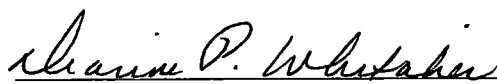


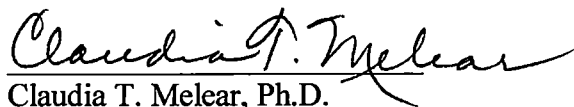
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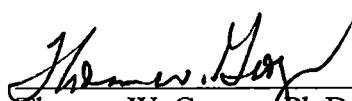
I am submitting herewith a dissertation written by Sheryl Brim entitled "A Comparison of the Electrophysiological and Psychoeducational Treatment Effects of Audio-Visual Stimulation and Bloodflow Feedback (HEG) on Children with ADHD." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.


Dianne P. Whitaker, Ph. D., Major Professor

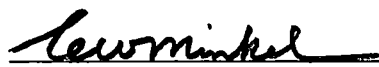
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A Comparison of the Electrophysiological and Psychoeducational Treatment Effects of
Audio-Visual Stimulation and Bloodflow Feedback (HEG) on Children with ADHD

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Sheryl A. Brim

August, 1999

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This dissertation is dedicated to my precious family, especially the Lights of my life (my children): Tina, Angela, and Gary Chronister, and my grandchild, Summer Joy Shelton . . . as well as those grandchildren who will arrive later. Thank you to my entire family, including brothers and sisters, for a lifetime of love, excitement, and emotional support. To my sweet mother, Beverly Mitchell, thank you for teaching me to give unselfishly by setting that example yourself. Thank you to all my family, including my children's father, for the valuable experiences in my life, which bring me to the place where I am today.

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Abstract

Barkley (1998) reports that 36% of students with ADHD never finish high school. DuPaul and Eckert (1997) reported that although there were positive effects of school-based interventions, the academic improvement was “almost uniformly low,” even for a significant minority of children on stimulant medication. A primary objective of this study was to explore how AVS and HEG interventions affect the psychoeducational and physiological states of the student with ADHD. Fifteen children with ADHD, who have varied psychoeducational and physiological manifestations of the disorder, including girls and boys ages 8-15, were chosen to participate. This was done in an effort to define changes that may occur as a result of audio-visual stimulation (AVS) or bloodflow feedback (HEG) training, laying the foundation for further investigations. Five participants received AVS, five received HEG for 20 sessions, five control participants received no intervention. Some changes were positive, and some were not. Although there were changes, no change was significant. The academic and behavioral manifestations of ADHD are different from child to child, even within the same family. Just as the behaviors and abilities of children with ADHD vary from day-to-day, their individual treatment effects from the interventions varied. A major limitation of this study was that these are evolving interventions, with several different treatment protocols. Another protocol with a larger sample size may obtain different results.

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Chapter I

INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD): An Overview

Children with attention deficit hyperactivity disorder (ADHD) exhibit educational and social manifestations of this problem, including inattention, hyperactivity, impulsivity, poor memory and lack of organizational skills. Three to 6% of all children have this neurological disorder for which there is no cure (Hynd et al., 1993). Some estimate that the prevalence rate may be 7 to 12% (Lubar, Swartwood, Swartwood, and Timmerman, 1995). It is well known that no intervention works universally with every ADHD student. This may be due to individual differences and the complexities of the different cerebral structures involved in sustaining attention.

Barkley (1998) reports that 36% of students with ADHD never finish high school. This is not due to a lack of intelligence, but rather a lack of successful interventions. These students are missing their education and a vital part of their social skill development because their educational needs are not being met. DuPaul and Eckert (1997) reported that although there were positive effects of school-based interventions, the academic improvement was "almost uniformly low," even for a significant minority of children on stimulant medication.

Why do some students with ADHD experience academic success in the regular school program, while others flounder and fail? Perhaps educational researchers are having a difficult time answering this question, because children with ADHD have

biological differences that the schools are not currently equipped to handle.

Cerebral Activation

In spite of extensive research indicating the regions of the brain affected by ADHD, the mechanisms by which stimulant medication works are still unknown (Medical Economics Company, 1999). Medication is not a viable treatment in approximately one-quarter of the patients with ADHD, for various personal and medical reasons. The research literature clearly demonstrates differences in cerebral structure and activation in patients with ADHD versus average patients. Furthermore, these differences vary from individual to individual in intensity and affected sites within the ADHD population, demanding a truly individualized intervention approach for the child with ADHD.

There is little scientific evidence of a biological nature supporting the use of medication in the treatment of ADHD (Swartwood et al., 1998; Matochik et al., 1994). Chabot, Orgill, Crawford, Harris, and Serfontein (in press) used quantitative electroencephalograph (QEEG) combined with behavioral assessment in order to predict children's treatment response to stimulant medication. They found that QEEG patterns could be used as a guide to predict medication responders from non-responders, and also determine which medication would be most effective for the person, based on his/her QEEG patterns. Children with attention deficits were differentiated from children with specific learning disabilities by their individual QEEG patterns.

ADHD is by no means a new disorder. In 1902 Still described this symptomology as a problem with "volitional inhibition" or "defect in moral control" (Barkley, 1994).

Since then, Minimal Brain Dysfunction in the Diagnostic and Statistical Manual of Mental Disorders (DSM), (American Psychiatric Association [APA], 1952), Hyperkinesis in the DSM-II (APA, 1968), Attention Deficit Disorder (with or without hyperactivity) in DSM-III (APA, 1980), and Attention Deficit Hyperactivity Disorder in the DSM-III-R and DSM-IV (APA, 1986, 1994) have been the accepted names for this complex neurobiological disorder.

Etiology

The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)¹ is the criterion that many clinicians use to diagnose ADHD. Although it is an improvement over its predecessors, there are controversies surrounding the use of the DSM-IV as a basis for diagnosis, including the lack of representativeness in the ethnicity and gender of its contributors (Nathan, 1994). Lahey et al. (1994) revealed that the DSM-IV is “less biased toward the symptom pattern typical of elementary school boys,” than previous versions of the DSM. ADHD is defined as three different subtypes in the DSM-IV: predominantly inattentive type, predominantly hyperactive-impulsive type, and the combined type. The DSM-IV test-retest reliability as criteria for diagnosis of ADHD is moderate, ranging from .51 - .64, which may result in either under-diagnosis, or over-diagnosis of the disorder.

The behavioral problems exhibited in ADHD children must exist in more than one setting, and be evident before age seven, causing “clinically significant impairment in social, academic, or occupational functioning” (APA, 1994, p. 84). This causes a problem

¹ See Appendix A

in the diagnosis of girls, because they may be more task oriented than boys (Jones, Callias, & Gray, 1994), allowing them to complete more of their school assignments. There is a "milder neuropsychological profile of girls with ADHD" (Seidman et al., 1997). Additionally, girls are usually older when they are referred for treatment, because their problems become more apparent (Brown, Madan-Swain, & Baldwin, 1991).

It is important that educators not develop tunnel vision regarding the age of referral for classroom problems associated with ADHD. Most teachers do not refer mild cases for assessment and do not document the behavioral problems in a child's permanent record unless an official staffing is convened for discussion of the child's problem. This may lead to an incorrect observation that a teenager has a recent onset of symptoms, although he may have been a non-problematic hyperactive and/or inattentive elementary student who was not referred. Many educators, reluctant to assign a label to the child, may inadvertently create confusion later on, when the behaviors can no longer be ignored.

Genetic Predisposition

Some studies show that there is a genetic predisposition to ADHD (Barkley, 1997; Blum, Cull, Braverman, Chen & Comings, 1997; Miller & Blum, 1996; Ruschko, 1996; Stevenson, 1992). Stevenson (1992) found a genetic influence on hyperactivity and attention difficulties in twins. The presence of more than one dopaminergic gene, obtained from a swab of the cheek cells, increases the likelihood that a person will exhibit characteristics of ADHD (Blum et al., 1997). This is a valuable tool for differentiation of

ADHD from other conditions having similar behavioral characteristics, such as conduct disorder, anxiety, depression, central auditory processing disorder (CAP-D), or substance abuse.

When the defective neurotransmitter has difficulty responding to dopamine, problems occur in the regulation of attention and normal production of good feelings. Because there is a deficit in pleasurable feelings, the child will “look for ways to create that reward,” (Miller & Blum, 1996). Blum's research links ADHD and addictive behaviors, calling it the “reward deficiency syndrome.”

Classroom Impact

Some concessions may need to be made for the ADHD student. Ruschko (1996) stated that “the traditional classroom requires of the ADHD student everything that he or she is no good at: sitting still and not talking, concentrating on skills work, and not acting or speaking impulsively” (p. 89). Motivation for school achievement is decreased when the student receives correction and ridicule for behaviors that help him to overcome his cognitive barriers.

Students, who do not appear to be motivated, may feel overwhelmed and incapable of accomplishing the required tasks. Such students may lose their desire to “try” in the face of failure (Santrock, 1987). Students feel demoralized when they believe that their successes will be blocked by circumstances out of their control – “the teacher has a bad opinion about me and I can't do anything to make him/her happy...so I won't try” (Long & Bowen, 1995).

The most important factor in school motivation and adjustment for an ADHD student is the student's relationship with parents and teachers (Ryan, Stiller, & Lynch, 1994). When the student believes he has the support of his teachers, there is a greater motivation to do well in school.

Rationale for this Study

ADHD appears to be a varied collection of symptoms revealing underlying neuro-anatomical and neuro-chemical processes in the brain, which may differ from children without ADHD. It is important to realize that this is not a disease process, or a single entity. There is a strong genetic component in ADHD. When one child has ADHD in the family, there is a good possibility that other siblings may also have the disorder, even though it may be expressed by a different set of behaviors and academic challenges.

A primary objective of this study was to explore how two alternative treatment interventions affect the psychoeducational and physiological states of the student with ADHD. A cross-section of the ADHD population having varied psychoeducational and physiological manifestations of the disorder, included girls and boys ages 8-15. This was done in an effort to define changes that may occur in an ADHD population, as a result of audio-visual stimulation (AVS) or bloodflow feedback (HEG) training.

Participants

Children of average intelligence were selected for inclusion in the study, based on psychoeducational assessments that included parts of an intelligence test, computerized continuous performance tests, parent and/or school behavior rating forms, and assessment

of theta/beta brain wave ratios. Children qualified for participation in the study if they met criterion levels on three out of four measures, as determined by Whitaker and Lubar (personal communication, April 27, 1998).

After the criteria were met, 15 participants were given quantitative electroencephalographs (QEEGs) and assigned randomly to treatment and matched control groups. An academic achievement test was given to the participants before the intervention began. At the conclusion of the pre-assessment battery, two of the participants self-selected their participation into a waiting control group who received no interventions. Then two of the matched controls from the waiting control group were slotted into the open spaces in the treatment group.

Five participants received audio-visual stimulation (AVS) for 20 sessions. The other five participants used a new method of bloodflow feedback training (HEG) for 20 sessions. The interventions were set for 20 sessions, because proponents of these methods indicated that therapeutic change could be seen at that point. HEG claims to monitor cerebral bloodflow using a computerized wireless infrared telemetered physiological monitoring system, with the intent of increasing frontal cerebral bloodflow (Fabiani & Gratton, 1999). At the conclusion of intervention, each group received all of the physiological and psychometric measures employed at the beginning of the study, with the exception of the measure for intelligence that was used for screening purposes only.

Hypotheses

This research study explored the following questions: 1) “What are the psychoeducational and electrophysiological treatment effects of audio-visual stimulation (AVS) and bloodflow feedback (HEG) on children with ADHD?” and

2) “How do HEG and AVS compare as treatment interventions for children with ADHD?”

These questions were answered by the testing of the following hypotheses:

Hypothesis #1: Children with ADHD improve on cognitive ability measures of the SCAD Index, which includes the Processing Speed Index and Freedom from Distractibility Index on WISC-III after intervention with AVS or HEG.

Hypothesis #2: Children with ADHD improve on parent’s rating of child’s behavior after AVS or HEG intervention.

Hypothesis #3: Children with ADHD improve on EEG measures of brain activity, demonstrating changes toward normal in five or more locations after AVS or HEG intervention.

Hypothesis #4: Children with ADHD demonstrate improvement on TOVA scores after AVS or HEG intervention.

Hypothesis #5: Children with ADHD have individual differences and variable treatment responses to HEG or AVS.

Discussion

Results from behavioral, cognitive, and achievement assessments by one-way analysis of variance (ANOVA) reveal no significant changes for the three groups, AVS,

HEG, and Control. Electroencephalographic (EEG) measures were evaluated by Principal Components Analysis (PCA). There were no significant differences in the factor scores observed in any group at any frequency.

The academic and behavioral manifestations of ADHD are different from child to child, even different expressions for children within the same family. Chapter V includes case – study representations, in order to provide more meaningful descriptions of those individual differences. Just as the behaviors and abilities of children with ADHD vary from day-to-day, individual treatment effects of the interventions varied, with some changes being positive, and some not. Some of the children in this project appeared to have improved cognitive functioning after the intervention, especially in the AVS group.

A major limitation of this study was that these are evolving interventions, with several treatment protocols. Another paradigm with a larger sample size may be more effective and elicit different results. This study is important because it brings more understanding into the complexities of the diagnosis and treatment alternatives in ADHD.

Children with ADHD struggle in the classroom today, just like they did 50 years ago. ADHD is not going to disappear. There are no “quick fixes.” School systems must be in compliance with federal special education testing guidelines, which may cause them to be more “test and place” oriented, than child needs oriented. There are tragic ramifications of not meeting the educational and social needs of children with ADHD. School psychologists, when given the time and latitude of developing and monitoring interventions for these children, can create positive change in these children’s lives.

Chapter II

REVIEW OF THE LITERATURE

History

As early as 1902, Still referred to this disorder as “defective moral control and volitional inhibition” (Barkley, 1994). Others followed with the terms “restless syndrome,” “postencephalitic behavior disorder,” and “brain-injured child syndrome.” Although identification of attention deficit-hyperactivity disorder (ADHD) has increased over the years, it is not a modern “fad” as the popular press and some educators have insisted.

Since 1957 “hyperkinetic impulse disorder,” “minimal brain dysfunction,” “hyperactive syndrome,” “hyperkinetic reaction,” and “attention deficit disorder” have been used to describe this neurologically based problem that has varied symptomatic and severity patterns. The emphasis has changed from a focus on a motor deficit (overactivity) to its current classification as a cognitive deficit in the 1980 publication of the Diagnostic and Statistical Manual of Mental Disorders (APA).

Theories of ADHD

Cerebral Structures and Activation

Research shows that the brain itself may be different in people with ADHD. Hynd et al. (1993) used Magnetic Resonance Imaging (MRI) to show that the head of the caudate nucleus, an elongated c-shaped nuclear mass deep in the brain, is a different size for subjects with ADHD than with normal controls. Decreased frontal lobe activity in adolescents with ADHD exists, with glucose metabolisms, on the average, 8% lower in

ADHD versus controls (Zametkin et al., 1993). Lou, Henriksen, and Bruhn (1984) discovered that the cortical regions of children with ADHD did not show normal increases in blood flow during activities requiring concentration.

Amen, Paldi, and Thisted (1993) used SPECT imaging to explore cerebral activation in children with ADHD as compared to “normal” children. “Sixty-five percent of the children and adolescents diagnosed with attention deficit hyperactivity disorder had significant prefrontal cortex deactivation in response to an intellectual challenge as compared to only five percent of those clinical patients who did not have ADHD or ADD” (p. 1081). Concentration on demand is very difficult for these children whose innate physiological responses to cognitive demands are opposite from the norm.

Sieg, Gaffney, Preston, and Hellings (1995) studied cerebral blood flow and metabolism in ADHD patients, and witnessed changes according to IQ differences, implying a relationship between intelligence and neuronal functions. There were significant differences of activity in the left frontal and parietal regions, with the greatest overall asymmetry in the frontal region of patients with ADHD.

Delayed Maturation

According to Sieg et al. (1995), the reason some children with ADHD improve in adolescence is because of the delayed maturation of these areas of the brain. The frontal regions are last to complete myelination, and brain imaging may be revealing maturational delays due to myelination.

Other research supports the theory of delayed maturation. Mann, Lubar, Zimmerman, Miller, and Muenchen (1992) compared Quantitative Electroencephalographic (QEEG) brain mapping of boys with ADHD to boys without ADHD. The boys with ADHD exhibited increased theta (slow wave) activity and decreased beta (fast wave) activity. Their EEGs resembled those typical of younger children. Therefore, it may be that when people give performance ultimatums to these children, they may “back them into a corner,” because the neurologic ability to meet those expectations are not fully developed (Miller & Blum, 1996).

