitation in the current study was the lack of random assignment to the study groups. The study sample was generated from parents who were willing to engage in research and may not be representative of the ADHD population at large. This method of sampling is commonly referred to as convenience sampling . Therefore the selection was based on the willingness of the family and individual to engage in the criteria of a specific group. Future research should include a sample that uses randomly assigned individuals to specific treatment groups. This form of sample assignment would increase the tightness of the design of the study and enable more valid generalizations to be made.

Implications for Social Work Practice

In today = s HMO & PPO world of shrinking access to mental health care the social worker is faced with problems of basic supply and demand. The ADHD individual Ademands@ a great deal of intervention to deal with their problems while the managed care companies restrict the Asupply@ or intervention that a social worker can deliver. The continuous battle of suppling enough help or intervention to the ADHD individual and family is always weighed with the amount of care that has been approved. In addition, there is a significantly large segment of society that has no insurance at all and access to mental health care is scarce and limited at best. The use of a non-pharmacological effective intervention (AVS treatment) to treat ADHD individuals becomes a viable answer to the limited resources in the mental health field.

This current study is important in four major arenas of social work. The first area that the study can have a major impact on is in practice. As stated previously, the

social worker is faced with the dilemma of providing appropriate care for the ADHD in a mental health world that is focused on reducing the number of visits given to any one individual. In addition, in some HMO & PPO plans ADHD is not a covered service for which social workers can obtain reimbursement. However, as the awareness and diagnostic techniques and procedures continue to improve more individuals are labeled with ADHD problems with little or no intervention except the use of medication. As noted earlier pharmacological intervention is not always the answer for many individuals. Additionally, a pharmacological intervention treats only the symptoms of ADHD with the return of ADHD characteristics soon after the medication effectiveness wears off. Therefore, the effectiveness of a non-pharmacological intervention like AVS treatment can greatly impact the way a social worker delivers services in his/her practice. As this study has indicated not only were positive changes noted in IQ test of individuals who used the AVS treatment, additionally improvements were also noted in the specific behaviors of attention span and impulsivity. More specifically, IQ scores did increase with the use of AVS treatment while inappropriate or non-functional behavior decreased in many of the subjects. This relatively cheap and effective form of intervention can greatly enhance the capabilities of a social worker to deal with ADHD individuals and address their symptoms in a entirely new way. The ease of use and the portability of the AVS units can supply the social worker with another tool to help the ADHD individual empower themselves and improve their cognitive and behavioral functioning level.

Another area that this study identifies is the lack of empirical research in the use of AVS treatment. Social Workers are in a unique position to have access to individuals that have ADHD and the knowledge to engage in research to look for viable and effective treatments. This combination of knowledge and availability to subjects is a great opportunity for continued research. Although this study employed the largest number of subjects to date, additional research is needed to replicate the findings that were presented in this study. Future research should focus on an improved study design and increase sample size. Historically, social workers often fail to conduct research to show the effectiveness of their particular intervention (s). The use of all interventions including AVS stimulation must continue to be researched to ascertain efficacy of this intervention. Although promising results were noted in this study continued exploration of efficacy is needed. Without additional research not only will the use of AVS treatment would remain questionable but the field of social work will miss an opportunity to serve a growing group of clients with a promising non-pharmaceutical intervention technique.

A third area that this study can potentially impact is in the social welfare policy development. Many social workers deal with policy development and implementation. Social workers who specialized in policy development and implementation can advocate for early detection and treatment for ADHD individuals. The existing literture on ADHD is very clear that if an individual in not diagnosed or treated their drop-out rate from school is greater than those who do not have ADHD or those who are treated for their ADHD problems (Barkley, 1988). In addition, those individuals who are not diagnosed or treated for their ADHD problems are more likely to engage

in anti-social behaviors, engage in drug use, or develop serious mental illnesses like mood disorder (depression) and anxiety disorder, and/or other problems that would reduce the overall functioning level of the individual (Barkley, 1988). Policy decisions can be driven by a new, effective, and relatively economical way of treating the ADHD population. Therefore policy decisions can focus on early detection, treatment, and continued research exploring the efficacy of AVS treatment.

