CLUSTERING OF BEHAVIORAL DATA FOR IDENTIFICATION OF PRESUMPTIVE SUBTYPES OF ATTENTION DEFICIT/HYPERACTIVITY DISORDER IN CHILDREN

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The objective of the present study was to investigate Amen's formulations of subtypes of AD/HD initially identified by brain imaging techniques, through the use of behavioral checklist data. And in testing Amen's theory of six separate subtypes of AD/HD, to identify and differentiate the subtypes based on symptom presentation. Data was obtained through retrospective chart reviews (N=161) of children between the ages of 5 and 12 who met the criteria for the major symptoms observed in AD/HD and were referred for a previous comprehensive AD/HD evaluation. Data from behavioral checklist (CBCL and DBRS-IV) were matched to Amen's Subtype Symptom Checklist and each subject was given a percentage score for six subtype symptoms. Cluster analysis reliably found six clusters and each subject was labeled according to their symptom presentation. The clusters found were labeled as AD/HD – Combined Type, AD/HD – Predominately Inattentive Type, AD/HD – Predominately Hyperactive-Impulsive Type, Ad/HD – Combined Type with Obsessive-Compulsive features, AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features and Undifferentiated AD/HD. However, the present study did not find evidence of subtypes that corresponded to Amen's Temporal Lobe ADD or Limbic ADD. Discriminant function analysis of the six clusters found that the variables in the model (symptom

percentage scores) significantly discriminated the subtype classification. Also, 76% of all cases were correctly classified according to their symptom presentation. Potential limitations of the sample and the data used for interpretation were discussed. Limitations of the study warrant further investigation making use of multi-modal assessment tools which relate well with brain imaging techniques, such as neuropsychological measures of attention and concentration, laboratory based measures of activity, continuous performance tests measuring inattention and impulsivity, and QEEG data measuring brain wave information. A multi-modal approach to investigating symptom subtypes of AD/HD would likely provide increased reliability and validity of differential diagnosis, and therefore, more effective treatment of children with the presenting symptomology of AD/HD. The diagnostic and clinical implications' of each cluster subtype symptomology found in the present study was discussed as well.

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INTRODUCTION

Attention Deficit-Hyperactivity Disorder (AD/HD) is one of the most extensively studied psychiatric disorders (Barkley, 1991). It is reported in the American Psychiatric Association's (APA) Diagnostic and Statistical Manual of Mental Disorders - Fourth Edition (DSM-IV) that AD/HD occurs across cultures (American Psychiatric Association, 1994). Although the diagnosis of AD/HD occurs more frequently in Western countries, this is most likely due to different diagnostic procedures rather than differences in clinical presentation (American Psychiatric Association, 1994). The prevalence reported by the APA in 1994 was estimated to be approximately three to five percent of school-age children. More recent estimates indicate a prevalence rate of three to seven percent of the childhood population (Barkley, 1998; Barkley & Murphy, 1998). The disorder is reported more frequently in males than in females, with males three to four times more likely to have AD/HD (American Psychiatric Association, 1994; Barkley, 1998; Barkley & Murphy, 1998; Lubar, 1995). Over the past century, a number of diagnostic labels have been given to clinically referred children having significant deficiencies in behavioral inhibition, sustained attention, resistance to distraction and the regulation of activity level (Barkley, 1998). Attention Deficit-Hyperactivity Disorder is currently the valid term used by the APA to describe this cluster of behaviors (American Psychiatric Association, 1994). Over the years, there has been extensive research on AD/HD that continues today. In 1991, a special edition of Child Neurology was devoted entirely to AD/HD. In the introduction to that special edition, it stated that even 10 years previously there were more than 2,000 papers published about this disorder and that the number of papers and books has grown exponentially since then (Lubar, 1995).

History of AD/HD

In the past, AD/HD had been referred to by a variety of descriptive terms. Some previous diagnostic labels include "Minimal Brain Damage, Minimal Brain Dysfunction, Brain Injured Child Syndrome, Hyperkinesis, Hyperactive Child Syndrome" and more recently, "Attention Deficit Disorder (with or without Hyperactivity)." Barkley (1998) indicated that the relabeling of AD/HD every decade or so reflects a shifting emphasis on the primary symptom focus, based in part on the tremendous amount of research conducted each year on AD/HD. In fact, AD/HD was one of the few disorders of childhood that was significantly revised in the DSM-IV (American Psychiatric Association, 1994; Wolraich, 1998).

The first conceptualization of a definition of AD/HD was formulated by George F. Still in 1902 in his lectures to the Royal College of Physicians in England (as cited in Barkley, 1998; Lubar, 1995). His behavioral descriptions of children seen within his clinical practice would now be considered AD/HD with the comorbid disorders of Oppositional Defiant or Conduct Disorder (as cited in Barkley, 1998; Lubar, 1995). The idea that a type of brain disturbance could be responsible for abnormalities in attention and hyperactivity in children actually arose from pathological findings and physiological theories related to an epidemic of “Encephalitis Lethargia” that spread through Vienna in the early 20th century (Sterman, 2000). In 1918, a Viennese physician described two patterns of symptomology related to two different areas of inflammatory injury to the brain (brain stem and hypothalamus; Sterman, 2000). One pattern was described as

inattentive and lethargic, the other as impulsive with uncontrolled physical behavior (Sterman, 2000).

Over the next forty years not much research was conducted on the subject of AD/HD. Barkley (1998) attributes this decline in published papers to a focus away from children, which was due to the two World Wars. A shift of focus from "moral deficits" in behavior as reported by Still to inattentiveness and hyperactivity was seen in the 1950's. In this decade, researchers advocated that two of the hallmark behaviors of AD/HD, restless and inattentive behaviors, were evidence of brain damage in children (Barkley, 1998; Lubar, 1995). The disorder was then referred to as Minimal Brain Damage (MBD). Researchers and clinicians believed that there was something structurally wrong within the central nervous system due to some type of brain injury or inadequate integration of perceptual mechanisms (Lubar, 1995). The concept of a physiological disturbance was further supported by findings of unusually slow EEG brain wave patterns in the children with MBD (Sterman, 2000).

The next two decades presented an additional shift of focus on the central defining characteristics of AD/HD. Throughout the 1960's and 1970's there appeared in the literature an increasing emphasis on excessive motor activity as the central symptom of the disorder (Barkley, 1997; Barkley, 1998). The emphasis of brain damage decreased over time, and with that, the terminology softened from "Minimal Brain Damage" to "Minimal Brain Dysfunction" or “Minimal Cerebral Dysfunction”. Eventually, the link with neurological damage was dropped from the diagnostic criteria, and the disorder was simply referred to as "Hyperactive Child Syndrome", "Hyperkinetic Reaction of Childhood" or "Hyperkinesis" (as cited in Barkley, 1998). At that point in

history, an equal if not greater role for poor sustained attention was stressed (Barkley, 1997; Barkley, 1998).

By the mid-1970's, researchers produced growing evidence that showed hyperactive children also had significant problems with sustained attention and impulse control (Barkley, 1997; Barkley, 1998). Excessive motor control was seen as being problematic, but not as central to the disorder as the attentional and inhibitory problems (Barkley, 1998). The APA (1980) then relabeled the disorder as "Attention Deficit Disorder (with or without Hyperactivity)" in the DSM-III. The publication of the DSM-III-R, and the relabeling of the disorder to "Attention Deficit/Hyperactivity Disorder" reflected yet another shift in focus, with hyperactivity no longer being considered an insignificant symptom (American Psychiatric Association, 1987). At the time of the publication of the DSM-III-R it was unclear whether children who were primarily inattentive represented a distinct subtype of this disorder or whether they represented an entirely separate diagnosis (Barkley, 1990; Barkley, 1998). It became clear to many that the syndrome was poorly defined and that its symptoms were often seen in combination with other behavioral and functional disturbances (Sterman, 2000). Throughout the 1980's the shift of focus on the central symptom for AD/HD came full circle. The focus was now on frontal lobe type behaviors of poor executive functioning and self-regulation of behavior. Barkley (1998) suggests the change in focus reflected a return the earlier conceptualization of poor moral regulation of behavior, as posited by Still in 1902.