However, not all psychologists agree that “delayed maturation” accounts for the ADHD syndrome. Robert Chabot, at a presentation to the Society for Study of Neuronal Regulation (SSNR) Annual Meeting in Austin, Texas on September 12, 1998, rejected the theory of delayed maturation saying, “if their EEGs were considered normal at any age, that would be possible.” Although there are developmental changes that occur, he stated that the EEG patterns associated with ADHD are not considered normal at any age, so the theory of delayed maturation is not a good explanation for EEG differences.

Genetics and “Reward Deficiency Syndrome”

Some studies show that there is a genetic predisposition to ADHD (Barkley, 1997; Blum et al., 1997; Miller & Blum, 1996; Ruschko, 1996; Stevenson, 1992). Stevenson (1992) found a genetic influence on hyperactivity and attention difficulties in twins. During functional magnetic resonance imaging (fMRI), Vaidya et al. (1998) found a “striatic response characteristic of the ADHD group” for two out of three “normal” siblings of

their ADHD participants. They concluded that, “these children did not meet behavioral criteria for ADHD, which suggests that brain abnormalities in ADHD may be necessary, but are not sufficient for the manifestation of ADHD” (p. 14498).

Vaidya et al. (1998) discovered through the fMRI a “possibility that an important feature of ADHD is atypical dopaminergic modulation of the striatum” (p.14498). Blum et al. (1997) found that the presence of more than one dopaminergic gene, obtained from a swab of the cheek cells, increases the likelihood that a person will exhibit characteristics of ADHD. This is a valuable tool for differentiation of ADHD from other conditions having similar behavioral characteristics, such as conduct disorder, anxiety, depression, central auditory processing disorder (CAP-D), or substance abuse.

When there is dysfunctional dopaminergic transmission, the neurotransmitter has difficulty responding to dopamine, and problems occur in the regulation of attention and normal production of good feelings. Because there is a deficit in pleasurable feelings, the child will “look for ways to create that reward,” (Miller & Blum, 1996).

Blum's research links ADHD and addictive behaviors, calling it the “reward deficiency syndrome.” The book, Overload: Attention Deficit Disorder and the Addictive Brain, relates David Miller's personal experience with ADHD in school. In adolescence Miller found relief from the pressure of mood swings, poor memory, attention problems and low frustration tolerance in excessive alcohol usage. He longed to succeed and belong, but said that he “didn't know how” (p. 7). “Many children with ADHD hear messages like, ‘you just don't try, sit still, pay attention, concentrate, you are interrupting’

for years. Is it any wonder that some children with ADHD give up, or turn to drugs or alcohol to allow them to feel good" (Brim & Whitaker, in press)?

Diagnosis

ADHD is by no means a new disorder. In 1902 Still (Barkley, 1994) described this symptomology as a problem with "volitional inhibition" or "defect in moral control." Since then, Minimal Brain Dysfunction in the DSM (APA, 1952), Hyperkinesis in DSM-II (APA, 1968), Attention Deficit Disorder (with or without hyperactivity) in DSM-III (APA, 1980), and Attention Deficit Hyperactivity Disorder in the DSM-III-R and DSM-IV (APA, 1986, 1994) have been the accepted names for this complex neuro-biological disorder.

According to Schwean and Saklofske (1998), the greatest problem with finding an acceptable name for ADHD lies with the many ways the disorder manifests itself within the population. "Research findings underscore the diversity among children with attention disorders in etiology, cognitive, academic, psychological, and family correlates, clinical courses, outcomes and intervention responses" (p. 103). Parents, teachers, and other professionals often have a typical "ADHD" profile in their minds, and if the child does not manifest the disorder in that manner, then she does not have ADHD. The parents of an ADHD-hyperactive child may not accept that their gifted well-behaved impulsive or inattentive daughter also may have ADHD.

The DSM-IV (APA, 1994) is the criterion that many clinicians use to diagnose ADHD. Although it is an improvement over its predecessors, there are controversies

surrounding the use of the DSM-IV as a basis for diagnosis, including the lack of representativeness in the ethnicity and gender of its contributors (Nathan, 1994).

Lahey et al. (1994) revealed that the DSM-IV is "less biased toward the symptom pattern typical of elementary school boys," than previous versions of the DSM. Since the vast majority of the research on ADHD students has been with male subjects, Arnold stated that "female manifestations and sex differences have been relatively neglected in the extensive ADHD research" (1996, p.555).

Problems with DSM-IV

ADHD is defined as three different subtypes in the DSM-IV: predominantly inattentive type, predominantly hyperactive-impulsive type, and the combined type. The DSM-IV test-retest reliability as criteria for diagnosis of ADHD is only moderate, ranging from .51 - .64, which is slightly better than chance and may result in either under-diagnosis, or over-diagnosis of the disorder.

The behavioral problems exhibited in ADHD children must exist in more than one setting, and be evident before age seven, causing "clinically significant impairment in social, academic, or occupational functioning" (APA, 1994, p. 84). This causes a problem in the diagnosis of girls, because they tend to be more task oriented than boys (Jones, Callias, & Gray, 1994), allowing them to complete more of their school assignments. There is a "milder neuropsychological profile of girls with ADHD" (Seidman et al., 1997). Girls are usually between the ages of 15 and 17 when they are referred for treatment, because their behavior, often manifested as inattention, becomes more problematic

(McDermott, 1996; Brown et al., 1991). These factors are some reasons why there are approximately three times as many boys diagnosed with ADHD as girls.

According to Campbell (1990), another concern about the DSM criteria is that it “does not address developmental manifestations of symptomatic behavior adequately, making the diagnosis of hyperactivity in children problematic.” The DSM-IV field trials selected 380 clinic-referred children and adolescents from the sample of 440 youths “described in the report of the DSM-IV field trials for oppositional defiant disorder and conduct disorder” (Lahey et al., 1994). As a result, only the severely behaviorally impaired children were included in the study. In fact, the only data on 14 to 17 year-olds were obtained from detention centers, which included 50 juvenile delinquents, 12 of them females. The observations appear to have been made by juvenile authorities, since the Measures section of the report states that “neither parent or teacher informants were available for any of the 56 juvenile detention subjects” (p.1674).

It is important that educators not develop tunnel vision regarding the age of referral for classroom problems associated with ADHD. Most teachers do not refer mild cases for assessment and do not document the behavioral problems in a child’s permanent record unless an official staffing is convened for discussion of the child’s problem. This may lead to the incorrect assumption that a teenager has a recent onset of symptoms, although he may have been a non-problematic hyperactive and/or inattentive elementary school student who was not referred. Many educators, reluctant to assign a label to the child, may inadvertently create confusion later on, when the behaviors can no longer be

ignored.

In the introduction to the DSM-IV, a paragraph is devoted to the importance of using sound clinical judgement when using it as a guide to diagnose disorders. It appears that many practitioners overlook the following statement:

The specific diagnostic criteria included in DSM-IV are meant to serve as guidelines to be informed by clinical judgement and are not meant to be used in a cookbook fashion. For example, the exercise of clinical judgement may justify giving a certain diagnosis to an individual even though the clinical presentation falls just short of meeting the full criteria for the diagnosis as long as the symptoms that are present are persistent and severe. (APA, 1994, p. xxiii)

Perhaps, the problems encountered when using the DSM-IV as diagnostic criterion for ADHD have more to do with the practitioner's unfamiliarity with the intent of the DSM-IV, than actual perceived "mandates" of the DSM-IV.

Girls with ADHD

Since the DSM-IV is the main diagnostic tool used in the evaluation of ADHD today, it is important that these problems be addressed in order to diagnose girls correctly. Historically, girls' attention and hyperactive/impulsive problems have been ignored, unless their symptoms were as severe as those of boys. Signorella states that some individuals "under certain conditions, are showing memory processes biased toward gender" (1992, p. 155). Parents and teachers may reprimand a boy for certain behaviors, but ignore the same behaviors in a girl. That may be a reason why teachers rarely identify and/or refer girls who are hyperactive (Breen & Altepeter, 1990). Girls, in general, are older at the time of referral for diagnosis of ADHD (Brown et al., 1991; Arnold, 1996), which causes misconceptions in the diagnosis of the progression of the disorder in girls.

In their study of the neuropsychological functioning of girls with ADHD, Seidman et al. found that girls have “relatively intact executive functioning,” although “neuropsychological deficits are core impairments in ADHD,” especially for boys (1997, p. 371). This may be a reason why more boys than girls have ADHD-related problems in school. Overlooked in this study was the fact that 84% of the girls were on stimulant medication, which may have confounded the purported results.

The ability to correctly identify ADHD girls at an early age is important, in part, because of the “higher adolescent pregnancy rate in girls with ADHD compared to normal girls” (Arnold, 1996, p. 566). It appears that parents are making decisions to refer their daughters for treatment based on cultural gender role models, which views their daughters’ behaviors as typical “girl” behaviors. Unfortunately, girls’ early symptoms are milder than boys, causing parents to wait an inordinate amount of time before securing the professional help their girls need. Usually a crisis situation occurs, then initial treatment and evaluation begins simultaneously and immediately. For some girls the consequences are devastating and pose severe limitations to their expectations for the future.

Faraone et al. report that “on the non-antisocial families, brothers and sisters are at equal risk for ADHD” (1995, p. 340). When one child in the family has a diagnosis of ADHD, it is important to recognize that other children in the family may have inherited the gene for ADHD as well. Their own behavioral expression of that gene may be quite different than their sibling’s. Vaidya et al. (1998) excluded boys as normal controls, who had a sibling diagnosed with ADHD, from their fMRI study on methylphenidate effects in

children with ADHD, because they found similar brain abnormalities in two out of three “normal” siblings. The current state of ADHD research still asserts that boys outnumber girls 3:1, ignoring Faraone and his colleagues’ (1995) findings.

Researchers attempt to justify the lack of female participants in their studies as representative of the ADHD population. Even if the ratio is 3:1, then females comprise at least 33% of the ADHD population. It is unacceptable to exclude such a sizable percentage of the population from ongoing research into the disorder.

Disorders with Similar Characteristics

The DSM-IV lists many disorders with some of the same behavioral characteristics as ADHD such as, short attention span, problems concentrating, and poor impulse control. These disorders include posttraumatic stress disorder, generalized anxiety disorder, substance abuse related disorders, mood disorders - including depression and bi-polar disorder, traumatic brain injury, conduct disorders, and sleep disorders (APA, 1994). Like ADHD, many of these disorders have a genetic base (Kendler, Neale, Kessler, Heath, & Eaves, 1992; Smith et al., 1992).

Jenkins and Pacella (1943) conducted an EEG study with juvenile delinquents in the early 1940s and determined that there were abnormal EEGs in the group of children who experienced “problems with school adjustment related to restlessness, distractibility, short attention span, inability to concentrate, inability to adapt to a program of highly restricted activity and sedentary study” (p. 120). Although the study did not differentiate which of the “borderline normals” and “moderate disordered” were included in that group,

the percentage of the total group membership was between 12 and 28 percent. Only 66 percent of the fifty delinquent boys had normal EEGs. Jenkins and Pacella stated that many children were labeled as conduct disordered or delinquent, when the “organic” cause of their delinquency was ignored (p. 119). They believed that a comprehensive differential diagnosis should be performed, and “it is possible that EEG may become a valuable aid in determining or recognizing many of these handicapped personalities” (p. 120). However, the use of EEG for the differential diagnosis of delinquents is not a common occurrence.

Some children with average intelligence are identified as learning disabled, because they fail to acquire basic reading or math skills. Others may have good reading skills, but poor comprehension, and good math reasoning skills, but poor computational ability (Zentall & Javorsky, 1998). In a well-behaved child, neurologically based attention problems may be an overlooked barrier to the acquisition of and/or the ability to demonstrate academic skills. These children may spend academic lifetimes in resource classrooms, receiving few benefits, because of the failure to identify or address the underlying attention problem.

Some school systems, alarmed at having a large percentage of their children identified as “Other Health Impaired” because they have ADHD, have attempted to decrease their special education roles by decertifying these children unless there is an IQ-achievement discrepancy that meets state special education guidelines. Zentall and Javorsky (1998) state that the so-called state discrepancy formulas “cannot be applied to children with ADHD . . . performance of daily classroom tasks, rather than achievement

tests, characterizes the performance problems of these students” (p. 38). These children with ADHD, who need special classroom modifications and behavioral considerations to succeed in school, will be placed at higher risk for failure when their educational needs are ignored.

Social Impact of ADHD

Whalen and Henker (1985) state that the DSM does not address the issue of social problems adequately. This lack of consideration may be the result of inadequate literature addressing the socialization and social development of hyperactive children. “Social conditioning in schools differ between boys and girls,” with teachers paying more attention to normal boys and bad girls, and less attention to bad boys and normal girls (McDermott, 1996). Girls experience a sharp rise in referrals for behavior problems such as suicide attempts, stealing, lying, and drug and alcohol problems between the ages of 15 and 17.

Breen and Altepeter (1990) discussed their findings that “teachers and parents have been conditioned to view boy-girl behavior patterns differently as a result of cultural biases . . . and girls are less likely to be referred for aggression than boys” (p. 486). Because teachers perceive boy-type disruptive behavior as more serious, they may choose to ignore the same type of behaviors from girls. This supports the contention that “a disorder is manifested only when the liability (or ‘vulnerability’) goes beyond a certain threshold” (Silverthorn, Frick, Kuper, & Ott, 1996, pp. 52-53).

Girls are less likely to be diagnosed with ADHD and therefore, others perceive a higher threshold for the disorder in girls (Silverthorn et al., 1996). They experience a

greater vulnerability to the combination of environmental and genetic factors that contribute to the manifestation of the disorder.

Across cultures, girls have fewer problems with attention and hyperactivity than boys do. There appears to be different expectations for boys in comparison to girls in our "macho culture," which dictates "appropriate behavior for girls" (Arnold, 1996, p. 563). Arnold supports the hypothesis that the true sex ratio would be different if there was gender specific diagnostic criteria used for each sex. "There have been discussions to whether the discrepant sex ratio in ADHD is due to the nature of the disorder or due to the differential sex expectations in society" (Silverthorn et al., 1996, p.58).

"It is our opinion that the frustration and anger of undiagnosed, untreated, or misunderstood ADHD lead to symptoms that are labeled conduct disorder" (Miller & Blum, 1996, p. 111).

By ages five to seven, half to two-thirds of children with ADHD are hostile and defiant; by age ten to twelve, they are at risk of developing conduct disorder . . . the risk of developing substance abuse disorder increases when the person with ADHD is hyperactive and increases even more when they have conduct disorder. (pp. 41-42)

Children with ADHD tend to develop an "I don't care" attitude, because "not caring" hurts less when others are berating the child for his/her impulsive actions.

Children with ADHD sometimes develop the persona of the socially unacceptable person, "yea, I'm bad." As this persona develops, they seek out friendships with others that are socially unacceptable, engaging in socially unacceptable activities. This may lead to delinquency as they attempt to "find their way" in a society that is not supportive of

children who act differently than the prescribed “norm” (Miller & Blum, 1996; Jenkins & Pacella, 1943).

Zagar, Arbit, Hughes, Busell, and Busch’s (1989) research on 1,056 juvenile delinquents discovered that 55 percent of them had ADHD. Eyestone and Howell’s (1994) study of prison inmates in Utah, found that over 25 percent of them had ADHD symptoms as children and most of them were never diagnosed with the disorder. That does not infer that a great number of children with ADHD are delinquent. However, it is important to recognize that more people with ADHD commit anti-social acts than the “normal” general population (Foley, Carlton, & Howell, 1996; Barkley, Fischer, Edelbrock, & Smallish, 1990).

Targeting these at-risk children for early intervention strategies, to help promote better coping skills, is critical in meeting their life-long challenges. Impulsive behaviors are a part of the very nature of many children with ADHD, and they need to learn how to cope productively with those impulses as they occur. According to Foley et al. (1996), “if it were possible to predict with a 70 percent accuracy rate, and if intervention was successful with 25 percent of that group, then the intervention would be cost effective” (p. 341).

Motivation and School Success

According to Barkley (1998), approximately 36% of students with ADHD never finish high school. One of the common reasons given for this alarming statistic is the lack of motivation. Ruschko asserted that “the traditional classroom requires of the ADHD

student everything that he or she is not good at: sitting still and not talking, concentrating on skills work, and not acting or speaking impulsively” (1996, p. 89). Motivation for school achievement is decreased when the student receives correction and ridicule for behaviors that help him to overcome cognitive barriers. “Students with ADHD cannot always be motivated in the same way as other students and some concessions may need to be made” (Brim & Whitaker, in press).