Another policy implication of this study is in legislation involving Supplemental Security Income or SSI for the ADHD child. As stated earlier the diagnosis and treatment of ADHD has developed over a long time from a very moralistic view to a more medical or pharmacological view. This evolutionary theme has also taken place with SSI. Since the enactment of SSI in 1972, [Public Law No. 92-603] the program has provided cash benefits to the financially needy individuals who are disabled, blind, or aged ("SSA's Implementation of the New SSI Childhood Disability Law", 1999). Children who are disabled can receive cash benefits from SSI. Between the years of 1980 to 1990 there was an increase in children who received SSI from 228,000 to more than 340,000. However, from January 1, 1974 to August 21, 1996 the Social Security Act did not contain a separate definition of disability for children. On February 20, 1990, the Supreme Court decided (*Sullivan v. Zebley)*, [493 U.S. 521 (1990)] that the "listing-only" approach that was used to deny children SSI benefits did not provide them with a "comparable severity" standard as in the adult interpretation with respect to overall functioning of the individual. Since the 1990 ruling until 1996 there was a substantial increase that tripled enrollment of children in SSI programs from 340,000 to approximately one million children ("SSA's Implementation of the New SSI Childhood

Disability Law", 1999). The related cost for the additional enrollment increased from 1.3 billion dollars annually to more than 5 billion dollars annually. The staggering increases not only with the number of individuals who qualified for SSI but the additional expenditures of revenue set off a myriad of responses from Congress, the media, and the general public. Allegations were made that children were being "coached" to manipulate the system to obtain cash benefits. Studies were conducted to determine the veracity of the allegations and to determine if there was any widespread abuse of the system. In the end, none of the studies found any significant abuse.

However, the above-mentioned increases in number of individuals coupled with increased expenditure for the children who receive SSI benefits has caused the Congress and SSI administrators to make changes in the programs. One of the most important changes in the SSI eligibility criteria is the establishment of new and stricter definition of disability for children. On August 22, 1996, the Personal Responsibility and Work Opportunity Reconciliation Act (Public Law 104-193) enacted the newer more stringent form of qualifications that children who are considered disabled are based on a "medically determinable physical or mental impairment which results in marked and severe functional limitations". On November 1, 1997 SSI notified the families of 135,800 children (52 percent) of an unfavorable redetermination of benefits. In addition, wide spread disparity was indicated from state to state that include the state of Mississippi termination rate of 81 percent to 35 percent in Michigan ("SSA's Implementation of the New SSI Childhood Disability Law", 1999).

The social worker who is trained in the political arena can address the severe reductions in benefits that has cascaded down since the inception of SSI. The social

worker who can influence, write, and advocate for more fair benefits. Social workers who specialize in policy development can determine fairness of the stricter criteria of SSI and address the disparity in state to state programs. Without the talents and skills of social workers, the poor and underprivileged will have little impact on influencing changes in the SSI programs that are enacted today.

Finally, this study has the potential to impact the academic curriculum of social work education. To date there are very few schools of social work that teach biofeedback as a treatment intervention. Although biofeedback is scarcely mentioned in many of the therapy textbooks few schools actually have a lab in which to teach their students. With today = s technology biofeedback can be utilized by social workers in their everyday practice. However, if social work schools fail to expose and educate their students about the use of biofeedback which can be a viable intervention not only for ADHD but for other disorder as well then another opportunity is lost. The use of AVS treatment can be easily taught to social workers thus allowing them the opportunity to utilize this potentially effective treatment.

Future Research

One of the first steps that future research should focus on is replication of the current study. Without replication, the results of this study are only one empirical validation of the benefits of AVS intervention. Further attention should also focus on selecting groups that would increase the validity and reliability of future research. In addition, a follow-up study should also include posttesting at 3 months, 6 months, and 1 year post treatment to measure long term effects of AVS treatment. Additionally, the refinement of the treatment i.e. standardized stimulation protocols should be considered

for future research. Finally, research conducted in the other social sciences would only enhance the potentiality of verification and possible other uses of AVS treatment.