Current Criteria for AD/HD Subtypes

Now in it's fourth edition, the DSM-IV recognizes that children with AD/HD represent a heterogeneous disorder that can be differentiated by the extent to which hyperactivity or inattention predominate (American Psychiatric Association, 1994; Ostrander, Weinfurt, Yarnold, & August, 1998). The shift from the DSM-III-R to the DSM-IV conceptualization of AD/HD occurred in response to studies which factor-analyzed parent and teacher rating of children with AD/HD (DuPaul, 1991; Lahey, et al., 1994; DuPaul, et al., 1997). These studies found the domains of AD/HD could be organized into two relatively distinct symptom categories (Marks, Himelstein, Hewcorn, & Halperin, 1999). Thus, the criteria shifted from one-dimensional in the DSM-III-R to two-dimensional (inattention and hyperactivity/impulsivity) forming three subtypes in DSM-IV (predominantly inattentive type, predominately hyperactive-impulsive type and combined type). Refer to Appendix A for a complete list of the criteria for the diagnosis of the three subtypes of AD/HD as presented in the DSM-IV.

Assessment Criteria for AD/HD

The evaluation of AD/HD requires a multimethod assessment (Eiraldi, Power, Karustis, & Goldstein, 2000). The most commonly employed approaches to the assessment of AD/HD are (a) categorical method, which uses structured interviews, and (b) a dimensional method, which uses behavior rating scales (Eiraldi, et al., 2000). The combination of structured interviews and rating scales is reported as the best approach for making a diagnosis of AD/HD (Biederman, et al., 1995). Behavior ratings of AD/HD offer many advantages in the assessment process (Shelton & Barkley, 1994).

Psychometric approaches involving paper-and-pencil checklists have shown to be valid, economical and efficient methods of assessing childhood disorders (Ostrander, et al., 1998).

During the last 15 years, research has accumulated on the validity and clinical utility of the Child Behavior Checklist (CBCL) as it relates to the various editions of the DSM (Eiraldi, et al., 2000). A large body of research has also shown the CBCL's reliability and validity in both clinical and non-clinical populations (Biederman, et al., 1993). The CBCL has been shown to be a good discriminator of AD/HD and other comorbid disorders (Biederman, et al., 1993). Results of numerous studies have indicated that the CBCL is the best instrument overall for discriminating AD/HD from controls and other disorders (Eiraldi, et al., 2000). The use of the CBCL can assist in the differentiation of AD/HD children with and without the comorbid disorders of Anxiety, Depression and Conduct Disorder. Specifically, several studies have shown that the Attention Problems scale, using a cut-off T-score of 60, is an excellent discriminator of AD/HD (Biederman, et al., 1993; Edelbrock & Costello, 1988; Shekim, et al., 1986).

It has been shown that while an elevation of the Attention Problems scale discriminates very well between AD/HD children and controls, the magnitude of this elevation differs in patients with and without comorbid disorders (Biederman, et al., 1993; Steinguard, Biederman, Doyle, & Sprich-Buckminster, 1992). Thus, a cut-off score above 60 in the Attention problems scale is sufficient to identify non-comorbid AD/HD children, while a higher cut-off tends to identify the co-morbid subgroups (Biederman, et al., 1993).

Ostrander, et al. (1998) used a discriminant classification tree analysis (CTA) to assess the ability of the CBCL to discriminate among DSM-IV subtypes of AD/HD or to identify non-specific AD/HD in a community based sample. The authors used a CTA model because it resembles a differential diagnosis decision tree used by clinicians. The authors found the Aggressive Behaviors scale was best at predicting the AD/HD-Combined type subjects, as opposed to the AD/HD-Inattentive subjects. The authors reported a CTA model for distinguishing the non-AD/HD subjects from the AD/HD subjects on the basis of higher scores on the Social Problems and Delinquent Behaviors scales. The Attention Problems scale of the CBCL was the most useful and effective as a means of fine-tuning predictions made on the basis of scores on the Social Problems, Aggressive Behaviors, and Delinquent Behaviors scales.

Neurophysiological Findings

Concurrent with shifts in conceptualization and changes in diagnostic nomenclature, research related to the neurological basis of AD/HD has taken a variety of theoretical approaches (Riccio, Hynd, Cohen, & Gonzalez, 1993). Yet, the definition and guidelines for diagnosing AD/HD by the DSM-IV is purely behavioral; that is, professionals rely entirely on a defined constellation of subjectively observed behavioral characteristics in the home, at school, and in social situations in order to diagnose the disorder (Sterman, 2000). However, research related to AD/HD and attentional disturbances has not focused solely on the behavioral aspects of the disorder. Evidence from neuropharmacological investigations, from genetic studies, and from studies demonstrating that AD/HD can be associated with other neuropsychological

syndromes has generally led to the acceptance that AD/HD is the result of CNS dysfunction (Zametkin & Rapoport, 1987). Research related to the clinical features of AD/HD can be viewed from the neurochemcial or neuroanatomical perspective.

The neurochemcial approach deals with the neurotransmitters involved in the neuronal circuits implicated in this disorder. Neurophysiological and behavioral studies of dextroamphetamine (Dexedrine) and methylphenidate (Ritalin) implicate dopamine and norepinephrine as a possible neurotransmitter for AD/HD (Elia, 1991; Calis, Grothe, & Eli, 1990). Tricyclic antidepressants and monamine oxidase inhibitors (MAOI's) have also been shown to be effective in the pharmacological treatment of AD/HD (Zametkin et al., 1985, Boliek & Obrzut, 1997). Tricyclic antidepressants such as imipramine (Tofranil) and desipramine (Norpramin) block the reuptake of both norepinephrine and serotonin (Boliek & Obrzut, 1997). MAOI's inhibit the enzyme MAO thus causing an increase in levels of dopamine and norepinephrine in the brain (Cooper, Bloom, & Roth, 1991). There is also evidence to suggest that different subtypes of AD/HD respond differently to stimulant medications (Barkley, DuPaul, & McMurray, 1991). Overall, children with AD/HD appear to respond to stimulant and other medications. These findings support the hypothesis that certain subtypes of AD/HD have a constitutional origin (Shaywitz & Shaywitz, 1987).

The neuroanatomical approach focuses on the location of brain areas that subserve those systems thought to mediate the regulation of attention and inhibit motor activity. Although brain damage was proposed years ago as the chief cause of AD/HD symptoms (e.g., MBD), it is now found as a causative factor in less than five percent of children diagnosed with AD/HD (Barkley, 1998). However, brain damage to the

prefrontal cortex (orbital prefrontal region) has frequently been associated with the symptoms of AD/HD (Barkley, 1998). Moreover, the evidence continues to build regarding the morphological neurological differences in the AD/HD population. This evidence typically comes from research involving neurocognitive tests and neuroimaging techniques. Studies making use of positron emission tomographic (PET), magnetic resonance imaging (MRI), quantitative electroencephalography (QEEG), and single-photon emission computed tomography (SPECT) imaging techniques have implicated the involvement of the frontal lobes, caudate nucleus and the corpus callosum in AD/HD.