In order to demonstrate their commitment to the acquisition of knowledge, many schools are production oriented. This is a problem for students with ADHD who require more time to complete assignments. Students, who do not appear to be motivated, often feel overwhelmed and incapable of accomplishing the required tasks. They lose their desire to “try” in the face of failure (Santrock, 1987).

Students feel demoralized when they believe that their successes will be blocked by circumstances out of their control. A student’s attitude may be that the teacher has a bad opinion about him and because he can’t do anything that will satisfy her, he won’t even try (Long & Bowen, 1995). The fear of rejection is a powerful emotion. Many of these students have endured years of having work rejected as inferior and/or late. Schoolwork becomes noxious to them.

When children have a low self-esteem, it may be difficult to stimulate their desire to engage in tasks (Lauchlan & Elliott, 1997). Unfortunately, if aversive feelings of failure are transferred to school in general, motivation to stay in school is gone.

Current Interventions

Sometimes the life of the child with ADHD becomes so dysfunctional and fraught with failure that his parents seek out medical and/or psychological interventions to help him become “normal.” In their attempts to recover their “dream child,” parents can go to many extremes to find the answers that will help their child.

Psycho-Stimulant Medications

There is little scientific evidence of a biological nature supporting the use of medication in the treatment of ADHD (Swartwood et al., 1998; Matochik et al., 1994). The Physicians’ Desk Reference (Medical Economics Company, 1999) states, “There is neither specific evidence which clearly establishes the mechanism whereby Ritalin produces its mental and behavioral effects in children, nor conclusive evidence regarding how these effects relate to the condition of the central nervous system” (p. 2078).

Chabot et al. (in press) used quantitative electroencephalograph (QEEG) combined with behavioral assessment in order to predict children’s treatment response to stimulant medication. Their group found non-significant EEG changes towards normal with methylphenidate treatment within specific subtypes of the ADHD population. Improvement was observed in the EEGs of 56.9% of the “hyperactive” subtype, 31.9% of the “inattentive”, and 5.5% of the “other.” Conversely, there was a movement towards greater abnormality in 9.3% of the “hyperactive,” 17% of the “inattentive,” and 16.7% of the “other” subtypes. In addition, they identified QEEG patterns that differentiated children with attention deficits from children with specific learning disabilities.

The literature is mixed regarding assessment of the effects of methylphenidate (MPH) on brain activity for children with ADHD. Vaidya et al. (1998) used fMRI to demonstrate that MPH "increased striatal activation in ADHD children but decreased striatal activation in control children . . . and reveal that ADHD and normal children differ neurophysiologically in frontal-striatal brain regions important for inhibitory control and in the striatal response to MPH" (pp. 14498-99).

However, since at least 1978, studies have demonstrated little or no direct effect of stimulant medications on school achievement (DuPaul & Eckert, 1997; Ruschko, 1996; Barkley & Cunningham, 1978). It may be reasonable to assume that initially, it is the classroom teacher or parent who experiences the beneficial effect of student medication.

Biederman, Faraone, Keenan, Steingard, and Tsuang (1991) found that stimulant medication had a detrimental effect on anxious children with ADHD. Medication may be contraindicated in children: 1) susceptible to Tourette Syndrome, 2) who have sleeping problems, 3) when there is possible drug abuse, 4) when there is a concern about long term effects, including growth problems, or 5) when there is intolerable physical discomfort. Since the administration of methylphenidate may exacerbate thought disorders, children with any form of psychosis-like symptoms should not take methylphenidate for their ADHD (Medical Economics Company, 1999; Swartwood, 1994). Medication is not a viable treatment in approximately one-quarter of the patients with ADHD, for various personal and medical reasons.

Matochik et al. (1994) studied the effects of chronic stimulant medication on the

cerebral glucose metabolism of adults with ADHD, and found no outstanding metabolic effects of the treatment. Lubar, Swartwood, Swartwood, and O'Donnell (1995) found that stimulant medication does not affect the EEG patterns in children with ADHD. On the surface this appears to conflict with Chabot et al.'s results; however, it is important to note that Lubar's criterion for assessing change was more rigorous. Lubar (personal communication, June 1, 1999) held the measurement of methylphenidate treatment effects to the same standards that he required of neurofeedback (1.5 Z-score differences) in order to rate the EEG as changed. Chabot rated the EEG as changed when 5 or more areas moved towards normal by at least a .5 Z-score (in press).

Wilkison, Kircher, McMahon, and Sloan (1995) supported the "reward deficiency syndrome" theory. They discovered that people with ADHD have abnormally high reward thresholds. Consequently, rewards for behaviors must occur at a higher or more intense level to motivate people with ADHD, as compared to those without ADHD. Their findings suggest that methylphenidate (Ritalin) increases the value of rewards, which may increase frustration tolerance as well. Barkley (1997) states that the behavior changes occurring as the result of Ritalin are best explained by the term "increased incentive motivation," (p. 73) that is, reward thresholds are reduced.

In spite of research indicating the regions of the brain affected by ADHD, the mechanisms by which stimulant medication works have been difficult to find. The Physicians' Desk Reference offers this warning, "Sufficient data and efficacy of long-term use of Ritalin in children are not yet available" (Medical Economics Company, 1999,

p.2078). This warning is applicable after 50 years of treating children with ADHD using Ritalin, a schedule II controlled substance. Another popular schedule II drug, Adderall, lists this warning, "Amphetamines have a high potential for abuse. Administration of amphetamines for prolonged periods of time may lead to drug dependence and must be avoided" (p. 3003).

The research literature clearly demonstrates differences in cerebral structure and activation in a patient with ADHD versus non-ADHD patients. Furthermore, these differences vary from individual to individual in intensity and affected sites within the ADHD population, demanding a truly individualized intervention approach for the child with ADHD. The first line of intervention for children with ADHD should not be medication, and medication "is not indicated in all cases of Attention Deficit Disorder with Hyperactivity" (Medical Economics Company, 1999, p. 3004).

Neurofeedback Training

An alternative to medication is neurofeedback training, which controls the manifestations of ADHD by training children to decrease the excessive theta activity (associated with daydreaming and shifting attention) and increase the duration and amplitude of beta activity (associated with concentration) (Mann et al.1992; Miller & Blum, 1996). Another name for neurofeedback is electroencephalographic (EEG) biofeedback, which uses a system of criterion-based reinforcements for target behaviors. It has been successful as an intervention to help children and adults in normalizing their abilities to attend to stimuli and process information (Lubar, Swartwood, Swartwood, and

O'Donnell, 1995).

Lubar, Swartwood, Swartwood, and O'Donnell (1995) conducted a summer training program to assess the effectiveness of neurofeedback training with ADHD children. They found significant increases in Test of Variables of Attention (TOVA) and Wechsler Intelligence Scale for Children-Revised (WISC-R) scores upon completion of the neurofeedback training under controlled conditions. There were significant improvements in EEG activity and behavioral ratings, corroborating earlier research findings that neurofeedback training does help many children to overcome learning and attention problems associated with ADHD.

The ability to manipulate the theta and beta activities in the brain appears to be an important factor in overcoming the effects of ADHD. This may be related to the hypo-activation, reduced blood flow, which occurs in the prefrontal cortex of patients with ADHD when they perform a task that requires concentration (Amen et al., 1993). Those research studies demonstrated the benefits of neurofeedback training, revealing that "the reduction of theta activity appears to be the key factor associated with improvement in Attention Deficit Disorder" (Lubar, Swartwood, Swartwood, and O'Donnell, 1995, p. 98; Lubar & Lubar, 1984; Mann et al., 1992).

Psychoeducational and behavioral assessments after the end of neurofeedback training support these results, revealing observable gains in Test of Variables of Attention (TOVA) and intelligence scores, as well as improvement on parent's subjective ratings of behavior using the Attention Deficit Disorders Evaluation Scale (ADDES). That is, the

participants in the study demonstrated increased intelligence scores, improvements in inattentiveness, hyperactivity and impulsivity ratings of behavior, and improved TOVA performance following neurofeedback training, “without continual external intervention” (Lubar, Swartwood, Swartwood, and O’Donnell, 1995, p. 91).

Numerous neurofeedback research studies demonstrate positive behavioral and cognitive improvements in ADHD students. Neurofeedback should be considered a viable alternative treatment integrated into a multi-component program of interventions facilitating school achievement. Since neurofeedback is a successful alternative and/or adjunct therapy to medication for the treatment of ADHD, it is possible that other treatment modalities could be effective as well.

Proposed New Techniques

Many parents, reluctant to use chemical interventions, welcome the use of an intervention that can train their child to internalize behavioral control. There are many stories of “miracle cures,” anecdotal incidences of children taking a “miracle vitamin,” taking part in a special program of therapy, experiencing some special tapes, buying a certain book . . . all with one thing in common, the quick fix. Unfortunately, most of those therapies have one major problem in common; their methods lack peer-reviewed scientific research into their claims. At first, people may experience the “miracles.” Once the “placebo” or “non-specific” effect is over, usually by the end of the second week, they are left with greater discouragement and less money.

Two new treatments for ADHD have been introduced on the market, audio-visual

stimulation (AVS) and bloodflow feedback (HEG). Although HEG is a relatively new intervention, AVS has been on the market for many years. There is little information published in peer-reviewed journals regarding the use of these interventions for children with ADHD.

Audio-Visual Stimulation (AVS)

“During the 1950s and 1960s, researchers became interested in using both visual and auditory rhythmic stimulation as a means of inducing relaxation and hypnosis” (Timmerman, Lubar, Rasey, & Frederick, in press). Within the past ten years, increasing interest in driving the EEG towards certain frequencies as therapeutic interventions has been explored in research. Russell (1997) utilized AVS as an intervention for learning disabilities within the school population. He demonstrated improvement in the academic functioning of those children.

Timmerman et al. (in press) used AVS alpha and beta stimulation with 13 college students. They found “significantly more power in the theta, alpha, beta 1 and beta 2 bandpasses after beta AVS, 30 minutes after the AVS sessions had ended.” A later study by Frederick, Lubar, Rasey, Brim, and Blackburn (in press) at The University of Tennessee, supported the “hypothesis that auditory and/or visual stimulation can entrain the EEG frequencies corresponding directly to the frequency of stimulation.”

Bloodflow Feedback (HEG)

HEG is a technique of using near-infrared (NIR) spectroscopy, mounted on a velcro headband, as a feedback system to monitor cerebral bloodflow with the intent of

increasing brain activation. Herschel Toomin, of Biocomp Research Technologies, developed this device in response to the expanding research literature connecting reduced frontal cerebral bloodflow and cognitive deficits in people with ADHD. He claims several "miracles," with increased cognitive abilities, based on improvement in TOVA scores college grades, and Micro-Cog scores (personal communication, June 14, 1998). There has been no peer-reviewed published research to date on this HEG device.

Fabiani and Gratton (1999) use near-infrared (NIR) technology as a brain imaging tool at the University of Missouri. This NIR technology is a similar device to the one used in HEG. Their Event-Related Optical Signal (EROS) is mounted on a stationary device, which allows a reliable measure of the "variations in the concentration of oxy- and deoxy-hemoglobin (which are absorbers of NIR light) . . . this makes optical measures ideal for studying the relationship between neuronal and hemodynamic brain responses" (p. 11). Penetration of the NIR is approximately 3-5 cm, which "makes it mostly a measure of cortical activity" (p. 12). So, the use of NIR light as a clinical application has theoretical support in research.

Expectations if No Intervention

"School maladjustments resulting from failure to recognize and provide for such handicaps results in classroom rebellion or truancy, and puts the child in a position where delinquent influences are likely to play upon him" (Jenkins & Pacella, 1943, p.120). What was true in 1943, holds true today. Children whose needs are not met in school, are at greater risk of school dropout, mood-altering substance abuse, and involvement in

criminal activity. Jenkins and Pacella recognized the role of cerebral activation in ADHD-type behavior during the early 1940s; that was more than 50 years ago.

Implications for Research and Practice

The National Institutes of Health (NIH)/National Institute of Mental Health (NIMH) 1994 publication entitled, "Attention Deficit Hyperactivity Disorder: Decade of the Brain," states that "a few success stories can't substitute for scientific evidence," referring to alternative treatments. DuPaul and Eckert (1997) reviewed the research literature about ADHD behavioral strategies within educational institutions. They reported that although there were positive effects of school-based interventions, the academic improvement was "almost uniformly low," even for a significant minority of children on stimulant medication (p. 22).

Therefore, it is time to explore those alternative treatments that lend themselves to objective investigation including audio-visual stimulation and bloodflow feedback. Research clearly supports the use of QEEG as a useful tool in the differentiation of learning disabilities and attention deficit hyperactivity disorder (Chabot et al., in press). Once we understand how different QEEG patterns in our students' brains effect their performance in school, we may find it easier to apply this new knowledge to the development of more effective classroom interventions for our students with ADHD.

Chapter III

RESEARCH METHOD

Participants

Participants for this study were 15 children who met the DSM-IV criteria for diagnosis of attention deficit hyperactivity disorder (ADHD). They had at least average intelligence, and were between the ages of 8 and 15 (11.16 years – mean age). Participants chosen met three out of four criterion presented in Table 1:² 1) below the 35th percentile on the Attention Deficit Disorders Evaluation Scale (ADDES) - Home or School rating form(s), 2) rating of “attentional problems” on a computerized continuous performance test, and 3) three or greater on the A620 Assessment software (uv squared), or 4) below the 40th percentile on the Processing Speed Index or Freedom from Distractibility Index from the WISC-III. (See Table 2, Comparison of Participants by Group)

Absolutely no child with a history of seizures, significant medical or neurological problems participated in this study. No child was on psychotropic medication during the assessment and intervention phases. Although one child was on Dexedrine during the school year, he took a summer break from medication beginning 72 hours prior to his first pre-test and continuing throughout his participation in this study.

All children participated voluntarily in the study. They were recruited through personal acquaintances of the principle investigator and the Home School group in the Knoxville area. An attempt was made to recruit participants through the local CHADD

² See Tables in Appendix B

support group. The leadership and members of the local organization refused participation. No monetary payment was used to recruit subjects. Parents of the participants received the results from the psychoeducational and neuropsychological test batteries.

Instrumentation

Behavioral Assessment

The Test of Variables of Attention (TOVA), both auditory and visual, and the Conners' CPT were the computerized continuous performance tests used to measure qualities of attention (Conners, 1994; Greenberg, 1991). The TOVA measures the ability to sustain attention and refrain from impulsive responding to stimuli (Greenberg & Waldman, 1993). The TOVA is 22.5 minutes long, and the Conners' CPT is 14 minutes long. The TOVA and CPT are not language based, and test the person's ability to respond to stimuli over time. The CPT was used for only one participant on the pre-test, Lance,³ after he performed well on the auditory and visual TOVAs. Lance presented as an inattentive and very hyperactive child, and in that particular instance, the CPT was more sensitive to the identification of his attention disorders than the TOVA.

The Attention Deficit Disorders Evaluation Scale (ADDES) - Home Version and School Version, and the Behavior Assessment System for Children (BASC-Self Report) were given to each participant. McCarney's (1989) ADDES has a mean standard score of 10 and a standard deviation of 3. Any child with an attention rating of less than seven,

³ Children are referred to by pseudo-names beginning with A - O

displays behavior significantly below the mean that may interfere with his ability to perform in the classroom. The BASC was given to each child as a screening measure to evaluate other factors in the child's behavior schema (Reynolds & Kamphaus, 1996).

Neurologic Assessment

Referential quantitative electroencephalographic (QEEG) data were collected, from 19 electrode sites of the International 10-20 system (see Figure 1⁴), using the Lexicor NRS-24. A referential Grass Instruments gold-plated electrode was placed on each ear after cleansing the earlobe with Omniprep. An electrode cap (Electro Cap Inc.) with Electrogel (Weaver and Co.) conductive agent, inserted at each electrode site, facilitated recording of the 19 channels of EEG data. Electrode impedance levels were below 5 kOhms. The recordings were made while the child was seated comfortably in a quiet and dimly lit room.

Autogenics A620 Assessment software was used to collect continuous data of EEG recordings, from a monopolar electrode placement at CZ per the International 10-20 system, using linked ears as reference. The electrode at CZ was affixed to the head by Elefix conductive paste after cleansing the area with Omniprep. This was done during the initial assessment as an inclusionary measure prior to acceptance into the study.