In summation, the current study = s results indicate empirical support and data for the proposed research hypotheses. More specifically, the use of AVS treatment did improve cognitive functioning levels as demonstrated by increased IQ scores. Additionally, behavioral improvements were also noted with the use of AVS treatment. This empirical support is consistent with the Stimulation Theory that if an individual is exposed to a stimulating environment cognitive and behavioral changes will be noted. The findings in this current study help verify that environment can impact one = s cognitive and behavioral functioning level. Specifically, the use of AVS treatment appeared in this sample to impact the basic neurological functioning of the individual who has ADHD. This realm of intervention is not the most common area for a social worker to intervene. However, with continued research in the area of AVS treatment to determine efficacy, a social worker can possibly have the potential possibility of changing neurological patterns and functioning in their patients. This change can greatly enhance the quality of life for the ADHD individual who would normally experience multiple disappointments and failures if treatment is not available.

Conclusion

The results obtained in this study have the potential to impact treatment of the ADHD population on a wide basis. Professional individuals can be trained within a few sessions and AVS treatment can become an important intervention for those who suffer with ADHD. The AVS units are relatively inexpensive and the ease of operation only increase the potentiality of use. This form of treatment is not the “cure-all” for

ADHD individuals but it can be an important adjunctive technique in the treatment of the disorder. Through continued research on the efficacy of AVS treatment, social workers can dramatically impact the standard treatment protocol of stimulant medication of ADHD individuals with a non-pharmacological treatment, thus reducing the reliance of an individual using stimulant medication as the only treatment for their disorder.

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Appendix A

Year	Diagnosis	Authors	Focus Population	Debates & Prognosis	Treatment
1900-1929	Brain Damage Post encephalitic illness	Still, 1902 Hohman, 1922 Kennedy, 1924	Deviant adol N = 20	morally weak, prognosis poor; post influenza epidemic	placed in highly supervised environment
1930's	Brain Damage Syndrome	Blau, 1936, Bradley, 1937, Levin, 1938,& Shirley, 1939	children & adolescents; premature babies, lead toxicities =	Children seen as being brain damage prognosis very guarded	Individual hospitalized and placed in supervised group homes
1937	Psychopharma-cological Age	Bradley, 1937	Children & adolescent with oppositional behavior	first use of amphetamines, improved functioning	use of amphetamine sulfate
1950's	Hyperkinetic Syndrome	Laufer, Denhoff, & Solomon, 1957	Children & Adolescents, focused on behavior	proposed hyperkinetic impulse disorder, deficits in CNS; poor thalamic area, cortical overstimulation	combination of behavioral modification and drugs with hospitalization
1960's (early)	Golden Age of Hyperactivity	Chess, 1960	Children/Adol; slow EEG signatures	spurred on by early EEG research; neurological deficits =	Continued behavioral modification; removal of blame from the individual
1960's (late)	Hyperactive Child Syndrome	Chess, 1960	Children/Adol; impulsive and aggressive individuals	shift away from accusatory to objective measures	Multi-modality treatment ie. Behavioral Modification, psychotherapy, and medication
1970-1979	Emergence of ADD	McGill, Douglas, & Peters, 1979, 80a,80b,83	Children/Adol Labeled Hyerkenitic Reaction in Childhood	explosion of research over 2000 articles published	Use of ritalin as the main treatment for ADHD
1980-1989	APA renames the disorder to Hyperkinetic Reaction of	Shaywitz, et al., 1983 Lou, et al.,1984 Lubar, 1985	Children/Adol; Individual & Family therapy, aggregation	Advances in research, Family History, cerebral blood flow, beh.	increased sophistication of diagnosing, multi-modality

	Childhood; ADD	Zametkin & Rapport, 1986-88	studies	Checklist, QEEG = s	approach
1990-early	ADHD with 4 subtypes	Barkley, 1990 Lubar, 1993 Riccio etal, 1993 Biederman, et al., 1993	Children/Adol & Adults	Neurological base disorder, neurochemical and neuroantomical dysfunction	Ritalin, primary drug of choice. Holistic approach
1990- late	ADHD with 4 subtypes	Carter, & Russell, 1994 Rosenfeld, et al., 1995 Linden, et al., 1996	Children/Adol & Adults	Effectiveness of EEG biofeedback	Multi-modality, EEG biofeedback; combination of medications, ie stimulants and antidepressants