The “frontal lobe hypothesis” has been used to describe children with AD/HD. This hypothesis includes the constructs of inhibitory motor deficits and attention control deficits, and describes difficulties with problem-solving, use of external feedback, generation and use of strategies, integration of prior learning, and the regulation and modulation of motivational and emotional states (Boliek & Obrzut, 1997; Mattes, 1980; Hamlett, Pellegrini, & Conners, 1987). The performances of AD/HD children on neuropsychological tests used to assess frontal lobe functioning have been found to be impaired (Barkley, 1997; Barkley, 1998; Boliek & Obrzut, 1997). Boucugnani and Jones (1989) found that children with AD/HD had more difficulty on tasks requiring disinhibition, attention, response planning, organization and follow-through. Shue and Douglas (1992) found that AD/HD children had difficulty with problem solving tasks, especially with regards to formulating and testing hypothesis, integrating and using feedback to modify responses, and organizing and directing their responses. In the

same study, the authors found that on motor tasks the children with AD/HD displayed difficulty inhibiting motor responses and alternating responses quickly and accurately.

Support for frontal lobe involvement in AD/HD also comes from PET scan studies with findings of reduced whole brain glucose utilization, particularly in the right frontal area, and specifically the posterior-medial orbital areas (Zametkin et al., 1990). Moreover, Lou, Henrikson, Bruhn, Borner, & Nelson (1989) found through regional cerebral blood flow comparisons, reduced metabolic activity in the frontal lobes of children with AD/HD when compared to controls (Chabot & Serfontein, 1996). MRI has also shown atypical morphology, with right equal to left not the expected left less than right, regarding the symmetry of the frontal regions in children with AD/HD (Hynd, Semrud-Clikeman, Lorys, Novey, & Eliopulos, 1990). Quantitative analysis of EEGs (QEEG) in boys with AD/HD has revealed increased slow wave activity, predominately in the frontal regions, and increased beta activity in the temporal regions, compared to normal controls (Mann, Lubar, Zimmerman, Miller, & Meunchen, 1992). Additional studies which analyze the QEEG of children with AD/HD continue to support and elaborate the findings that children with AD/HD display deficits in cortical arousal in the frontal regions (Chabot & Serfontein, 1996; Lubar, 1995; Monastra, et al., 1999).

The caudate nuclei have extensive pathways to the frontal lobes as well as the thalamus and could be implicated as one of several underlying mechanisms for motor regulation and behavioral inhibition (Boliek & Obzut, 1997; Riccio, et al., 1993). MRI studies have shown significant hypoperfusion in the caudate-striatal region and asymmetry in the caudate nucleus (Hynd, et al., 1993; Lou, et al., 1989).

Some studies have found that as many as one third of subjects with attentional problems showed signs of interhemispheric dysfunction (Chabot & Serfontein, 1996). The corpus callosum plays a role in the transfer of information between the hemispheres and interhemispheric regulation (Boliek & Obrzut, 1997). MRI abnormalities were found in children with AD/HD (Hynd, et al., 1990). Abnormal QEEG findings also reflect disturbances in corpus callosum functioning (Chabot & Serfontein, 1996).

EEG findings continue to build and provide an important contribution to the classification and treatment of AD/HD. A growing number of scientific reports have strongly supported and shown evidence of EEG abnormality as a possible marker for AD/HD (Sterman, 2000). Chabot & Serfontein (1996) report that the disorder actually includes several different neurophysiological subtypes. The authors state that their findings are not “subtle” and the “deviant patterns literally jump out of the EEG studies” in children with attentional and behavioral problems. In their study, the authors found two to three distinct subtypes of AD/HD. The first subtype included frontal lobe theta/alpha excess with increased alpha mean frequency. A variant of this type included excess beta activity. The second subtype of children had theta/alpha excess accompanied by decreased alpha mean frequency, which occurred across all cortical regions, but more often in the frontal regions.

Based on the growing EEG literature focused on AD/HD, and on the researchers own observations, Sterman (2000) has recently identified three basic and sometimes overlapping patterns of QEEG abnormality in children diagnosed behaviorally as having ADD. Sterman described each subtype, in general they are: first, non-localized slowing

of EEG rhythms in all states of attention; second, abnormal prefrontal and frontal slow activity; and third, increased central and parietal alpha activity. The expanding research base on QEEG has also led to specific assessment and treatment protocols for AD/HD (Lubar, 1995; Lubar & Lubar, 1999; Nash, 2000; Othmer, Othmer, & Kaiser, 1999;)

SPECT Scan Results for Subtypes of AD/HD

In addition to other neurological and neuropsychological techniques, brain SPECT imaging has been researched for the evaluation and treatment of AD/HD (Amen, 1993; Amen, 1994; Amen, 1997; Amen & Carmichael, 1997; & Amen, et al., 1997). Amen (1994 & 1997) stated that the impetus for his research on brain SPECT imaging and AD/HD was two fold. First, Zametkin, et al.'s (1990) study with PET which showed that subjects with AD/HD had decreased brain activity in their frontal lobes in response to an intellectual challenge, rather than the expected increase in activity that was seen in normal controls. Second, Lubar's (1995 & 1999) studies with QEEG which found that when the subject's with AD/HD performed a concentration task, such as reading or copying figures, there was an increase in slow wave activity in the frontal lobe activity rather than the expected decrease in frontal lobe slow wave activity that is found in normal controls. Both of these findings were consistent with frontal lobe deactivation in response to an intellectual challenge, in persons with AD/HD.

Amen's research investigating AD/HD and prefrontal lobe deactivation made use of brain SPECT imaging. Brain SPECT imaging is a nuclear medicine study, utilizing minute doses of radioactive isotopes bound to neurospecific pharmaceuticals to study cerebral perfusion and thus to indirectly study brain metabolic activity (Amen, Yantis,

Trudeau, Stubblefield & Halverstadt, 1997). Amen, et al., (1997) reported that the use of SPECT imaging has the potential to be more clinically useful and provides several advantages over both PET studies and computerized EEG. First, opposed to the EEG, SPECT gives a three-dimensional picture of the cortex of the brain as well as the deeper structures of the brain, whereas EEG depends solely on scalp readings. Second, PET, which is direct measure of metabolic activity, would seem the most sensitive study of cerebral metabolism. However, with the cost approximately twice that of a SPECT study, the limited availability of the PET equipment (SPECT equipment is found in most community hospitals), and the requirement for an intra-arterial line (as opposed to an intravenous line for SPECT), Amen feels that the research may be the most feasible with SPECT studies.

A preliminary study on AD/HD and brain SPECT imaging supported findings of other researchers who found decreased frontal activity in response to an intellectual challenge in children and adolescents diagnosed with AD/HD (Amen & Carmichael, 1997). This study involved 54 children who met the DSM-III-R criteria for ADD/AD/HD and who were compared with 18 controls. This study stemmed from work with more than 750 SPECT studies on neurological and psychiatric patients in Solano County, California (Amen, 1994). Examination of SPECT images from the subjects at rest and while performing an intellectual challenge found that 67% of the AD/HD children had significant prefrontal cortex hypoperfusion in response to an intellectual challenge. These individuals displayed a significant decrease in relative blood flow, as measured by SPECT, to the prefrontal cortex when required to perform a standardized continuous performance task, the Conners CPT. This is compared to only 5% of the controls. The

authors found that of the 19 (34%) AD/HD children who did not suppress their prefrontal lobe activity, 12 (63%) displayed decreased prefrontal lobe activity at rest, predominantly on the left side. The authors also found a group of AD/HD that children displayed a higher percentage of left temporal lobe activity both at rest and with an intellectual challenge.