Psychoeducational Assessment

Selected parts of the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) assessed the current level of cognitive functioning (Wechsler, 1991). The reading and

⁴ See Figures in Appendix C

mathematical subtests from the Wechsler Individual Achievement Test (WIAT) were given to determine the participant's academic achievement levels in those areas (Wechsler, 1992). The WISC-III and WIAT have a mean standard score of 100 with a standard deviation of 15.

Whitaker (personal communication, February, 1998) recommended the use of the Vocabulary, Symbol Search, Coding, Arithmetic, and Digit Span subtests, as an abbreviated cognitive assessment battery, for the purposes of this study. Symbol Search and Coding comprise the Processing Speed (PS) Index of the WISC-III, while Arithmetic and Digit Span are the components of the Freedom from Distractibility (FD) Index on the WISC-III. Together these two Indexes form the SCAD Index (Kaufman, 1994). A lower than average score on either of the indexes might have implied possible attention and/or processing problems, and improvement in ADHD symptoms might be reflected in those post-test scores.

Since intelligence is highly correlated with the Vocabulary Subtest at (.79), instead of giving the entire WISC-III test battery, Whitaker (personal communication, February, 1998) recommended use of the Vocabulary Subtest as a screening device for intelligence. The Vocabulary Subtest scaled score had to be at least an 8 for possible inclusion in the study. If the Vocabulary Subtest scaled score was not at least 8, the complete WISC-III battery was given to the participant to confirm whether or not he/she had at least average full scale intelligence. Only participants with at least average cognitive functioning participated in this study.

Kaufman (1994) first defined this "SCAD Index" through his inquiry into the PS and FD factors from the WISC-III. He used Wechsler's 1991 formula based on the intercorrelations among the four subtests, Symbol Search (S), Coding (C), Arithmetic (A), and Digit Span (D) to develop a SCAD standard score and percentile rank.

Kaufman (1994) asserts that there are "some compelling reasons for the SCAD profile to be such a potent land mine for identifying children with neurological impairment or with exceptionalities that are believed to be associated with minimal brain dysfunction" (p. 224). The PS and FD Indexes measure mental processes "without contamination of content (Arithmetic is an exception)" (p.218). Separately their application cannot differentially diagnose ADHD (Hynd, Cohen, Riccio, & Arceneaux, 1998); however, evaluated together as the SCAD profile, they lend insight into the processing problems of children with ADHD (Kaufman, 1994). The split-half reliability of the SCAD Index is .90 and the test-retest reliability is .90.

Kaufman (1994) stated that "all four SCAD subtests place heavy demands on the child's ability to encode information for subsequent mental processing" (p. 223). "Symbol Search is mainly a measure of mental speed and Coding is mainly a test of psychomotor speed" (p. 242). Auditory processing, poor executive processing or planning abilities, motivation, and distractibility are factors that effect performance on the SCAD Index.

Intervention Equipment

Bloodflow training (HEG) was accomplished using a Biocomp 2001 biofeedback system, which is a computerized, wireless infrared telemetered physiological monitoring

system. Audio-visual stimulation (AVS) utilized a Polysync Pro (Synetic Systems) device for entrainment. This small unit was programmed to deliver 18.5 Hz of auditory and visual stimulation, through stereo earphones and photoscopic eyeglasses. The photoscopic lenses had eight light-emitting diodes (LEDs) that were arranged in a cross-pattern with four on each lens. The lenses held the LEDs approximately 1.5 cm from the eyes, and emitted red light at a candle power of .166 (Timmerman, 1998). The stimulation was modulated sinusoidally.

Procedure

Human Subjects Review

Prior to seeking research participants, approval for this project was obtained from The University of Tennessee, Office of Research. During the initial visit, potential participants and their parents were read the informed consent, given an opportunity to ask questions about the project, and signed the informed consent forms.

Assessment:

Potential participants were given parts of the WISC-III to determine whether they met the first criterion for participation in the study by having at least average intelligence. Then, they were given an auditory and visual TOVA, which is a computerized continuous performance test. False negatives occur rarely; however, the Conners' CPT was given to one child whose scores were normal on the TOVA. ADHD is not a unitary construct, and some tests are more sensitive to the manifestations of the disorder for a particular child than others.

A parent and a teacher (when available) completed the ADDES rating forms.

Participants were assessed using the Autogenics A620 Assessment software, to determine their theta/beta brain wave ratios. Finally, those who met the criterion for study inclusion were assessed using a 19 channel brain map (QEEG), and were given a WIAT to assess their current level of academic achievement. The QEEGs were assessed for abnormalities not attributable to ADHD before randomized assignment.

Originally, Lubar and Whitaker met in the neuropsychology laboratory at The University of Tennessee and assigned the 15 participants randomly to three groups by age and gender. Two of the children assigned to the experimental groups could not participate in the intervention, so they self-selected into the matched waiting control group and had no interventions. Two children from the waiting control group were then placed into their matched position in the experimental group.

Training group "A" was trained using bloodflow feedback, while training group "B" was entrained by audio-visual stimulation at 18.5 Hz. All subjects were trained for 20 sessions. One child discontinued the intervention after 12 sessions, because she had difficulty getting transportation to and from the neuropsychology laboratory. She was in the bloodflow feedback group. Two brothers heard about the interventions from other participants, and were evaluated for participation in the study. One boy was selected, because he met the criterion of the study and was a closer "match" to the person who had discontinued participation from the bloodflow group.

Training Protocol for Group A

Training group "A" consisted of five participants who were trained with HEG using the Biocomp 2001, a computerized wireless infrared telemetered physiological monitoring system. A velcro headband held the sensor in place on the forehead just over the eyebrow, with the sensor directly in line with the pupil of the eye. The first 11.6 minutes of training was accomplished on one side of the forehead, approximately at electrode placement FP1 or FP2. Afterward, the participant read quietly for 2.4 minutes, and then the sensor was placed on the corresponding opposite electrode placement site. He/She underwent training for an additional 11.6 minutes.

To control for order effects, every other participant began training at FP1, while the others had their first session at FP2. Additionally, each training period began on the opposite location from the training day before. When the headband was placed on the left side of the forehead, it was turned upside-down, in order for the near-infrared light to refract from the oxygen molecules in the blood in nearly the same direction for each side. During the training sessions, the subject was asked to consciously want to increase their bloodflow to the frontal area of his/her brain, in accordance with the instructions that Toomin said that he gave to his HEG patients in his clinical practice (personal communication, June 14, 1998).

Training Protocol for Group B

Training group B was entrained with audio-visual stimulation (AVS) at 18.5 Hz, in an attempt to stimulate the production of more beta waves in the brain, using a Polysync

Pro (Synetic Systems) device. A beep was heard through the earphones, and red LEDs flashed through photoscopic goggles for a period of ten minutes at 18.5 Hz. Then the participant read for five minutes. Finally, he/she received AVS for the last ten minutes.

Post-Assessments

The TOVA computerized continuous performance tests and a QEEG were given, within one week of the 20th session, for comparison of the pre- and post- treatment effects. Post assessments were given at the same time of day as the pre assessments in order to control for diurnal effects. The SCAD Index from the WISC-III was given to check for changes in those cognitive functions. Parents completed the ADDES Home Version rating scale to assess for changes in behavior, and finally, the WIAT was given to assess for any change in academic achievement.

Chapter IV

RESULTS

One-way analysis of variance (ANOVA) was used to test most of the data for significance. If any measure had demonstrated a significant finding, a post-hoc adjustment for group size would have occurred.

Cognitive-Academic Measures

The SCAD profile (Kaufman, 1994), which includes the WISC-III FD and PS Indexes, was evaluated post-intervention for each participant by group. A one-way analysis of variance (ANOVA) for group differences resulted in significant differences ($F 0.052$, $df [2,12]$, $p = 0.949$)(See Table 3 - SCAD GAIN and Table 4). There were no differences in the SCAD gain scores in the three groups. An assessment of reading skills, reading comprehension, math reasoning, and numerical operations was evaluated by group post-treatment with the WIAT (Table 5 and Table 6). Group difference scores on the WIAT were compared via one-way ANOVAs and were not rated as significantly different at: .345 for reading skills, .328 for reading comprehension, .907 for math reasoning, and .598 for numerical operations (Table 7). Since there were large variations of the data within each group, analysis of group data was not a good representation of the treatment effects of AVS or HEG within the individual child.

Behavioral Measures

Results from the Attention Deficit Evaluation Scale (ADDES) indicate no significant change in behavior as measured by the participants' parents after the

intervention period for any of the groups of children in this study, ($F 0.940, df [2,12], p < ns$) for Inattention Gain and ($F 1.019, df [2,12], p < ns$) for the Hyperactivity Gain (Table 8, Table 9). Measures of inattention and hyperactive/impulsive behaviors were evaluated using one-way ANOVAs, and remained essentially unchanged in the HEG, AVS, and control groups.

The interventions had little effect on the overall TOVA standard scores (Table 10, Table 11, Table 12, Table 13). One measure, Errors of Commission, showed improvement on both the auditory and visual TOVAs for children who were in the AVS group only, but those were not significant (Table 14). Errors of Commission measures impulsivity or the lack of inhibiting responses (Greenberg & Waldman, 1993). Other TOVA measures do not appear to reveal any differences between the experimental and control groups.

EEG Measures

QEEG data collected, during a three-minute eyes-closed condition, were analyzed after removing muscle movement and eye-blink artifact via evaluation of the raw EEG and Fast Fourier transformations. The data was segmented into four frequency bands (delta, theta, alpha, and beta) across 19 recording sites.

The theta to beta ratios at CZ were compared pre- and post- QEEG measures (Figure 2). One-way ANOVA revealed no significant group difference post- intervention (Table 15).

Simple t-tests could be used to assess changes within the individual, but it would require 76 paired t-tests to accomplish this task. The inflation of the Type-I error rate was

avoided by using a formula of reducing the data set with factor analysis using the “maximum likelihood” method. This is a statistical tool that reduces the “data to those variables, or combinations of variables (frequency, location, or condition), accounting for the most variability” (Swartwood, 1994, p. 26).

The variables, during pre-assessment, of the recording sites were reduced to two factors, or groups of locations, the composition of which varied slightly with respect to frequency (Figure 3, Figure 4). The amount of variance accounted for by the two factors was between .88 and .94, and was different for each frequency (See Table 16).

The maximum likelihood method of factor analysis requires at least as many participants as variables, in this case 19. On the surface, that appears to be impossible; however, there were other children who were given QEEGs and met the criterion for study inclusion. Their QEEG data were included in the factor analysis, increasing the participant pool to 21. These six children were not included in the pre – post test analysis, but only for the purposes of establishing the two factors. These factors are accurate for this participant group, reflecting their idiosyncratic variance from the general population.

The main objective in factor analysis was to see which variables correlated in this data set. A criterion was established subjectively to accept .65 as the criterion for high loading on a factor. If the variable loaded on another factor within .20 of the first factor, it then had a “cross-loading” and was discarded. Factor – based scores for each of the two factors were computed for each participant from the unweighted average of the 19 electrode locations that loaded highly and specifically on each factor for each frequency

band (See Table 17). Differences in the factor scores between the pre- and post- treatment conditions in each of the three groups were tested for normality with the Shapiro-Wilks test ($\alpha = .01$). Normal cases tested for significance with Student's t-test and non-normal cases tested with Wilcoxon's sign rank test. At a critical value of .05 not corrected for multiple comparisons, no significant differences in the factor scores were observed in any group at any frequency.

Chapter V includes case-study representations of the data as a means to describe the cognitive and academic changes reported by each participant. Case studies are presented for the children who experienced differences in their academic or cognitive abilities, as reported by the child and his/her parents.

Chapter V

CASE STUDY

Audio-Visual Stimulation Group

Ann:

Ann is nine-years-old and is the fraternal twin sister of Lance, who was in the bloodflow group. She has two older brothers, and one of them (Jim) was a control participant. Ann has an inattentive form of ADHD and has never been on medication. She is a third grader, who loves school, and is well-behaved. Ann had problems with reading prior to intervention and made "Satisfactory, Progressing, and Needs Improvement" grades. This year her grades were "A's," her reading improved, and she "learned her multiplication tables easily."

Bob:

Bob is a 15-year-old eighth grader, who was retained in school last year. He has the inattentive form of ADHD, and "school has been a struggle for him since he began." Last year he moved to a different school district. His mother told the school officials that Bob had an "individualized education plan" when he enrolled; however, it was never implemented in his new school and he was retained. Bob's mother reported that he "almost never" did his homework, and that she did the work for him when the teachers "gave him too much grief and threatened to fail him." Bob has average intelligence, and is "street smart." He loves to take things apart and reassemble them, like motors, bicycles, skateboards. Bob's learning disabilities were diagnosed in reading and written expression.

He had problems getting on task. Remaining on task was a constant battle for him. Bob is described by his mother as a "well-behaved child, who picks on his sister 'til she cries, is a practical jokester, and never a behavior problem in school." After intervention, Bob reported understanding what he read better, decoding better, and has learned how to do fractions. Bob's mother was surprised by some of his academic changes. He left her a note explaining his whereabouts, after the study. The words were spelled correctly and she could read the note. This has been a good school year for Bob, although he and his parents were angry that he was retained. He lives with his biological parents, and younger sister Hanna, who was in the control group.

Carl:

Carl was 12-years-old at the time of his intervention with AVS. He is the middle child, living at home with two brothers and his biological parents. Carl's mother realized that he was "not with it" in kindergarten, as he had difficulty learning basic concepts. She asked the school to evaluate him. During 4th grade, Carl was placed on Ritalin after diagnosis with the inattentive form of ADHD, experiencing improvement for the first two weeks. He complained that he "felt funny" and that his "stomach hurt," so he ate much less food. His mother reported that his behavior changed from "a comedian" to "very subdued." Carl has occasional motor tics that are obvious to the trained observer, but not others. He never qualified for special services in school, although he made failing grades, "D's and U's." Carl's mother said that she discontinued the medication, because of the side effects and the fact that the change in Carl's personality was "alarming." He was

never a behavior problem at home or at school. After AVS intervention, Carl's grades improved to "C's and D's with a couple of B's," and he is completing more of his work. Carl reports that "it is easier for me to sit down and do my work, and I don't feel agitated when I do it now."

Dana:

Dana, a 13-year-old seventh grader, had been home schooled since the third grade. Dana lives with her biological father and step-mother, who has been with her since she was a toddler. Her younger brother, Mark, is in the bloodflow group. She has an older sister and one step-sister who live on their own now. Dana's step-mother wrote a detailed note about her previous experiences in public school as follows:

Dana hated public school . . . no confidence and low self-esteem. She was in resource because we were told she could not comprehend what she read. Kids in school asked her if she was retarded. She was afraid to try new things. One girl actually picked her up and put her in the garbage can. This hurt Dana very bad! She started begging me to home school, so now we home school. She was two to three years behind in public school and her test anxiety was 98. She liked home school, but seemed to have a problem concentrating. In math she would have the concept, but would somehow wander off (maybe daydream) and get the wrong answer. After one year of homeschooling she improved drastically. I had her privately tested, and was told that Dana was intelligent, but had poor study habits. I felt there might be something else, ADD.

Dana does meet the criterion for ADHD – Inattentive type. She is a well-behaved child who takes her responsibilities seriously. When she read during her third session of AVS, Dana got a strange look on her face and said, "I am reading at least twice as fast as I used to." Dana returned to public school mid-year and they insisted that she go into the

seventh grade, rather than the eighth. She is doing well in school, and is well liked by her peers.

Ed:

Ed is a nine-year-old fourth grader who has been medicated for hyperactivity since he was four-years-old, first on Ritalin, and then on Dexedrine. His hyperactivity has been a problem since he was a toddler. He is a very well-mannered boy, but he has had problems with lying and stealing. He lives with his father and step-mother. Ed makes good grades in school, but is certified as learning disabled in written expression. His parents report that he always seeks the attention of the adults in his environment. Ed was in the AVS group, and went off his Dexedrine for the duration of testing and the study. While off Dexedrine during the summer, his aunt reported that he "looked healthier," adding 25 pounds and growing five inches, catching up with his peers. Ed was the only child who was hyperactive in the AVS group, and his distractibility and theta/beta ratio increased during the study. Although Ed's behavior ratings improved at the end of the study, his parents put him back on medication after the teacher asked them to reconsider it. Within two months of the reinstitution of Dexedrine, Ed lost much of the weight he gained during the study. His aunt reported that he "lost that healthy appearance."

Control Group

Fran:

Fran, a 9-year-old girl, lives with her biological mother and father, and her older brother and sister. She is certified with a reading disability in school, although her

cognitive ability is above average. Fran is described by her mother as a “very responsible child, who is quite clumsy.” She is hyperaware of her environment and is therefore easily distracted. She has periods of excitability, but is well behaved. Fran was in the Control group and got no intervention. This year she has experienced problems in getting her homework completed, and her reading is still a concern.

Gail:

Gail is Fran’s older sister, and is 15-years-old. She has been in trouble since she was five-years-old for stealing, lying, being inattentive and “totally irresponsible.” Gail is in gifted classes at school, but is not making good grades, because she “does just enough to keep from failing.” Gail’s parents threatened to send her to a military school last year if her behavior did not improve. Gail is inattentive, and always “bored,” unless she “stirs the pot to create excitement.” Gail’s behavior has improved recently, because she “wants her driver’s license;” however, she still doesn’t complete all her work at school and continues to steal and lie.

Hanna:

Hanna is 13-years-old and is in the eighth grade. She is Bob’s younger sister. Hanna is a cheerleader at school, and her ADHD behaviors were overlooked by her parents, until her brother left for a vacation during the study. During that time, Hanna’s parents were “surprised that she did many of the ADHD things her brother did, such as hyperactivity and missing homework and class assignments.” As a result, Hanna’s parents rated her pre intervention behavior as less problematic than her post intervention behavior.

Actually, her behavior did not change, but her parents' perceptions of her behavior changed when they did not have her brother's "boy-type" behavior hiding her hyperactive and impulsive behavior. Hanna has experienced more difficulty this year in completing her assignments and has been lying to her parents about her schoolwork more than before. They no longer overlook Hanna's ADHD behavior.

Ike:

Ike is Gail and Fran's brother, and is the middle child. He is a 12-year-old sixth grader. An excellent student throughout his school years, Ike won a school math contest when he was in the fourth grade. Ike is "responsible," but a "comedian," who likes to play practical jokes on people. He was in the Control group, like his sisters. He has good grades, and "works diligently until he figures out a problem, no matter how long it takes." Ike takes pride in his work. He complains about having to read and reread his books, because he "can't keep his mind on his book, and loses his place." Lately, he has been missing some homework assignments and has been caught taking things from a store.

Jim:

Jim, Ann and Lance's older brother, is an 11-year-old sixth grader. He has an older brother, and lives with his mother. His parents were divorced when he was a toddler. Jim is a well-behaved child, who has the inattentive type of ADHD. He was diagnosed with learning disabilities in written expression, and has problems in reading. Although his math achievement is good, he has not been able to memorize his multiplication tables. Because

Ann and Lance have experienced no problems in school this year, his mother is more aware of Jim's school difficulties and is very worried about him.

Bloodflow Feedback Group

Kat:

Kat is ten-years-old and is in the fifth grade. She is an only child and lives at home with her mother. According to her mother, Kat began experiencing behavior problems in school in the second grade, such as, "disruptive behavior, attention-seeking behavior, getting out of her seat, not taking turns, etc." During the fourth grade, Kat started lying to her mother and teacher, "erasing assignments written in her book, getting out of seat, not following directions, and either made all 'A's or mostly 'F's." Kat's standardized group achievement scores were above average. She has problems with "intermittent explosive anger" with her mother. Many times when Kat came to her bloodflow sessions, her mother was joking and laughing with her. Once Kat confided that she "wished her mother would do that all the time, because she is usually cranky and yelling at her (Kat)." This school year has been a better year for Kat, because her behavior is improved. Her mother reports that Kat doesn't have as many explosive outbursts. They seem to have a more relaxed home environment, without the mother constantly fussing at Kat about something.

Lance:

Lance is Ann's fraternal twin brother, and is nine-years-old. He meets the diagnostic criterion for ADHD – combined type, and is in the third grade. During his classroom observation, he demonstrated the following behaviors: out of seat constantly,

rushing through his work to be finished first (without regard to accuracy), seeking out the teacher's attention constantly (even when the teacher was involved in group time with other students), in constant motion, and absorption in checking one child's folder over and over again. Lance liked helping his teacher. She gave him little jobs to do, such as checking children's folders to make sure their work was there. Once into the folder, he spent an inordinate amount of time "messaging" with the child's personal things. His second grade teacher was slow to recognize that Lance had academic problems, because he was a good "faker." She said that he was so "loveable, and put on such a good act, that she was not concerned until Thanksgiving that Lance was not as capable as she once thought." Like his sister Ann, Lance had problems with reading prior to the intervention and made "Satisfactory, Progressing, and Needs Improvement" grades. This year his grades were "A's," his reading improved, and he "learned his multiplication tables easily." His mother was very impressed when Ann and Lance learned their multiplication tables so easily, because neither of her two older sons (including Jim who was in the control group) could learn them.

Mark:

Mark is ten-years-old and in the fifth grade. He is Dana's younger bother, and lives at home with his biological mother and father. His mother wrote this about his public school experience:

Mark hated public school. He had no confidence and low self-esteem. In second grade he broke out in shingles. Every time he cleared up and went back to school, he would break out again. The doctor told him that he just needed to get over it, because he had to go to school. I had to sit right with Mark in order to get his

work done. Even before kindergarten, I could not in any way get Mark interested in saying his "ABC"s. We started home schooling two years ago. I didn't know how far behind in school he was. I had him tested after the first year of home schooling. He had improved drastically, but still I felt something was wrong. I didn't know if it was because I was his mom, or his lack of interest in learning was because I wasn't teaching him the way he learns. I felt like he did better with "hands on." We went on lots of field trips and played learning games. I cut down all the math problems, and tried to find things he was interested in. I'm no expert by no means, and it has drained me. I also hold down a job and started feeling there might be a problem with ADHD.

Mark met the criterion as ADHD – Combined type. This year he returned to public school and still hates school. Mark has learning disabilities in reading and written expression. He is overweight, and some children make fun of him because of his weight and reading problems. Mark has recently made new friends, because he has expensive toys and exciting hobbies like riding his four-wheeler and dirt bike. He no longer breaks out in hives because of school.

Nan:

Nan is a 13-year-old, in the seventh grade this year. She lives with her two older brothers, biological mother, and step-father who has lived with her since she was three-years-old. Nan demonstrated superior intelligence and achievement on her pre-test scores, but her grades in school do not reflect this. She was denied evaluation for the gifted program, because of her impulsive classroom behavior. Her pediatrician diagnosed her with ADHD in the fifth grade, and prescribed Ritalin. Nan's step-father, a pharmacist, did not want her on the medication and after some uncomfortable side-effects, it was discontinued. Nan has a problem with "spouting off" when someone offends her, If someone makes her mad, she "play" hits them on the arm. During the sixth grade, Nan's

school called her mother about behavior problems a minimum of every other week, and sometimes weekly. She failed to do many assignments that year. After bloodflow feedback, Nan's seventh grade year was different. Her school called her parents twice the entire year, although one of those times, she was given in-school suspension. At times she wants to hit her peers, but she is able to control herself. According to her mother, Nan "controls her mouth" better, and seems to have "better focus," doing her schoolwork even when she "doesn't want to" do the work.

Oscar:

Oscar was in resource classes for learning disabilities in reading, math, and written expression from the second through the fourth grades, but was placed in an inclusion classroom during the fifth grade. He lives with his biological parents, brother and sister. He is the middle child. Oscar is a good baseball player, and has artistic talent. He has occasional motor tics that are obvious to the trained observer, but not others. Oscar is eleven-years-old, and is not a behavior problem at home or in school. Oscar was on Ritalin for ADHD for two weeks last year. His teacher called, because she was worried that "he was not the same person and appeared drugged out all the time." She was concerned, and voiced her opinion that Oscar "should not be on the medicine." Oscar's parents stated that he has always been "distractible, and had problems with concentrating." They report that Oscar still has the same problems with concentration, and the bloodflow intervention "did not change anything."

Chapter VI

DISCUSSION

The efficacy of using alternative treatment interventions for children with ADHD was explored by this study. Finding viable treatments is important, because an estimated 36% of this population drops out of school (Barkley, 1998) and has a higher probability of involvement in illegal activities leading to incarceration (Eyestone & Howell, 1994).

There was sufficient evidence throughout the context of this study not to reject Hypothesis five, that is, children with ADHD have individual differences and variable treatment responses to bloodflow feedback (HEG) and audio-visual stimulation (AVS). This may be one of the major reasons why school-based interventions have little impact on academic achievement for children with ADHD, even for the significant minority of children on stimulant medication (DuPaul & Eckert, 1997).

The exploratory nature of this project leaves it open to the possibility of making Type-I errors; that is, stating there was a significant change when there was none. Type-I errors did not appear to be an issue with this project, because there were no significant results from group data. The hypotheses were rejected on items 1 through 4. According to the assessment measures employed in this study, after intervention with AVS or HEG, the participants did not demonstrate improvement on:

1. cognitive ability measures of the SCAD Index,
2. parents' ratings of child's behavior,

3. EEG measures of brain activity, demonstrating changes in five or more locations toward normal, or
4. TOVA scores after AVS or HEG intervention.

The academic and behavioral manifestations of ADHD are different from child to child, with variations of expressions for children within the same family. Just as the behaviors and abilities of children with ADHD vary from day-to-day, their individual treatment effects from the interventions varied. Some changes were positive, and some were not.

Although there were changes toward normal in the QEEG, no change was significant. Furthermore, the Z-Score differences in Relative Power moved towards and past “0” considered “normal,” to an opposite and sometimes equally “abnormal” state. Although this is not necessarily “bad” (Hudspeth, 1998), a question that needs to be answered in future research is, “Would long-term treatment, greater than 20 sessions, of either AVS or HEG continue this trend?”

Clinical Impressions

Some of the children in this project appeared to have improved cognitive functioning after the intervention, especially in the AVS group. Carl seemed to “awaken” as if from a deep sleep, acting more “with it” in and out of school. Bob was able to sit and focus long enough to get classwork done and process information for learning. However, he still needed reminders in order for him to meet the expectations of adults in his environment. Dana’s test anxiety diminished, and she was able to read faster than before

the intervention. Ann, from the AVS group, and Lance, from the HEG group, improved their achievement in the classroom from “needs improvement” to “A”s. Their reading became fluent, and they learned their multiplication tables easily.

Lance and Ed (from the AVS group) became less attentive, but also less impulsive after the interventions. They were the most hyperactive/impulsive children in the study, and it is unclear why they became more inattentive. Their theta/beta ratios increased, which is not a positive indicator, during the study. Whether this is a function of the interventions used, or the natural negative progression of the disorder in boys, who are eight to nine-years old, is not known.

There is a strong trend towards a unique improvement in the standard scores of the TOVA Assessment of Commission Errors (Table 13) for children in the AVS group. However, this trend does not occur in the HEG or control groups. Although this trend missed significance by .007, it should be an area of further research. This measure is considered to be a marker for impulsivity.

Limitations

A major limitation of this study was that these are evolving interventions, with several possible treatment protocols. There are many ways to apply these interventions to the treatment of ADHD. I employed one paradigm that was described by some clinicians as an effective intervention; however, another paradigm with a larger sample size may be more effective and elicit different results.

There were problems encountered with the headbands used in the HEG intervention. The headbands were designed to fit adult heads, but not the smaller heads of children. When the headbands were tightened according to the instructions given by Toomin (personal communication, June, 1998), several times participants experienced headaches. The researchers speculated that this could have been a myo-facial pain response, due to the tight headband. Sometimes participants came to the interventions perspiring from recent exertion. That moisture caused problematic and unreliable readings from the Biocomp device. The participants were monitored closely to assure that observed increases in "bloodflow" were not the results of intentional artifact production.

The problem, encountered with exploratory studies of this kind, is the probability of Type I errors, because of the small sample size and number of independent variables. Because AVS and HEG are new interventions for ADHD, there is a need for controlled studies that examine the physiological, behavioral, cognitive processing and achievement experience of children with ADHD. This type of exploratory inquiry tends to stimulate further research.

Implications

Children with ADHD struggle in the classroom today, just like they did 50 years ago. ADHD is not going to disappear, and there are no "quick fixes," either in tablet form or neurotherapeutically. The difference between psychotropic medication and neurotherapy has to do with permanent change. Children can learn to change the electrical activity in their brain, which may improve their cognitive abilities and classroom

performance, but it takes time (Rasey, Lubar, McIntyre, Zuffuto, & Abbott, 1996; Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Mann et al., 1992; Lubar & Lubar, 1984).

In this study, neither AVS nor HEG provided the same level of results in an ADHD population as neurofeedback did in previous studies. The non-specific and positive effects experienced by several of the children in the classroom this past year, from both experimental groups but not the control, indicate that there may be changes in cognitive functioning that were not revealed by the tests employed in this study. These results were discussed within the framework of neurotherapy, which emphasizes the effect of brain electrical activity on cognitive states and mental performance (Timmerman, 1998).

It is unfortunate that the interventions used in this study were not as powerful as anticipated. Neurofeedback intervention does have powerful effects on many children with ADHD. However, the cost of neurofeedback training, although less than for years of medical and pharmacological interventions, keeps it unavailable for many children. The fees charged for therapeutic interventions, delivered in a therapist's office, are about the same, regardless of the intervention. AVS is more portable than HEG or neurofeedback, and can be purchased for home or school use at a cost of approximately \$700.00. Although the effects in this study did not reach significance, clinically changes were observed raising concerns regarding the indiscriminant use of either AVS or HEG by untrained professionals.

There are a few school systems around the country using neurofeedback with their

ADHD students. New York is considering instituting neurofeedback as an intervention for ADHD statewide within the next few years. The increasing use of neurofeedback in the schools for children with ADHD lends availability of this powerful intervention to many children who need it, and cannot afford it.

This study was important because it brings more understanding into the complexities of the diagnosis and treatment alternatives in ADHD. In a recent copy of the Communique (Dawson, 1999), the National Association of School Psychologists (NASP) newspaper, psychologist Peg Dawson presented the following monologue:

The researchers of this world may be able to define a specific population of children who fit all the diagnostic criteria for ADHD and present with no confounding symptoms. But the children I see in my practice, week in and week out, rarely fit that neat definition. And as long as that reality continues to dominate, people will continue to read and write books questioning both the diagnosis and treatment of this challenging condition.
(p. 33)

Recommendations

There are things that can be done within the classroom to help a child with ADHD maintain the motivation he needs to overcome the limitations sometimes experienced with ADHD. According to Santrock (1987), making the environment more rewarding is foundational to motivation. This is where we need to begin as educators, creating a "safe" environment that facilitates motivation and achievement. When the environment is unpleasant, shaping behavior is difficult, because the student is processing feelings and resolving conflicts rather than responding with changes in behavior (Cacioppo, Priester, & Berntson, 1993). Shorr (1993), in his research on attributions of punishment, found that

the avoidance of perceived verbal or physical abuse often becomes a goal for children.

When perceived abuse is received in connection with schoolwork, motivation for avoidance, rather than for schoolwork is increased.

“Motivation will be increased if the emphasis is on the production of quality work from start to completion, however long that takes. This may mean that the length of an assignment is reduced to facilitate the process. The motivation for precision and accuracy is not fostered when there are many tasks demanding attention” (Brim & Whitaker, in press). One small task at a time completed well is a more realistic goal for the ADHD child. Accuracy, rather than speed or volume of work should be reinforced, because a good product increases student motivation (Santrock, 1987).

Assistance can be provided by bringing the task back to within the student’s capabilities. It is important to actively listen to the student and demonstrate regard for their concerns and opinions, in order to increase motivation.

Astute teachers often recognize that an ADHD child may need to move in order to stimulate concentration. Therefore, one way of motivating ADHD children is to allow them more freedom to structure their environments. This environmental restructuring may be accomplished in several ways. For the student who needs to move, a teacher can allow him to sit at a table or on the floor when doing independent assignments. A student might be allowed to go to the library to work or into the hallway. A study carrel is useful for some students. Sometimes allowing the student to go to a quiet place will allow her to demonstrate her knowledge to the best of her ability. Circumstances may vary, but the student should be encouraged to structure his environment for success. (Brim & Whitaker, in press)

Successful school experiences can be provided in many ways. An interesting and meaningful curriculum will enhance student learning and active participation in class. It is important to listen to the student, letting him know that you genuinely care about his

situation. Many students with ADHD believe that their education is done to them, rather than with them. Actively including the student in planning to meet his educational needs will foster a sense of ownership and responsibility, which will increase the potential for academic success (Long & Bowen, 1995).

Empowerment of the student regarding his education will create intrinsic motivation and personal satisfaction, helping that student to develop an internal locus of control and overcome problems when they occur instead of giving up. The perception of greater control in school can translate to the perception of greater control in life (Brim & Whitaker, in press).