The research of Amen & Carmichael (1997) did support the QEEG and PET findings that showed decreased frontal activity in children with AD/HD. However, further investigations and reports by Amen (1997 & 1998) do not appear to support only three subtypes of AD/HD as delineated in the DSM-IV. Instead, Amen's research with brain SPECT imaging and AD/HD have identified six different patterns, or subtypes of AD/HD, which he and his colleagues have used to direct medication and behavioral management of the presenting symptoms. The following subtypes of AD/HD have been described and identified (Amen, 1997; & Amen, 1998):

1. Classic ADD: These individuals show markedly decreased frontal lobe activity upon challenge when compared to a resting baseline. Their baseline SPECT scans appear normal when at rest, but with an intellectual challenge there is marked decrease in frontal lobe activity. This is the more classic AD/HD type individual who often responds well to the psychostimulants alone. These individuals tend to present with the classic symptomology of AD/HD: inattention, distractibility, and restlessness. See Appendix B for a complete list of symptoms related to this subtype.

2. Inattentive ADD: These individuals have widespread cortical deactivation and with an intellectual challenge they show even further decreased activity in the prefrontal cortex. These individuals tend to respond to psychostimulants such as, Ritalin

(methylphenidate), Adderall, Dexedrine (dextroamphetamine sulfate), Desoxyn (methamphetamine hydrochloride), & Cylert (pemoline), often in combination with stimulating antidepressants, such as Wellbutrin (buproprion) and Tofranil (imipramine). These individuals tend to present with a short attention span, distractibility, disorganization, and are often sluggish with low motivation. See Appendix B for a complete list of symptoms related to this subtype.

3. Overfocused ADD: These individuals display increased activity in the anterior medial aspects of the frontal lobes at rest and with intellectual challenge. In addition to the increased activity seen in the cingulate gyrus area (in front of the septal region), these individuals also display a significant frontal lobe drop-off with an intellectual challenge. This pattern is often made worse by stimulant medication. The problem is not inattention, but over-attention. Therefore, Effexor (venlafaxine) is the first choice for medication management of the presenting symptoms. Moreover, these individuals tend to respond best to medications that increase the serotonin in the brain (serotonergics). These medications include Prozac (fluoxetine), Paxil (paroxetine), Zoloft (sertraline), Celexa and Luvox (fluvoxamine). Often, these work best in combination with psychostimulants. This pattern is associated with overfocusing to the point of being unable to complete a variety of tasks. This subtype of individuals experience a type of attention deficit which includes an inability to shift attention and an excessive overattending to often irrelevant details. See Appendix B for a complete list of the symptoms related to this subtype.

4. Temporal Lobe ADD: This subtype is represented by temporal lobe dysfunction. These individuals display left temporal lobe dysfunction at rest with normal

prefrontal activity. However, with an intellectual challenge they display continued decrease of left temporal lobe activity and a decrease in the prefrontal lobe activity. These individuals will often have temporal lobe dysrhythmias or epileptiform activity, and experience an attention deficit disorder that seems to respond best to anticonvulsants, sometimes combined with psychostimulants after stabilization of the presenting symptomology. These individuals tend to present as inattentive with emotional instability, memory problems, and periodic anxiety. See Appendix B for a complete list of symptoms corresponding to this subtype.

5. Limbic ADD: This pattern is characterized on SPECT scan with hypofrontality at rest, but normal frontal activity with the challenge of intellectual stress. They often respond well to stimulating anti-depressants, such as Wellbutrin (buprion), Tofranil (imipramine), Norpramin (desipramine), and Effexor (venlafaxine, only if Type III also), and also may need psychostimulants. These individuals tend to be inattentive, but are also sad, moody and irritable. See Appendix B for a complete list of the symptoms related to this subtype.

6. Ring of Fire ADD: This pattern is characterized on a SPECT scan as disruption in the lateral prefrontal cortex, parietal lobes, temporal lobes and the cingulate gyrus. They often respond to the anticonvulsants, as well as the newer antipsychotic medications, such as, Risperdal (risperidone) and Zyprexa. These individuals often present as hypersensitive to light, sound, taste or touch, and are moody, easily distracted and hyperactive. See Appendix B for a complete list of symptoms corresponding to this subtype.

Amen (1998) has developed a list of the criteria of corresponding symptomology for the six subtype's (Appendix B) to assist clinicians in the diagnostic and treatment issues surrounding AD/HD.

Utility of Amen's Subtype Research

Amen (1994) reported that the SPECT imaging research findings could lead to a better understanding of AD/HD. Of course, more systematic clinical research is needed to validate these findings. Nonetheless, Amen reports that brain SPECT studies have the potential to help clinicians more quickly evaluate patients who are not responsive to traditional treatments, rather than going through months or even years of medication trials.

Barkley (1998) reports that until recently, AD/HD has lacked a reasonably credible scientific theory to explain its basic nature and associated symptoms and to link it with normal developmental processes. In the past, treatments were tried primarily because they worked with other disorders (e.g., behavior modification with the mentally retarded) or were discovered to have beneficial effects primarily by accident (e.g., stimulant medication). Treatment decisions for children with AD/HD had not been guided as much by scientific theory as by pragmatics; whatever seemed to work was retained, and whatever did not was discarded, with little guidance from any sound theoretical rationale. However, that statement is now dated as there is presently a growing body of literature based on the neurophysiological aspects of AD/HD from EEG, MRI and SPECT studies in conjunction with neurocognitive and behavioral data which provide evidence for a “sound theoretical rationale” for assessment and treatment

of AD/HD. Amen's research of SPECT imaging and the resulting conceptualization of the six subtypes of AD/HD can serve as a basis for clinicians to continue solve the problems of diagnostic and treatment difficulties.

Barkley (1998) reports that at present the neuropsychological, neuroimaging, and genetic studies described are beginning to set clear limits not only on theories about the origins of AD/HD but on theories of its nature as well. Any credible theory on the nature of AD/HD must now posit psychophysiological constructs that are related to the normal development of inhibition, self-regulation and executive functioning -- and must explain how these go awry in AD/HD. And such a theory of AD/HD will need to argue that these constructs arise from the functions of the prefrontal-striatal brain regions and its interconnections with other brain regions that appear to subserve the executive functions and self-control. The studies with SPECT, PET, MRI and EEG have suggested that AD/HD may result from abnormality in the frontal/cortical, striatal and thalamic circuits and the interconnections both within and across hemispheres. Amen's research and conceptualization of subtypes of AD/HD continues to add to the information which can begin to satisfy the criteria for defining AD/HD set forth by Barkley and others.

Summary and Hypotheses

Attention Deficit-Hyperactivity Disorder (AD/HD) is one of the most extensively studied psychiatric disorders (Barkley, 1991). Over the past century, a number of diagnostic labels have been given to clinically referred children having significant deficiencies in behavioral inhibition, sustained attention, resistance to distraction, and

the regulation of activity level (Barkley, 1998). Attention Deficit-Hyperactivity Disorder is the current valid term used by the American Psychiatric Association (1994) to describe this cluster of behaviors. Barkley (1998) indicated that the relabeling of AD/HD every decade or so reflects a shifting emphasis on the primary symptom focus, based in part on the tremendous amount of research conducted each year on AD/HD.