Conclusion

Some children spend academic life times in resource classes, making little or no improvement in their academic performances. Learning Disabled is a non-specific construct, and is defined according to State Special Education guidelines that are unique to every state. Usually there is a formula that the schools follow based on a discrepancy between cognitive abilities and standard achievement scores. The label "learning disabled" says nothing about the etiology, although there is an assumption of some type of processing deficit. Some processes, such as memory, are highly loaded on the ability to sustain attention, and therefore the underlying cause of the process disability could be attention.

School systems must be in compliance with federal special education testing guidelines. This causes pressure for them to become more "test and place" oriented, than

child needs oriented. When school psychologists become “testing machines” whose main goal is to meet testing time limits, the child is the ultimate loser. School psychologists, who test children and are given the latitude to develop interventions for the children with the goal of success in the classroom, have a valuable place in the schools and society.

Many children with ADHD equate their school experience with their concept of “Hell.” This is an unacceptable experience for our children with ADHD, which may be a reason why 36% just give up the struggle for an education (Barkley, 1998). When childrens’ educational needs are not met in school, children often rebel and the “child is put in a position where delinquent influences are likely to play upon him” (Jenkins & Pacella, 1943).

There are tragic ramifications of not meeting the educational and social needs of children with ADHD including, higher pregnancy rates (Arnold, 1996), substance abuse (Miller & Blum, 1996), and juvenile offending leading to incarceration (Foley et al., 1996; Eyestone & Howell, 1994; Zagar et al., 1989). Therefore; it is a social imperative to address those psychoeducational, behavioral, and social issues with innovative interventions, rather than the good old “tried and failed” methods of current standard practices.

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APPENDICES

APPENDIX A

FORM B

IRB # 5369-B

DATE RECEIVED in OR _____

THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Application for Review of Research Involving Human Subjects

I. IDENTIFICATION OF PROJECT

A. Principal Investigator

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Co-Principal Investigator

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Faculty Advisor

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Department/Unit: College of Education - Psychoeducational Studies Unit
Department of Psychology

B. Project Status: Doctoral Dissertation

C. Title of Project: Comparison of the Electrophysiological and Psychoeducational Effects of Audio Visual Stimulation on treatment effects of EEG Biofeedback on children with ADHD (attention deficit hyperactivity disorder)

D. Starting Date: "Upon IRB Approval"

E. Estimated Completion Date: June 1, 1998

F. External Funding: None

II. PROJECT OBJECTIVES

The purpose of this project is to observe the experimental and whole-brain EEG effects of training children to increase beta and decrease theta waves, using a biofeedback monitor and the impact of Audio-Visual Stimulation on the training process. The data collected will facilitate the understanding of individual differences in the ability to learn the biofeedback task, and to improve therapeutic methods for treating attention deficit hyperactivity disorder (ADHD).

III. DESCRIPTION AND SOURCE OF RESEARCH SUBJECTS

Source: Children who are referrals from personal and professional acquaintances of the principal investigator (PI). Most of the parents have contacted the PI because they heard by word of mouth about the study. Other parents expressed interest in the study when talking about their children's ADHD during casual conversation. The parents identify their children as ADHD, with documentation from school or doctor to back up the diagnosis. The population size is less than 20 participants, and word of mouth referral is adequate for the purpose of this study. The PI will contact the parents to set up the psycho-educational testing when the schedule for testing has been determined. Then the potential subjects are screened by eligibility for the project. The Foundation Academy is not involved in the recruitment of subjects, although two participants attend the school.

Description: Children ages 8-15 who are at least average intelligence (WISC-III ≥ 90) with ADHD, who are primarily inattentive/impulsive as determined by Attention Deficit Disorders Evaluation Scale (Home Version): inattentive ≥ 2 , and hyperactivity ≤ 1.6 . Absolutely **no** child with a history of seizures, significant medical or neurological problems will participate in the study. Children must be medication free to participate.

IV. METHODS AND PROCEDURES

EVALUATION TECHNIQUES:

1. Psychoeducational testing prior to EEG Biofeedback training and six months post-training: Wechsler Intelligence Scale for Children - Third Edition (WISC-III).
2. Psychoeducational testing prior to EEG Biofeedback training and May 1998 post-test: Wechsler Individual Achievement Test (WIAT).
3. Behavior rating scale prior to EEG Biofeedback training, the 2nd evaluation in October 1997, and May 1998 post evaluation of behavior: Attention Deficit Disorders Evaluation Scales (Home and School Versions).
4. Pre- and post- EEG Biofeedback training and six months post- EEG Biofeedback training: Auditory and Visual Test of Variables of Attention (T.O.V.A.), and Intermediate Visual and Auditory (I.V.A.) continuous performance tests.
5. Pre- and post- biofeedback quantitative bipolar 19 channel EEG (QEEG) brain maps: used to derive power and coherence measurements following the International 10-20 system for electrode placement. Attachments will be made using an electrode cap (Electro Cap Co.) and Elefix conductive cream (Weaver and Co.). Subject will have the electrode cap with 19 sensors placed on his/her head. Electrode gel is applied to each sensor by a small tube inserted through the sensor. The gel forms a conductive pathway between the sensor and the scalp. There is no significant discomfort with this procedure, either in the preparation or the wearing of the cap during testing. One earclip electrode will be placed on each earlobe after a light cleaning with Omniprep solution, which removes skin oil and allows for good sensor contact. Following data collection, the cap will be removed, and the electrode gel, which is similar to hair mousse, will be wiped off with a tissue or paper towel and water. All creams and gels used during this evaluation are hypo-allergenic, with no known risk of irritation. During the recording, the child will be asked to perform the following tasks: 1) three minutes with eyes open, 2) three minutes with eyes closed, 3) three minutes of child reading grade appropriate material of his/her choice, 4) three minutes of Raven's color progressive matrices, 5) three minutes of listening to the reading material of choice being read to him/her, and 6) a Bender drawing task.
6. Pre- and six months post- EEG biofeedback original essay by the participants on their experience in school and at home with ADHD problems.

7. Children will not be given the WISC-III initial evaluation if they have taken the test within the past year.

PROJECT SUMMARY

1. Assessment battery described above. Subjects will be asked to describe any expectations, feelings or concerns they have about the study.
2. Students will be assigned randomly to two groups (3a or 3b) for training, and matched according to age and gender.
- 3a. Training: 35-40 sessions, thirty minutes each, of EEG Biofeedback training will be conducted with an Autogenics Corporation A-620 neurofeedback software and equipment. This procedure is known to improve attentional processing in subjects with attention deficit hyperactivity disorder and in some "average" subjects. There is no significant discomfort associated with this procedure.
- 3b. Training 35-40 sessions, twenty minutes each, of EEG Biofeedback training will be conducted with an Autogenics Corporation A-620 neurofeedback software and equipment. Preceding EEG Biofeedback training will be ten minutes of Audio-Visual Stimulation using a Polysync Pro (Synetic Systems) device to increase the beta waves, as a preparatory phase for EEG Biofeedback training. There is no significant discomfort associated with these procedures.
4. All EEG recordings will be administered by following the International 10-20 system for electrode placement, positions at FCZ and CPZ on the scalp, and one earclip electrode on each ear.
5. Amount of time required:
Subjects will participate in initial assessments and baseline recording session:
total time approximately 6.5 hours.
Thirty-five to forty sessions of neurofeedback (40 minutes including connections):
26.7 hours.
Post training assessments: 5.5 hours.
Total project time per subject: 39 hours.
6. Confidentiality: The Principal Investigator and Co-Principal Investigator will be the only people with access to the names of the participants.

V. SPECIFIC RISKS AND PROTECTION MEASURES

There is minimal risk to participants in this study. Confidentiality will be maintained with respect to the data collected on individuals, and the procedures are not disturbing or harmful. Each subject will be assigned a number which is the only identifier for all materials. In addition, group or numbered data will be presented in any future publication, paper, or conference presentation. All materials containing the names of subjects will be stored in a locked file cabinet in the Brain Research and Neuropsychology Laboratory, Walters Life Science Building, Room A-305. Only those individuals listed as directors, or co-directors will have access to those files. The computer used in the EEG biofeedback sessions will store continuous data on the subjects, as the training occurs, but will not contain identifying information, except gender, age and subject number. This computer will always be in a locked room, either in the resource room at the Foundation Academy, or at Walters Life Science Building.

VI. BENEFITS

The benefits of this study described within this form will be a contribution to the understanding the physiological basis of attention deficit hyperactivity disorder (ADHD), and the effect of Audio Visual Stimulation and EEG Biofeedback on this

disorder. For the subjects with ADHD, a potential benefit will be a clinical improvement in their ADHD symptoms, behaviors, and cognitive processing. The physical or psychological risks are minimal to none. The procedures described in this form have been used in many previous studies, and posed no risk to the participants.

VII. METHODS FOR OBTAINING "INFORMED CONSENT" FROM SUBJECTS

The subjects and their parents or legal guardians will be required to read and sign the following consent form:

I, _____, as the parent/ legal guardian of _____, agree to the participation of my child in the research study entitled, "Comparison of the Electrophysiological and Psychoeducational Effects of Audio Visual Stimulation on treatment effects of EEG Biofeedback on children with ADHD (attention deficit hyperactivity disorder)." Participation in this research study is strictly voluntary, and I may withdraw at any time with no penalty. The total time involved in participating in the study is about 40 hours, with 35 to 40 individual sessions.

Participation in this study involves minimal to no-risk to the children, and the procedures used have been done in many other studies with no harm to those children who participated. It is possible that my child's ADHD symptoms, behavior, and school work may improve, resulting in an increased ability to get along better with teachers and peers.

The information collected in this study will remain confidential. The data gathered during this research project may potentially be shared professionally, but will include numerical coding to insure the privacy of the participants. I will be given detailed information concerning the evaluation procedures that will be used during this study. I have read and agree to have my child participate. I have been given the opportunity to ask questions about this research study. My child's participation is given voluntarily without coercion or undue influence. The information gained may be used as part of data collection for these and/or future studies.

This consent form will be stored for three years past the completion of the study at a University of Tennessee location.

Parents/legal guardian _____

Date of consent _____

Witness _____ Date _____

*If you have any questions about this study, please contact the following:
Sheryl Brim, College of Education, Psychoeducational Studies,
University of Tennessee, Knoxville, (423) 974-3222 or 974-8145,
or, Dr. Joel Lubar, Department of Psychology,
University of Tennessee, Knoxville, (423) 974-3222 or 974-3360.*

VIII. QUALIFICATIONS OF THE INVESTIGATOR(S) TO CONDUCT RESEARCH

Sheryl Brim is entering her third year of graduate study in the school psychology doctoral program at The University of Tennessee, Knoxville. She will receive a Master of Science degree in Education-Educational Psychology Collaborative Learning in the summer 1997, at The University of Tennessee, and received her Bachelor of Science degree in Education from Southern Illinois University-Carbondale in 1995. Ms. Brim has worked with educational interventions with ADHD children for more than nine years.

Ms. Brim has completed the psychoeducational assessment and practicum sequence of twelve hours at the University of Tennessee, and is qualified to give the assessments required for this project. She was trained during the summer of 1996 to use EEG-biofeedback, and then spring of 1997 to administer Quantitative EEG, and works under supervision of Dr. Lubar and other graduate psychology students in the neuropsychology laboratory at the University of Tennessee.

Dr. Joel Lubar is a Full Professor in the Department of Psychology at The University of Tennessee, and has more than 25 years of experience working in the field of neuroscience. He is a licensed psychologist in the State of Tennessee, and has the designation of "Health Service Provider."

IX. FACILITIES AND EQUIPMENT TO BE USED IN THE RESEARCH

The data for this study will be collected in the following two locations:

1) The Brain Research and Neuropsychology Laboratory, Walters Life Sciences Building, University of Tennessee, Room A-302. The equipment is owned by Dr. Lubar, Ms. Brim, Autogenics Corporation (on a loan), or the University of Tennessee.

2) The Foundation Academy, 107 3rd Ave. S., Jacksonville Beach, FL. The equipment is owned by Ms. Brim or the Autogenics Corporation (on a loan).

All instrumentation and test materials used in this study are directly comparable to materials used in hospital and clinical settings.

X. RESPONSIBILITY OF THE PRINCIPAL/CO-PRINCIPAL INVESTIGATOR(S)

By compliance with the policies established by the Institutional Review Board of The University of Tennessee, Knoxville, the principal investigator(s) subscribe to the principles stated in "The Belmont Report" and standards of professional ethics in all research, development, and related activities involving human subjects under the auspices of The University of Tennessee, Knoxville. The principal investigator(s) further agree that:

- a. Approval will be obtained from the Institutional Review Board prior to instituting any change in this research project.**
- b. Development of any unexpected risks will be immediately reported to the Compliances Section.**
- c. An annual review and progress report (Form R) will be completed and submitted when requested by the Institutional Review Board.**
- d. Signed informed consent documents will be kept for the duration of the project and for at least three years thereafter at a location approved by the Institutional Review Board.**

Signed consent forms and the research data will be kept on disk in a locked cabinet in the Brain Research and Neuropsychology Laboratory, Walters Life Sciences Building Room A-302, for the duration of the project and for at least three years thereafter. Continuous data from the training sessions will be stored in the computer that is used for the training. The computer will be located in the Neuropsychology Laboratory in a locked room for the duration of the project, except for the four weeks of training occurring at The Foundation Academy, when it will be in a locked resource room at that location. At the conclusion of the study, all research data will be stored on disk and removed from the hard drive of the computer.

DATE

Dear Mr. and Mrs. Name, and Child,

You have expressed interest in being part of a research study entitled, "Comparison of the Electrophysiological and Psychoeducational Effects of Audio-Visual Stimulation on the treatment effects of EEG Biofeedback on children with ADHD (attention deficit hyperactivity disorder)." The training will occur at The University of Tennessee Walter's Life Science Building, at a time mutually agreed upon. Some children from Florida will be participating and the first four weeks of their training will occur at The Foundation Academy. The results of this research study will be used to partially fulfill requirements of my doctoral dissertation.

Although studies have indicated that EEG biofeedback training is an effective tool that helps many students with ADHD achieve better school performance, **no** intervention works universally with every ADHD student. Dr. Lubar and his researchers compared Quantitative Electroencephalographic (QEEG) brain mapping of boys with ADHD to boys without ADHD. The boys with ADHD exhibited increased theta (slow wave) activity and decreased beta (fast wave) activity. Their EEGs resembled those typical of younger children. He found that stimulant medication does not impact the EEG patterns in children with ADHD.

An alternative to medication is EEG biofeedback training, which controls the symptoms of ADHD by training children to decrease the excessive theta activity (associated with daydreaming and shifting attention) and increase the beta activity (associated with concentration). Electroencephalographic (EEG) biofeedback utilizes a system of reinforcements for the target behavior of decreasing theta during concentration. There are no invasive X-RAY type occurrences; the student will either *learn* to control his/her theta production which should assist him/her in normalizing his/her behavior, or the child will not *learn* to control his/her theta production which would result in little benefit for the student. The ability to manipulate the theta and beta activities in the brain appears to be an important factor in overcoming the effects of ADHD.

In 1995, Dr. Lubar and other researchers conducted a summer training program to determine the effectiveness of EEG biofeedback training with ADHD children. They saw significant increases in standardized test scores upon completion of the EEG biofeedback training, and significant improvements in EEG activity and behavioral ratings, which supported earlier research findings that EEG biofeedback training does help many children overcome learning and attentional problems associated with ADHD.

Again, it is important that you realize that there is no guarantee associated with this intervention. There are certain attributes which help to make the student successful in *learning* to control the theta activity in his/her brain:

- 1) the strong desire to make the change
- 2) commitment to attending the training sessions, and the
- 3) support of his/her parents.

There is a screening process which will determine if your child meets the criteria. In order to participate, your child must go to the University of Tennessee Knoxville for QEEG evaluation and two computerized attention testings, before the beginning of the study, and after EEG biofeedback training at the end of August. Car pooling is encouraged. The QEEG must be consistent with the diagnosis of ADHD, the child must not have a history of any seizure activity or other neurological problems. This is a research project which does not affect your child's current treatment program.

Please sign this letter and the consent form and return to me as soon as possible. A copy is enclosed for your files. If you have any questions, please call me at (423) 974-3222.

Sincerely,
Sheri Brim

Participant

Parents/Legal Guardian

Date

*****Note to Human Subjects...all parents have a sufficient reading level to understand this*****

The following form is a fact sheet which answers most of the parents' questions, and is given to the parents prior to formal assessment to determine eligibility for the study.

Children's Assent Form

To be read to the participant and signed by the participant prior to study, and after the Signed Consent has been signed by the participant's parents/legal guardians.

DATE _____

Your parents signed permission for you to be a part of this research study using EEG Biofeedback to try to help you with ADHD (attention deficit hyperactivity disorder). This information will be used as part of my doctoral dissertation requirement and is used for research purposes only. Do you have any questions that you want me to answer?

At this time I want to know if you want to be a part of this study. Your participation is voluntary, and that means that you do not have to be a part of it if you don't want to. If you decide at any time that you do not want to continue in the study, then you may stop without any penalty and no one will get mad at you. This will take a lot of your time, about 40 hours all together and including 35 to 40 sessions. It is important that you decide now if you want to do it.

You will be given a personal number, which will be what is used for all of your sessions. This will make sure that all of your information is private, and that no one besides Dr. Lubar and me will know who you are. I will use the information I get from this study to help other people work better with children who have ADHD.

There is very small to no risk of being harmed by this study. In fact, other children have been in studies similar to this one, and have never been harmed by the study. Some good things that could happen are that you may find it easier to get along with your parents, teachers and friends after the training. You may also find school work a easier to do. This is a research project only, and does not affect your current treatment program.

If you would like to be in this study, please sign here. If you have any questions, please call me at (423) 974-3222.

Participant

Sheryl Brim
Principal Investigator

Date



Office of Research
404 Andy Holt Tower
Knoxville, Tennessee 37996-0140
PHONE: (423) 974-3466
FAX: (423) 974-2805
URL: <http://www.ra.utk.edu/ora>

Date: 10/20/98

To: Brim, Sheryl
Psychology
1611 Laurel Ave. #301
Knoxville, TN 37916

Whitaker, Dr. Dianne
Psychoeducational Studies
425 Claxton Addn.
Campus

From: Brenda Lawson
Compliances

Subject: Annual Review and Progress Report: IRB # : 5369 B
Project Involving Research with Human Subjects

IRB-APPROVED RENEWAL

Project: Comparison of the Electrophysiological and Psychoeducational Effects
of Audio Visual Stimulation, Bloodflow Neurofeedback,...

Initial Approval Date: 07/02/97 Last IRB Approval Date: 10/20/98

(Approval Expires 07/02/99)

In response to our request regarding annual review and a progress report of the above protocol, you indicated that the study is still active and that there have been no changes with regard to the use of human subjects in this project since the last date of review. Therefore, the Institutional Review Board has approved the protocol until **July, 1999** which coincides with the anniversary month of your initial approval date.

If there should be any modifications in the project before the date of next annual review, please submit them, utilizing a Form D, to the Compliances Office immediately for review. Requests for your next annual review will be sent to you approximately one month prior to the expiration date noted in the previous paragraph.

APPENDIX B

Table 1. Instrumentation

Instruments	Criteria Measure	Pre-Test	Post-Test	Type Data Analysis
1. WISC-III VOC	X	X		
2. WISC-III SCAD		X	X	ANOVA
Including FD	X	X		
Including PS	X	X		
3. TOVA	X			
Auditory		X	X	ANOVA
Visual		X	X	ANOVA
4. ADDES-Parent	X	X	X	ANOVA
5. A620 Assess	X	X	X	ANOVA
QEEG		X	X	PCA T-TESTS
BASC-SRP		X		
WIAT				
Reading		X	X	ANOVA
Math		X	X	ANOVA

Criterion Measures

1. Average intelligence or above

*Must meet 3 of 4 following criterion:

2. Below 40th percentile on FD or PS Index
3. Rating of "attention problems" on auditory or visual TOVA
4. Below 35th percentile on home or school rating form ADDES
5. A620 assessment of 3 or greater theta/beta ratio (uv squared)

Exclusionary Criteria

1. No history of seizures
2. No history of significant medical problems
3. No history of significant neurological problems

Table 2. Comparison of Participants by Group

	Age	Gender	ADHD- type	Interventi on	WISC-III VOC/IQ	WISC 3 SCAD	T/B CZ- PRE
Ann	8.5	F	I	AV	98 FS	100	3.9
Bob	15	M	I	AV	11 VOC	74	2
Carl	12.2	M	I	AV	103 FS	102	4
Dana	12.9	F	I	AV	99 FS	81	1.9
Ed	9	M	C	AV	104 FS	105	3.3
Fran	9.4	F	C	C	9 VOC	110	3.7
Gail	15	F	I	C	13 VOC	102	1.1
Hanna	13	F	C	C	9 VOC	93	3.3
Ike	11.8	M	C	C	11 VOC	95	1.6
Jim	11.1	M	I	C	10 VOC	110	2
Kat	9.7	F	I	BF	13 VOC	112	6.3
Lance	8.5	M	H	BF	9 VOC	105	3.2
Mark	10.2	M	C	BF	9 VOC	77	2.1
Nan	12.7	F	C	BF	14 VOC	110	1.9
Oscar	11.2	M	I	BF	8 VOC	91	3.3
	A = AVS		B= Bloodflow		C= Control		
				ANOVA	df	F	Sig.
AGE			Between Groups		2	0.69	0.52
			Within Groups		12		
			Total		14		
WISC SCAD						0.758	0.49
T/B CZ Pre						0.754	0.492

**Table 3. One-Way Analysis of Variance of SCAD Profile Difference
Between Groups**

ONE-WAY ANOVA

		<i>df</i>	F	Sig.
SCAD PRE	Between Grps	2	.546	.593
	Within Grps	12		
	Total	14		
SCAD POST	Between Grps	2	.903	.431
	Within Grps	12		
	Total	14		
SCAD GAIN	Between Grps	2	.052	.949
	Within Grps	12		
	Total	14		

Table 4. Physiological and Cognitive Assessment

	ADHD- type	Interventi on	WISC-III VOC/IQ	WISC-III FD-Pre	WISC-III FD-Post	WISC-III PS-Pre	WISC-III PS-Post	SCAD PRE	SCAD POST	T/B CZ- PRE	T/B CZ- POST
Ann	I	AV	98 FS	96	104	106	111	100	109	3.9	3.6
Bob	I	AV	11 VOC	75	87	86	80	74	77	2	2.4
Carl	I	AV	103 FS	84	90	119	111	102	100	4	4.3
Dana	I	AV	99 FS	75	72	96	104	81	84	1.9	2.6
Ed	C	AV	104 FS	101	96	109	99	105	97	3.3	5.6
Fran	C	C	9 VOC	124	124	96	96	110	110	3.7	3.4
Gail	I	C	13 VOC	96	81	109	117	102	99	1.1	1.1
Hanna	C	C	9 VOC	106	98	86	99	86	99	3.3	3.2
Ike	C	C	11 VOC	104	104	91	96	95	99	1.6	1.7
Jim	I	C	10 VOC	98	93	119	117	110	105	2	2.2
Kat	I	BF	13 VOC	93	93	126	122	112	109	6.3	5.7
Lance	C	BF	9 VOC	101	96	109	96	105	93	3.2	4.9
Mark	C	BF	9 VOC	87	90	80	96	77	90	2.1	2
Nan	C	BF	14 VOC	109	106	109	119	110	116	1.9	1.6
Oscar	I	BF	8 VOC	87	78	101	104	91	88	3.3	2.6

Table 5. WIAT Achievement Assessment

	Intervention	WIAT READ		WIAT MATH		WIAT Read S		WIAT Read C		WIAT Math C		WIAT Math R		WIAT Num O	
		PRE	POST	PRE	POST	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Ann	AV	92	83	102	94	89	84	99	88	102	98	102	98	102	91
Bob	AV	78	88	75	70	75	81	91	105	79	79	78	78	78	68
Carl	AV	80	79	75	67	85	81	83	87	86	74	70	70	68	68
Dana	AV	88	88	97	92	89	89	91	92	96	98	98	98	98	86
Ed	AV	104	100	97	104	98	97	113	104	103	109	91	91	91	98
Fran	C	84	78	109	107	84	78	92	87	113	123	102	102	102	90
Gail	C	106	104	92	90	102	103	111	105	99	97	85	85	85	83
Hanna	C	115	115	101	99	120	123	104	101	96	96	108	108	108	101
Ike	C	102	96	118	117	94	94	115	100	125	120	110	110	110	110
Jim	C	86	81	112	103	85	82	93	87	120	116	102	102	102	107
Kat	BF	109	109	92	101	103	107	120	114	84	102	105	105	99	99
Lance	BF	81	81	98	83	84	80	86	88	102	86	94	94	87	87
Mark	BF	79	79	95	87	77	76	90	90	102	95	87	87	81	81
Nan	BF	110	115	98	107	107	113	117	113	103	118	92	92	95	95
Oscar	BF	80	81	86	90	81	90	85	77	92	88	81	81	95	95

Table 6. Pre- and Post- Test Differences

	Intervention	WISC-III FD	WISC-III PS	T/B CZ	WIAT READ	WIAT MATH	WIAT Read S	WIAT Read C	WIAT Math R	WIAT Num O
Ann	AV	8	5	-0.3	-9	-8	-5	*15	-4	-11
Bob	AV	12	-6	0.4	10	-5	6	10	0	-10
Carl	AV	6	-8	0.3	-1	-8	-4	4	-12	-2
Dana	AV	-3	8	0.7	0	-5	-5	-11	-4	-11
Ed	AV	6	-8	0.3	-1	-8	-4	4	-12	-2
Fran	C	0	0	-0.3	-6	-2	-6	-5	10	-12
Gail	C	*-15	8	0	-2	-2	1	-6	-2	-2
Hanna	C	-8	13	-0.1	0	-2	3	-3	0	-7
Ike	C	0	5	0.1	-6	-1	0	*-15	-5	0
Jim	C	-5.6	4.8	-0.02	-3.8	-3.2	-1	-7	-0.2	-3.2
Kat	BF	0	-4	-0.6	0	9	4	-6	*18	-6
Lance	BF	-5	-13	1.7	0	*-15	-4	2	*-16	-7
Mark	BF	3	*16	-0.1	0	-8	-1	0	-7	-6
Nan	BF	-3	10	-0.3	5	9	6	-4	*15	3
Oscar	BF	-9	3	-0.7	1	4	9	-8	-4	14

* =1 standard deviation of
change

Table 7. WIAT Achievement ANOVA Pre – Post Differences Between Groups

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
WIAT Reading Gain					
Between Groups	63.333	2	31.667	1.568	.248
Within Groups	242.400	12	20.200		
Total	305.733	14			
WIAT Math Gain					
Between Groups	37.200	2	18.600	.336	.721
Within Groups	664.400	12	55.367		
Total	701.600	14			
WIAT Reading Skills Gain					
Between Groups	45.733	2	22.867	1.165	.345
Within Groups	235.600	12	19.633		
Total	281.333	14			
WIAT Reading Comprehension Gain					
Between Groups	116.133	2	58.067	1.223	.328
Within Groups	569.600	12	47.467		
Total	685.733	14			
WIAT Math Reasoning Gain					
Between Groups	19.600	2	9.800	.098	.907
Within Groups	1194.800	12	99.567		
Total	1214.400	14			
WIAT Numerical Operations Gain					
Between Groups	67.733	2	33.867	.537	.598
Within Groups	757.200	12	63.100		
Total	824.933	14			

Table 8. ADDES and TOVA Ratings of Behavior Pre and Post

	A D H D	Group	TOVA-	TOVA-	TOVA-	TOVA-	ADDES		ADDES	
			Audit.	Audit.	Visual	Visual	INATT		HYP-	
			Atten	Atten	Atten	Atten			IMP	
			Prob	Prob	Prob	Prob	PRE	POST	PRE	POST
Ann	I	AV	Y	Y	N	Y	7	2	6	6
Bob	I	AV	Y	N	Y	Y	2	11	5	11
Carl	I	AV	Y	N	N	N	2	9	9	12
Dana	I	AV	Y	Y	Y	Y	2	1	7	9
Ed	C	AV	Y	Y	Y	Y	5	5	5	8
Fran	C	C	Y	N	Y	Y	6	5	8	10
Gail	I	C	N	Y	Y	Y	2	4	2	8
Hanna	C	C	Y	Y	Y	N	7	3	10	3
Ike	C	C	Y	N	N	N	6	8	9	11
Jim	I	C	Y	Y	N	Y	13	7	14	9
Kat	I	BF	Y	Y	Y	N	3	7	8	10
Lance	C	BF	N	N	Y	Y	7	5	5	6
Mark	C	BF	Y	Y	N	Y	1	4	2	6
Nan	C	BF	Y	Y	N	N	1	0	2	1
Oscar	I	BF	Y	Y	N	N	1	5	9	9

ADDES Standard Scores
Mean=10, sd=3
*Lower score indicates
worsening of behavior

ANOVA				
Inattention Gain	Between Groups	df	F	Sig.
	Within Groups	12	.940	.418
	Total	14		
Hyperactive/Impulsive			1.019	.390

Table 9. TOVA Changes from Baseline

	Improved	No Change	Declined
A/V Stimulation	2	3	0
Bloodflow Feedback	0	5	0
Control	2	2	1

Auditory TOVA

	Improved	No Change	Declined
A/V Stimulation	0	4	1
Bloodflow Feedback	1	3	1
Control	2	2	1

Visual TOVA

Table 10. TOVA Assessment of Response Time

A/V Stimulation	F8 Inattentive	M15 Inattentive	M12 Inattentive	F13 Inattentive	M9 hyperactive
	<u>Ann</u>	<u>Bob</u>	<u>Carl</u>	<u>Dana</u>	<u>Ed</u>
	97	76	103	79	61
<u>TOVA-A, pre</u>	81	80	107	56	62
<u>TOVA-A, post</u>	16	-4	-4	23	-1
<u>TOVA-V, pre</u>	128	77	117	59	73
<u>TOVA-V, post</u>	113	85	105	<40	64
Bloodflow (HEG)	15	-8	12	>19	9
	F9 Inattentive	M8 Inattentive	M10 Inattentive	F12 Inattentive	M11 hyperactive
	<u>Kat</u>	<u>Lance</u>	<u>Mark</u>	<u>Nan</u>	<u>Oscar</u>
<u>TOVA-A, pre</u>	69	82	60	83	65
<u>TOVA-A, post</u>	85	81	50	87	67
	-16	1	10	-4	-2
<u>TOVA-V, pre</u>	88	98	44	*	98
<u>TOVA-V, post</u>	107	99	62	*	90
Controls	-19	-1	-18	*	8
	<i>*pre assessment data missing for visual TOVA</i>				
	F9 Inattentive	F15 Impulsive	F13 Inattentive	M11 Inattentive	M12 Inattentive
	<u>Fran</u>	<u>Gail</u>	<u>Hanna</u>	<u>Ike</u>	<u>Jim</u>
<u>TOVA-A, pre</u>	84	90	79	87	69
<u>TOVA-A, post</u>	83	72	98	89	69
	1	18	-19	-2	0
<u>TOVA-V, pre</u>	57	79	104	106	93
<u>TOVA-V, post</u>	64	60	109	106	70
	-7	19	-5	0	23

Table 11. TOVA Assessment of Variability

A/V Stimulation	F8 Inattentive <u>Ann</u>	M15 Inattentive <u>Bob</u>	M12 Inattentive <u>Carl</u>	F13 Inattentive <u>Dana</u>	M9 hyperactive <u>Ed</u>
	77	98	114	90	94
TOVA-A, pre	74	118	126	102	100
TOVA-A, post	3	-20	-12	-12	-6
TOVA-V, pre	119	80	123	79	73
TOVA-V, post	86	81	120	72	64
Bloodflow (HEG)	33	-1	3	7	9
	F9 Inattentive <u>Kat</u>	M8 Inattentive <u>Lance</u>	M10 Inattentive <u>Mark</u>	F12 Inattentive <u>Nan</u>	M11 hyperactive <u>Oscar</u>
TOVA-A, pre	104	106	91	94	96
TOVA-A, post	119	105	103	96	93
TOVA-V, pre	-15	1	-12	-2	3
	81	95	84	*	104
TOVA-V, post	102	106	98	*	98
Controls	-21	-11	-14	*	6
	<i>*pre assessment data missing for visual TOVA</i>				
	F9 Inattentive <u>Fran</u>	F15 Impulsive <u>Gail</u>	F13 Inattentive <u>Hanna</u>	M11 Inattentive <u>Ike</u>	M12 Inattentive <u>Jim</u>
	110	108	122	95	101
TOVA-A, pre	113	90	104	103	100
TOVA-A, post	-3	18	18	-8	1
TOVA-V, pre	88	74	79	112	104
TOVA-V, post	104	<40	105	107	92
	-16	>34	-26	5	12