Barkley (1998) has set forth the necessary criteria for the psychophysiological constructs that are related to AD/HD. He states that such a theory of AD/HD will need to argue that these constructs arise from the functions of the prefrontal-striatal brain regions and its interconnections with other brain regions that appear to subserve the executive functions and self-control. With his research in SPECT imaging and AD/HD, Amen has begun to formulate such a conceptualization. He has proposed six subtypes of AD/HD which correspond to specific SPECT findings and behavioral symptomology. Based on patterns of brain metabolic activity as measured by SPECT imaging, Amen (1998) has proposed the following subtypes of AD/HD: Classic ADD, Inattentive ADD, Overfocused ADD, Temporal Lobe ADD, Limbic ADD and Ring of Fire ADD.

Amen (1994) reported that the use of SPECT imaging in AD/HD is more clinically useful, since it provides more in depth information than cortical readings of EEG and is more economical than PET imaging. Although SPECT scans may have more utility for physicians, the feasibility for psychologists, school counselors, educators, etc. is questionable. Most professionals who work with children with attentional problems most likely do not have access to SPECT imaging techniques. It has been shown that behavior ratings of AD/HD offer many advantages in the assessment process (Shelton & Barkley, 1994). Psychometric approaches involving paper-and-pencil checklists have

shown to be valid, economical and efficient methods of assessing childhood disorders (Ostrander, et al., 1998). Numerous studies have demonstrated the reliability and validity of the CBCL in both clinical and non-clinical populations (Biederman, et al., 1993).

A significant contribution could be made to the continuing evolution of the diagnosis and clinical treatment of AD/HD by demonstrating that a single structured behavioral assessment tool such as the CBCL can reliably identify and differentiate the six subtypes of AD/HD theorized by Amen. With this in mind, the purpose of the present study is to investigate Amen's formulations of identifiable subtypes of AD/HD and to test his theory and hypothesis of AD/HD. It is hypothesized that Amen's six AD/HD subtypes can be identified and differentiated through the use of behavioral checklist data.

METHOD

Subjects

Subjects included an initial sample of 180 children referred to a Dallas, Texas, private practice group comprised of child and pediatric clinical psychologists and clinical neuropsychologists. All children were referred for a previous comprehensive AD/HD evaluation and data was obtained through retrospective chart reviews. All subjects included in this research protocol were randomly selected and were previously administered a comprehensive assessment battery for AD/HD. Nineteen subjects were excluded from the analysis due to missing data from the respective chart reviews and criterion restrictions.

Subjects included in the analysis (N=161) met the APA (1994) criteria for the major symptoms observed in AD/HD and had a diagnosis of either: AD/HD, Combined Type (n=116, 72%); AD/HD, Predominately Inattentive Type (n=31, 19%); AD/HD, Predominately Hyperactive-Impulsive Type (n=8, 5%); or AD/HD, Undifferentiated Type (n=6, 4%). The diagnosis was made by their clinician based on the previous assessment data. The symptoms of AD/HD correspond to three different dimensions: Inattention, Hyperactivity and Impulsivity (American Psychiatric Association, 1994). These three dimensions are referred to as Criteria A for AD/HD. A diagnosis of AD/HD requires the individual display six (or more) of the symptoms of inattention and/or hyperactivity-impulsivity which have persisted for at least six months to a degree that is maladaptive and inconsistent with developmental level. The diagnosis of AD/HD also requires that four additional criteria (B, C, D, and E) be met. Refer to Appendix A for the

list of diagnostic criteria as reported in the DSM-IV (American Psychiatric Association, 1994).

It is difficult to establish the diagnosis of AD/HD in children younger than 4 years (American Psychiatric Association, 1994). Therefore, the subject pool included only school-age children between the ages of 5 and 12 years. Of the 161 subjects, 14 were five-years-old (8.7%), 27 were six-years-old (16.8%), 48 were seven-years-old (29.8%), 37 were eight-years-old (23%), 14 were nine-years-old (8.7%), 11 were ten-years-old (6.8%), 4 were eleven-years-old (2.5%), and 6 were twelve-years-old (3.7%).

There were 131 male (81%) and 30 female (19%) subjects included in the study. The study was limited to English speaking persons because of test norm availability and to prevent possible confounding effects of language. Of the subjects reporting their race (n=160), 152 (95%) were of Caucasian heritage, five were Hispanic (3.1%), two were of African-American Heritage (1.3%), and one was of Asian heritage (0.6%)

Typically, research protocols may exclude children with a history of head injury to eliminate confounding factors. However, the present study included children with a history of head injury, as this is a symptom included in Amen's (1998) criteria for Subtype V: Temporal Lobe ADD. Moreover, those children with a history of head injury had a comorbid diagnosis of AD/HD only.

Eight subjects (5%) reported concurrent treatment with psychostimulants (Methylphenidate hydrochloride “Ritalin”, n=4; Amphetamine, “Adderall”, n=2; and Dextroamphetamine sulfate “Dexedrine”, n=2), but were medication free ten days prior to, and at the time of their assessment. Nine subjects (5.6%) also reported a previous diagnosis of asthma and the concomitant use of medication management of the

presenting symptoms of the medical disorder (Albuterol sulfate “Ventolin”, n=5; Montelukast sodium “Singulair”, n=1; and Fluticasone “Flovent”, n=1). Thirty-four subjects also reported a previous diagnosis of non-specific allergies (21%) with five of those individuals using medications (Loratadine “Claritin”, n=4 and Mometasone furoate monohydrate “Nasonex”, n=1) to treat their allergies.

Of the 161 subjects included in the analysis, 153 reported the parental status. Married parental status comprised the majority of the sample (75%, n=115), thirty-five (23%) reported divorced parental status, and three (2%) reported widowed parental status. Of the subjects reporting Father’s occupation (n=131), the majority reported professional occupations (82%, n=108), twenty reported technical occupations (15%), two reported stay-at-home (1%), and one other reported a retired status of employment. Of the subjects reporting the Mother’s occupation (n=139), seventy reported professional occupations (50%), sixteen reported technical occupations (12%), fifty-one reported stay-at-home (37%), and one other reported a retired status and one a student status.

Intelligence testing was reported in 51 of the subjects. The average Full Scale IQ for those reported was 108, with average verbal IQ and performance IQ scores reported (n=44) of 108 and 106, respectively.

Materials

Personal Information

Personal information was obtained from the clinician's comprehensive psychological report. The report was used gather the following information: age, grade,

DSM-IV diagnosis, medical history and medication usage, history of head injury, family history of violence or explosiveness (also a diagnostic symptom for Temporal Lobe ADD), parental status and occupation and previous IQ testing.

Child Behavior Checklist

The Child Behavior Checklist (CBCL; Achenbach, 1991) is a well-standardized assessment of child behavior problems. The CBCL was used to assess and rank the specific symptoms that correspond to the six subtypes postulated by Amen (1997 & 1998). The CBCL is a behavioral checklist for children from four to eighteen years of age. Items and scale construction were determined empirically using principal components analysis. Items were permitted to contribute to more than one scale. The scales were originally constructed from analysis of parent ratings of 2,300 clinically referred children, and normed on 1,300 non-referred children.

The parent version, behavioral problems portion of the CBCL is comprised of 113 items that are rated by the parent following a Likert-type format, each scored on a 0-to-2-point scale. Parents are asked to rate their child's behavior for each item that describes the child within the past six months. A response of 0 indicates not true, 1 indicates somewhat or sometimes true, and 2 indicates very true or often true. The instrument yields normalized T-scores for all scales and subscales. The CBCL has two broadband scales (Externalizing and Internalizing Problems) and eight narrow band subscales. The Externalizing Problems scale is comprised of the Aggressive Behaviors subscale and the Delinquent Behaviors subscale. The Internalizing Problems scale is comprised of the Anxious/Depressed, Somatic Complaints, and the Withdrawn

subscales. Additional subscales that comprise the CBCL Profile include the Social Problems, Thought Problems and Attention Problems subscales. The subject's full profile of all the subscales was used in the post-hoc individual analysis following the initial cluster analysis.