Table 12. TOVA Assessment of Omission Errors

A/V Stimulation	F8 Inattentive	M15 Inattentive	M12 Inattentive	F13 Inattentive	M9 hyperactive
	<u>Ann</u>	<u>Bob</u>	<u>Carl</u>	<u>Dana</u>	<u>Ed</u>
<u>TOVA-A, pre</u>	93	106	102	<40	94
<u>TOVA-A, post</u>	100	106	102	95	92
	-7	0	0	>55	2
<u>TOVA-V, pre</u>	104	104	109	99	103
<u>TOVA-V, post</u>	96	108	109	99	102
	8	-4	0	0	1
Bloodflow (HEG)	F9 Inattentive	M8 Inattentive	M10 Inattentive	F12 Inattentive	M11 hyperactive
	<u>Kat</u>	<u>Lance</u>	<u>Mark</u>	<u>Nan</u>	<u>Oscar</u>
<u>TOVA-A, pre</u>	100	105	95	98	80
<u>TOVA-A, post</u>	95	107	104	105	94
	5	-2	-9	-7	-14
<u>TOVA-V, pre</u>	78	98	105	*	103
<u>TOVA-V, post</u>	104	95	105	*	100
	26	3	0	*	3
	<i>*pre assessment data missing for visual TOVA</i>				
Controls	F9 Inattentive	F15 Impulsive	F13 Inattentive	M11 Inattentive	M12 Inattentive
	<u>Fran</u>	<u>Gail</u>	<u>Hanna</u>	<u>Ike</u>	<u>Jim</u>
<u>TOVA-A, pre</u>	107	102	105	103	72
<u>TOVA-A, post</u>	106	101	104	102	108
	1	1	1	1	-36
<u>TOVA-V, pre</u>	104	107	89	109	100
<u>TOVA-V, post</u>	109	96	103	105	103
	-5	11	-14	4	-3

Table 13. TOVA Assessment of Commission Errors

A/V Stimulation	F8 Inattentive	M15 Inattentive	M12 Inattentive	F13 Inattentive	M9 hyperactive
	<u>Ann</u>	<u>Bob</u>	<u>Carl</u>	<u>Dana</u>	<u>Ed</u>
	50	74	53	82	90
<u>TOVA-A, pre</u>	72	109	86	112	103
<u>TOVA-A, post</u>	-22	-35	-33	-30	-13
<u>TOVA-V, pre</u>	98	73	93	110	106
<u>TOVA-V, post</u>	83	90	109	117	112
	15	-17	-16	-7	-6
Bloodflow (HEG)	F9 Inattentive	M8 Inattentive	M10 Inattentive	F12 Inattentive	M11 hyperactive
	<u>Kat</u>	<u>Lance</u>	<u>Mark</u>	<u>Nan</u>	<u>Oscar</u>
	106	103	101	98	78
<u>TOVA-A, pre</u>	106	109	112	89	85
<u>TOVA-A, post</u>	0	-6	-11	9	-7
<u>TOVA-V, pre</u>	100	89	136	*	115
<u>TOVA-V, post</u>	102	109	132	*	109
	-2	-20	4	*	6
	<i>*pre assessment data missing for visual TOVA</i>				
Controls	F9 Inattentive	F15 Impulsive	F13 Inattentive	M11 Inattentive	M12 Inattentive
	<u>Fran</u>	<u>Gail</u>	<u>Hanna</u>	<u>Ike</u>	<u>Jim</u>
	106	99	106	65	115
<u>TOVA-A, pre</u>	106	103	53	96	111
<u>TOVA-A, post</u>	0	-4	53	-31	4
<u>TOVA-V, pre</u>	112	107	72	87	117
<u>TOVA-V, post</u>	115	110	95	99	122
	-3	-3	-23	-12	-5

Table 14. TOVA Assessment of Commission Errors ANOVA

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
TOVA-A Gain					
Between Groups	2621.200	2	1310.600	3.678	.057
Within Groups	4276.400	12	356.367		
Total	6897.600	14			
TOVA-V Gain					
Between Groups	85.614	2	42.807	.342	.717
Within Groups	1375.600	11	125.055		
Total	1461.214	13			

Table 15. Group Mean ANOVA of Pre – Post Theta/Beta Ratios at CZ

ANOVA					
Theta/Beta Difference	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.588	2	.794	1.222	.329
Within Groups	7.796	12	.650		
Total	9.384	14			

Table 16. Multivariate Rotated Pattern Factor Analysis of 19 Electrode Recording Sites

LOCATIONS	DELTA		THETA		ALPHA		BETA	
	F1	F2	F1	F2	F1	F2	F1	F2
F1	83	30	88	29	93	20	88	35
F2	79	34	83	34	92	19	89	31
F7	84	19	88	19	87	25	81	46
F8	91	19	94	19	90	18	90	38
F3	92	35	91	36	88	45	94	23
FZ	93	35	90	37	90	42	96	22
F4	76	49	77	50	64	53	65	47
T3	X	X	75	53	73	43	56	62
T4	X	X	67	67	57	74	76	52
C3	X	X	58	72	53	73	74	55
CZ	41	86	41	86	49	67	29	80
C4	X	X	59	63	65	45	26	88
T5	27	96	26	96	30	91	39	89
T6	38	81	34	83	26	83	28	92
P3	22	78	23	78	29	51	26	79
PZ	20	69	20	69	8	25	21	84
P4	92	37	90	39	88	45	96	20
O1	X	X	72	55	69	67	82	45
O2	29	90	27	91	18	91	42	86

Table 17. Factor 1 and 2

Delta

Factor 1: F1, F2, F7, F8, F3, FZ, F4, P4

Factor 2: CZ, T5, T6, P3, PZ, O2

Theta

Factor 1: F1, F2, F7, F8, F3, FZ, P4

Factor 2: T4, C3, CZ, T5, T6, P3, O2

Alpha

Factor 1: F1, F2, F7, F8, F3, FZ, T3, C4, P4

Factor 2: C3, CZ, T5, T6, O2

Beta

Factor 1: F1, F2, F7, F8, F3, FZ, F4, T4, P4, O1

Factor 2: CZ, C4, T5, T6, P3, PZ, O2

APPENDIX C

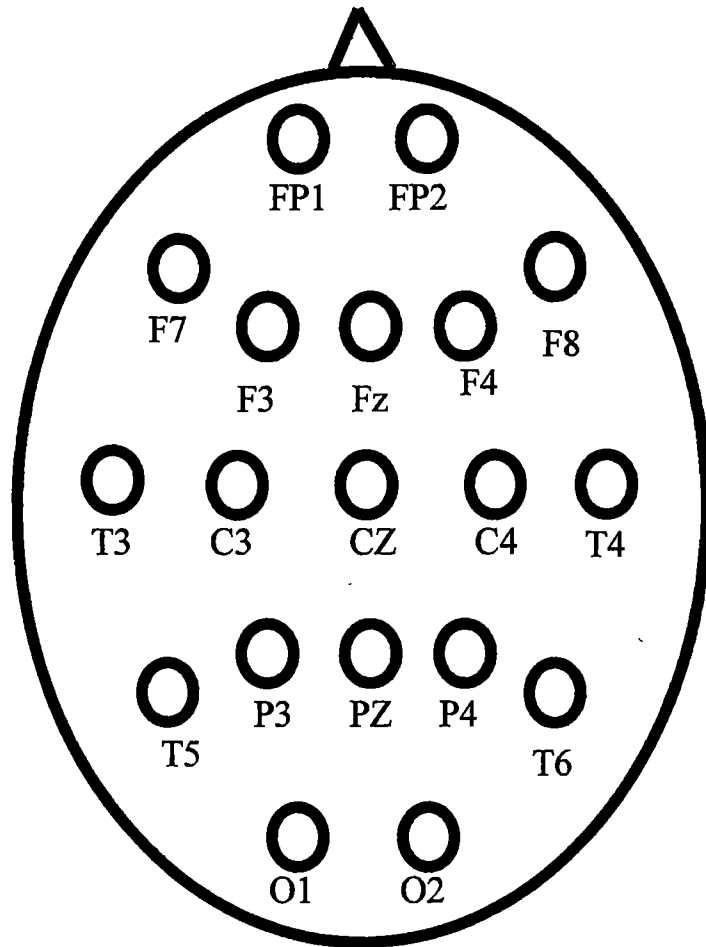
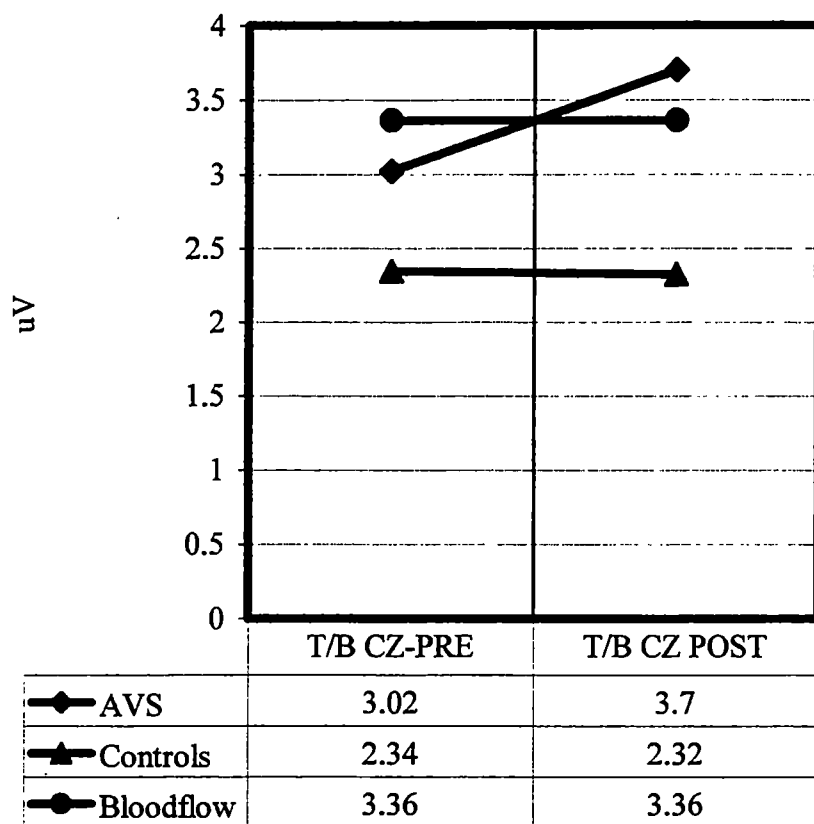


**Figure 1. International 10-20 System
For Electrode Placement**



Eyes-Closed Condition: Pre Treatment versus Post Treatment

AVS Controls Bloodflow

Figure 2. Group Mean Theta/Beta Ratio at CZ

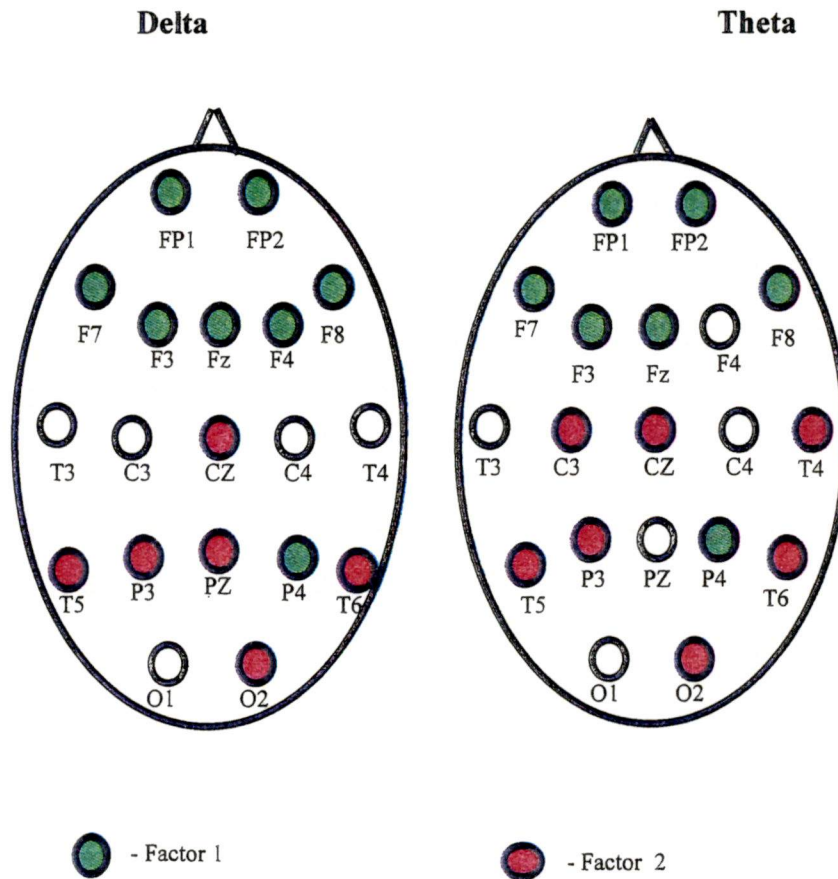


**Figure 3. Eyes – Closed Factor Analysis
of Percent Power in Delta and Theta**

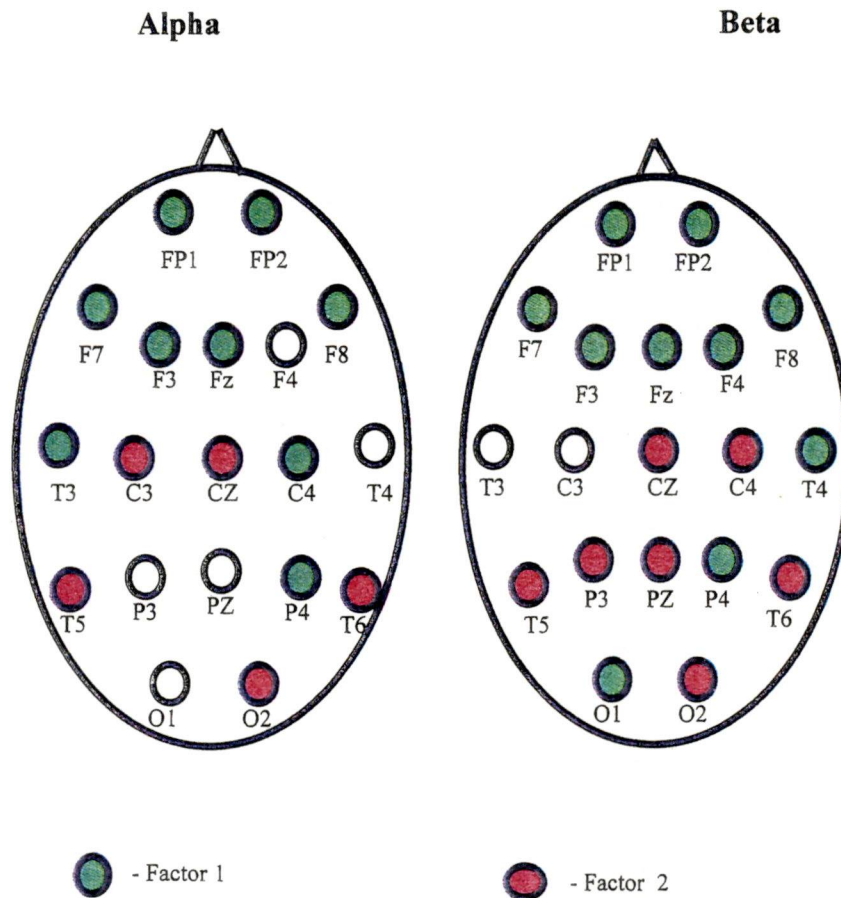


**Figure 4. Eyes – Closed Factor Analysis
of Percent Power in Alpha and Beta**

VITAE

Sheryl Ann Brim was born on August 12, 1954 in Kansas City, Missouri. She completed her undergraduate work at Southern Illinois University – Carbondale in 1995, through the military program at Mayport, Florida, graduating Magna cum Laude. The University of Tennessee granted her Master of Science degree in Education, with a concentration in Educational Psychology – Individual and Collaborative Learning, in 1997.

Sheryl has three grown children, Tina, Gary, and Angela Chronister, and one grandchild, Summer Joy Shelton. She is returning to northeast Florida to continue her work with children as a school psychologist for Bradford County Schools, in Starke. She will incorporate school-based research designed to help at-risk children into her practice as a school psychologist. Sheryl will continue providing neurotherapy for ADHD and LD children in private practice at Ponte Vedra Beach, Florida early in the year 2000.