The CBCL has shown good internal consistency and 15-day test-retest reliability (Achenbach, 1991). The mean test-retest reliability of all problem scales is .89 (Pearson r; p<.01). All correlation's are in the .80's and .90's except the Withdrawn scale for boys (r=.75) and the Thought Problems scale for girls (r=.63). Interparent correlation's are reported to range from .70's to .80's, except on the scales which comprise the relatively uncommon items, Somatic Complaints (r=.52), Thought Problems (.48) and Sex Problems (.52). Long term stability correlation's across all problem scales are reportedly large. The mean correlation's ranged from .71 to .74.

The CBCL has also shown good concurrent and discriminative validity (Achenbach, 1991). Analysis of covariance has shown the ability of nearly all the CBCL items to discriminate significantly between demographically matched referred and nonreferred children. The difference between the referred and nonreferred children accounted for 29% of the variance in the Total Problems score. These differences were consistent across all groups, as there were no significant effects of sex, age, interactions or ethnicity on the Total Problems score. Construct validity is supported by numerous correlates of CBCL scales including significant associations with analogous scales on the Conners Parent Questionnaire and the Quay-Peterson Revised Behavior Problem Checklist.

Disruptive Behavior Rating Scale-Parent Form

The Disruptive Behavior Rating Scale - Parent Form (DBRS) is a checklist questionnaire formulated by Barkley and Murphy (1998) which contains the symptoms for AD/HD, Oppositional Defiant and Conduct disorder as they appear in the DSM-IV. This checklist was used to assess and rank specific symptoms that correspond to the five subtypes theorized by Amen (1997 & 1998). The parent version, AD/HD Rating Scale-IV of the DBRS is comprised of 18 items that are rated by the parent following a Likert-type format. See Appendix C for a list of the 18 items. The parent is asked to rank each item that best describes the behavior of the child during the past six months. Each item is scored on a 0-to-3-point scale. A score of 0 indicates never or rarely, 1 indicates sometimes, 2 indicates often and 3 indicates very often. The AD/HD Rating Scale-IV of the DBRS is directly adapted from the AD/HD symptom checklist as specified in the DSM-IV. Odd numbered items are from the Inattention symptoms list for AD/HD and even-numbered items are from the Hyperactive-Impulsive symptoms list.

The AD/HD Rating Scale-IV of the DBRS was originally factor analyzed on parent ratings of 4,860 children from various school districts across the United States, and normed on a sample of 2,000 children randomly selected from the first sample (DuPaul, et al., 1998). Factor-analysis has demonstrated the scale confirms the two dimensional theoretical structure of AD/HD as described in the DSM-IV (DuPaul, et al., 1998; Power, et al., 1998; DuPaul, et al., 1997). Parent and teacher ratings were found to be internally consistent, to be stable over a 4-week period, and to correlate significantly with subscales of the Conners Parent and Teacher Rating Scales. The scales demonstrated

predictive validity as well (Power, et al., 1998). The AD/HD Rating Scales-IV of the DBRS has shown the ability to differentiate the AD/HD-Combined and Inattentive subtypes from each other and controls. However, the study reported that the sample of AD/HD-Hyperactive/Impulsive was too small to be used in the logistic regression analysis used to demonstrate the predictive validity.

Amen ADD Subtype Checklist

Amen (1998) has developed a list of symptomology of the six AD/HD subtypes. He has further developed a symptom checklist for Subtypes I – VI for clinicians to employ for diagnostic and therapeutic purposes. There are currently no published norms available for Amen's checklist. This checklist was used to determine the frequency of symptoms related to each subtype for each subject. The checklist is comprised of 58 symptoms that correspond to the various subtypes. The Classic ADD subtype is comprised of symptoms relating to both Hyperactivity/Impulsivity and Inattentiveness. The sixth subtype, Ring of Fire ADD, is not included in the symptom checklist. However, Amen (1998) has presented a list of symptoms that correspond to the subtype.

Procedure

Phase I

The first step of the procedure involved relating Amen's Subtype Checklist to standardized checklist items. Specific items from the CBCL and the DBRS were identified and matched to each symptom on the Amen Subtype Checklist and the Ring

of Fire ADD symptomology. This was based on a consensus agreement from three clinical psychologists. Therefore, each item from the Amen Subtype Checklist was assessed and a consensus agreement was reached for each item determined to correspond clinically to items from the CBCL or DBRS. See Appendix D for the list of Amen subtype (I-VI) questions and the corresponding CBCL and DBRS matched items.

Phase II

The next step involved transferring checklist scores. Each subject was given a ranking score for each Amen Subtype Checklist item that corresponded to CBCL and DBRS items. A score of 0 indicated that the item does not apply to the subject, 1 indicated the item sometimes applies and 2 indicated the item often or very often applies to the subject. The scoring for the Amen Subtype Checklist items was determined by the parental responses to the questions from the CBCL and DBRS.

Scores from the corresponding CBCL items were ranked exactly as they were scored by the parent on the CBCL (0, 1 and 2). Items from the DBRS were scored as follows: a score of 0 and 1 was ranked as 0 and 1, respectively; a score of 2 (often) and 3 (very often) was ranked as 2 for the subtype symptoms. One item from the subtype symptom checklist (history of head injury or family history of violence or explosiveness) was gathered from the subjects' personal information and ranked as a 2 if it was true.

Phase III

The next step provided a ranking for each Amen Subtype. Item ranking for each subtype was then totaled and the subject was given a percentage score for each

presumptive subtype symptom profile. Therefore, each subject had six symptom percentage scores that corresponded to the Amen conceptualization of AD/HD subtypes symptomology. These six symptom percentages were comprised of symptoms relating to Amen's conceptualization and included "Hyperactive/Impulsive" symptoms, "Inattentive" symptoms, "Overfocused" symptoms, "Limbic" symptoms, "Temporal Lobe" symptoms and "Ring of Fire" symptoms.

Clustering of Subjects

Data Analysis

K-means cluster analysis was performed with STATISTICA - Version 6 to investigate Amen's formulations of identifiable subtypes of AD/HD. K-means clustering was performed making use of the Euclidean distance of each subject's percentage score for each "subtype" symptomology. The cluster analysis solution was set for identification of six clusters based upon the conceptualization of the six subtypes posited by Amen. Maximum number of iterations was set at ten to ensure that all iterations possible are performed as each iteration moved the subjects into different clusters. Therefore, initial cluster centers were set to choose observations to maximize between cluster distances. This directed the cluster analysis to cluster subjects according to their greatest possible distinction.

Casewise deletion of missing data was employed which resulted in a final cluster sample of N=160. A split-half method was employed with the first half of the sample (n=80) used for clustering and the second half (n=80) used for comparison and additional classification purposes.

Results

Sample 1.

The first sample was analyzed and the clusters found did not result in six acceptable clusters, as there was a single-member cluster. This was determined to be an outlier and this case was deleted and the analysis was run again. This resulted in a final cluster sample of N=159, with the first sample (n=79) used for the cluster analysis and the second sample (n=80) clustered for comparative purposes.

The cluster analysis then resulted in six different acceptable clusters after five iterations. The cluster means and standard deviations for each "subtype" symptom percentage scores are presented in Table 1. A graphic representation of the plot of means for the first sample is presented in Figure 1.

Although significance testing is not a part of cluster analysis, the Analysis of Variance (ANOVA) results, which compared the means of each percentage score between the groups (clusters), does provide information regarding the importance of each percentage score for assigning cases into clusters. Based upon the magnitude of the F-values (5, 73) and the levels of significance (ps<.05), the percentage scores of "Hyperactive/Impulsive" Symptoms (F=38.71), "Overfocused" Symptoms (F=34.97), "Ring of Fire" Symptoms (F=32.91), and "Limbic" Symptoms (F=31.05), all appear to be major criteria for assigning cases into clusters. The "Temporal Lobe" Symptoms (F=23.80) and "Inattentive" Symptoms (F=20.73) are important as well but not as highly significant.

Review of the means and graphs of the cluster analysis of the first sample revealed clear patterns within each cluster. Cluster 1 showed very high mean scores, greater than one standard deviation above the group mean only on the “Inattentive” symptomology, with low mean scores on the rest of the symptom scales. Cluster 2 showed the highest mean scores on a combination of the “Hyperactive/Impulsive” symptomology and “Inattentive” symptomology, both greater than one standard deviation above the cluster group mean score. This was seen in combination with high scores, greater than the mean cluster score, on the “Overfocused” and the “Ring of Fire” symptomology as well. Cluster 3 showed high mean scores, greater than one standard deviation above the mean for the cluster group on both the “Hyperactive/Impulsive” symptomology and the “Inattentive” symptomology. Cluster 4 showed mean scores greater than one standard deviation above the cluster mean on the “Hyperactive/Impulsive” symptomology only. Cluster 5 showed high mean scores on the “Hyperactive/Impulsive” symptomology, greater than one standard deviation above the group mean, in combination with high scores, greater than the mean on the “Inattentive” and “Overfocused” symptomology. Cluster 6 showed very low scores on all the scale symptoms and reflected endorsement of less than approximately 30% of the symptomology across the scales.

Based upon the combination and the pattern of scores revealed in the presentation of symptomology, the cluster analysis of the first sample revealed six different groups labeled according to their respective symptom endorsement. The clusters were then labeled as: AD/HD – Combined Type (cluster 3); AD/HD – Predominately Inattentive Type (cluster 1); AD/HD – Predominately Hyperactive-

Impulsive Type (cluster 4); AD/HD - Combined Type, with Obsessive/Compulsive features (Amen's Overfocused classification) (cluster 5); AD/HD – Combined Type, with Obsessive/Compulsive and Conduct Disorder (Amen's Ring of Fire classification) features (cluster 2) and Undifferentiated AD/HD (cluster 6).

Sample 2.

The second sample cluster analysis resulted in six different acceptable clusters after only three iterations. The cluster means and standard deviations for each subtype percentage score are presented in Table 2. A graphic representation of the plot of means for the second sample is presented in Figure 2. Based upon the magnitude of the F-values (5, 74), and the levels of significance (ps<.05), the percentage scores for "Hyperactive/Impulsive" Symptoms (F=85.67) appeared to be the highest criteria for assigning cases into this second sample of clusters. The "Limbic" Symptoms (F=34.23), "Overfocused" Symptoms (F=30.78), "Ring of Fire" Symptoms (F=29.66), "Inattentive" Symptoms (F=24.48) and "Temporal Lobe" Symptoms (F=21.20) appeared to be important as well and are listed in relation to the magnitude of importance for clustering the second sample.

Review of the means and graphs of the cluster analysis of the second sample revealed clear patterns within each cluster. Cluster 1 reflected high scores greater than one standard deviation above the group mean on the "Hyperactive/Impulsive" and "Inattentive" symptomology in combination with high mean scores on the "Overfocused" symptomology. Cluster 2 reflected low scores on every scale with endorsement of less than 25% of symptoms on the six scales. Cluster 3 showed high scores, greater than

one standard deviation above the mean score, on the “Hyperactive/Impulsive” and “Inattentive” symptomology. Cluster 4 showed high scores, greater than one standard deviation above the mean group score on the “Hyperactive/Impulsive” symptomology only. Cluster 5 showed high scores, greater than one standard deviation above the mean score on the “Inattentive” symptomology only. Cluster 6 showed scores greater than one standard deviation above the mean on the “Hyperactive/Impulsive” symptomology, with elevated scores higher than the mean on the “Inattentive”, “Overfocused” and “Ring of Fire” symptomology.

Custer analysis of the second sample was very similar to the first sample with regard to the pattern of scores within each cluster. The second sample was then labeled according to the observations made in the first sample cluster analysis. The second sample revealed: AD/HD – Combined Type (cluster 3); AD/HD – Predominately Inattentive Type (cluster 5); AD/HD – Predominately Hyperactive-Impulsive Type (cluster 4); AD/HD - Combined Type, with Obsessive/Compulsive features (cluster 1); AD/HD – Combined Type, with Obsessive/Compulsive and Conduct Disorder features (cluster 6) and Undifferentiated AD/HD (cluster 2).

However, it is important to note that results of sample 2 did not entirely match the clusters found in the analysis of sample 1, as cluster 3 in the second sample was also high and above one standard deviation on the scale of “Limbic” symptomology. However, the distinction of cluster 3 as AD/HD - Combined Type still seemed tenable based upon high “Inattentive” and “Hyperactive/Impulsive” symptomology. Moreover, there were only four subjects in the cluster 3 group of this second sample. Therefore, the higher “Limbic” symptom scores may be a reflection of the small cluster size. These

subjects were not removed from the analysis as they did not appear to reflect outliers. The significance of the higher scores on the second cluster sample will be assessed through further analysis. More specifically, the discriminant function analysis will provide information as to whether the higher scores on "Limbic" symptomology represent an entirely different cluster, as the cluster of AD/HD - Combined type should yield a lower percentage of correct classifications, if the four subjects in the second sample Cluster 3 group truly do not belong in the sample.

Each case (subject) was then identified, classified and labeled according to the cluster group in which they were placed. The cases (N=159) were each identified as either:

1) AD/HD – Combined Type (n=16),
2) AD/HD – Predominately Inattentive Type (n=24),
3) AD/HD – Predominately Hyperactive-Impulsive Type (n=42),
4) AD/HD – Combined Type with Obsessive/Compulsive features (n=32),
5) AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features (n=25),
6) Undifferentiated AD/HD (n=20).

Validation of Cluster Subtypes

Data Analysis

The sample was then analyzed via Discriminant Function Analysis (DFA) to determine the validity of the Cluster Analysis. The DFA classifies cases into groups and was used to determine if the subjects' six percentage scores (IV's) predict group

membership for the specific subtype (DV's). The present analysis was interested in correct predictive classification, therefore, a 60/40 split of the cases was performed and the first sample (n=95) was used to build the classification functions and the second sample, the "hold-out" sample (n=64), was used to cross-validate the classification functions.

DFA was run with a forward stepwise method of entry. This method of entry was chosen to maximize the order of entrance of the variables that show the most significant contribution to the discrimination at each step. F to enter was set at 1.00 and F to remove was set at 0.00 so as to enter all variables in a forward stepwise analysis. Tolerance was set at 0.01 to ensure that if variables in the model are more than 99% redundant with the other variables they were not included, as said variables' practical contribution to the improvement of the discriminatory power would be doubtful.

Analysis of the Classification Functions was also performed and since each of the subtype group sample sizes was unequal, a priori probabilities were set at cluster group 1 = .101, cluster group 2 = .151, cluster group 3 = .264, cluster group 4 = .201, cluster group 5 = .157 and cluster group 6 = .126 to control for the effect of sample size on the classification process. The a priori possibilities reflected the sample size of each group found via Cluster Analysis and the likelihood that the percentage of overall cases belonged to that group. The classification function of the second sample, the "hold-out" sample, was used for cross-validation.

Results

All variables were included in the model and the overall discrimination between subtypes was highly significant (Λ = .03016; F (30, 338) = 15.768, p<.0001). Thus, this

analysis could conclude that the six percentage scores are the major variables used to discriminate between specific subtypes identified within the Cluster Analysis. The summary of the DFA is presented in Table 3.

The “Hyperactive/Impulsive” percentage scores entered the model at step 1, Λ = .070, $\underline{F}$ (5,84) = 22.28, $\underline{p}$ < .0001. The “Inattentive” percentage scores entered the model at step 2, Λ = .069, $\underline{F}$ (5,84) = 21.91, $\underline{p}$ < .0001. Therefore, these scores contributed the most, and fairly equally, to the overall discrimination. The “Temporal Lobe” percentage scores entered the model at the last step, Λ = .035, $\underline{F}$ (5,84) = 2.94, $\underline{p}$ = .017, and although a significant discriminator, was the least powerful discriminator in the model.

A Canonical Analysis was performed to compute the actual discriminant functions and to determine how the six percentage scores discriminate between the different specific subtypes identified within the Cluster Analysis. Four discriminant (or canonical) functions were statistically significant. A summary of the Chi-Squared tests with each discriminant function (successive roots removed) is presented in Table 4.

The first discriminant function was weighted most heavily on the “Inattentive” percentage scores (ꝏ = .448), “Limbic” percentage scores (ꝏ = .374) and “Hyperactive/Impulsive” percentage scores (ꝏ = .371). But, the other three subtype scores also contributed to this function (“Temporal Lobe”, ꝏ = .273; “Ring of Fire”, ꝏ = .224 and “Overfocused”, ꝏ = .156). Moreover, analysis of the factor structure matrix, which showed the correlation variables of the connonical roots, revealed that all six percentage scores are fairly equally positively correlated (the correlations ranged from .593 to .487) with the first discriminant function. Examination of the canonical variable

means revealed that the first discriminant function did, however, discriminate primarily the AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features (M = 3.99). Thus, the higher the scores on the six subtype percentage scores the more likely it is that the subtype was AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features.

The second discriminant function was weighted most heavily on the "Hyperactive/Impulsive" percentage scores (ᘐ = .837) and was positively correlated (r = .732) with this function. The "Inattentive" percentage scores were negatively correlated with this function (r = -.464). This function discriminated primarily the AD/HD – Predominately Hyperactive/Impulsive Type (M = 1.678). Thus, the higher the Hyperactive/Impulsive percentage scores and the lower the Inattentive scores, the more likely it is that the subtype was AD/HD – Predominately Hyperactive/Impulsive Type.

The third discriminant function was weighted most heavily on "Inattentive" percentage scores (ᘐ = .636), then with the "Hyperactive/Impulsive" percentage scores (ᘐ = .412), and was positively correlated with these scores (r = .620 & .346, respectively). This function was negatively correlated with the "Limbic" scores (r = -.512), "Ring of Fire" scores (r = -.408), and the "Temporal Lobe" scores (r = -.330). This function discriminated primarily the AD/HD –Combined Type (M = 1.169). Thus, the higher the "Inattentive" and "Hyperactive/Impulsive" scores and the lower the "Limbic", "Ring of Fire" and "Temporal Lobe" scores, the more likely that the subtype was AD/HD – Combined Type.

The fourth discriminant function was weighted most heavily on the "Overfocused" percentage scores (ᘐ=1.133) and positively correlated with this function (r = .798). This

function discriminates primarily the AD/HD – Combined Type with Obsessive/Compulsive features (M = .564). Thus, the higher the "Overfocused" scores, the more likely that the subtype was AD/HD – Combined Type with Obsessive/Compulsive features.

Analysis of Classification Matrix revealed that approximately 86% of all cases were correctly classified. The classification of cases into the AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features and Undifferentiated AD/HD were the most accurate with 100% of cases correctly classified. The AD/HD – Predominately Inattentive group showed 89% of cases correctly classified, while the AD/HD – Predominately Hyperactive/Impulsive group showed 87% of cases correctly classified. The lowest percentage of correctly classified cases was seen within the AD/HD – Combined Type and the AD/HD – Combined Type with Obsessive/Compulsive features, which showed 75% and 71% correct classification of cases, respectively.

Inclusion of the "hold-out" sample decreased the overall incidence of correctly classified cases to 76%. There was no change seen in the Undifferentiated AD/HD group as the percentage of correct classification stayed at 100%. The AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features group dropped to 88% correct classification. The AD/HD – Predominately Inattentive group dropped to 83%, while the AD/HD – Predominately Hyperactive-Impulsive group dropped to 74% correctly classified. The AD/HD – Combined Type with Obsessive/Compulsive features dropped to 56% correct classification. The largest change in correctly classified cases when including the "hold-out" sample was seen within the AD/HD –Combined Type group, which dropped to 56% correct.

During the cluster analysis of the second sample, the third cluster, although classified as AD/HD – Combined Type showed high scores on the "Limbic" percentage scores as well as high "Hyperactive/Impulsive" and "Inattentive" scores. However, since there were only four subjects in that cluster and the subjects displayed high scores on the other two percentage scores aside from the "Limbic" scores, the classification was generally matched to the first sample and the cases retained for classification as AD/HD – Combined Type. However, it is interesting to note that the results of the DFA classification analysis dropped from 75% correct to 56% when the "hold-out" sample was included. Moreover, the cases which comprised the second cluster analysis sample (Case #'s 135, 148, 152 & 169) were also part of the "hold-out" sample in the DFA which was used to cross-validate the discriminant functions. Each of the four cases showed a higher prediction to belong within the AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features. However, the higher scores on the "Limbic" subtype percentage scores likely explain this preferred classification as the highest mean "Limbic" percentage scores are seen within the ADHD – Combined Type with Obsessive/Compulsive and Conduct Disorder features group ($\underline{M}$ = 37.4, $\underline{SD}$ = 10.62), although the next highest mean "Limbic" scores are seen within the AD/HD – Combined Type group ($\underline{M}$ = 30.31, $\underline{SD}$ = 22.84). Moreover, there was no significant difference between the two groups (AD/HD – Combined Type vs. AD/HD Combined Type with Obsessive/Compulsive and Conduct Disorder features) on the basis of the scores for the "Limbic" percentage scores, $\underline{t}$ (39) = -1.347, $\underline{p}$ = .186.

DISCUSSION

The present study investigated Amen's formulations of identifiable subtype of ADHD. The purpose of the study was to test Amen's theory and conceptualization of subtypes of AD/HD. It was hypothesized that Amen's six AD/HD subtypes could be identified and differentiated through the use of behavioral checklist data. In testing Amen's theory of subtypes of AD/HD, cluster analysis found and differentiated six subtypes. However, the six subtypes found were not commensurate with Amen's formulations of AD/HD subtypes. Based on each subjects' symptom presentation which revealed a pattern of percentage scores for "Hyperactive/Impulsive", "Inattentive", "Overfocused", "Limbic", "Temporal Lobe" and "Ring of Fire" symptomology, the present study was able to correctly classify 76% of subjects into their respective subtypes and all six percentage scores were found to be significant discriminators between the subtypes. The present study found the cluster and presentation of symptomology was best described as: 1) AD/HD – Combined Type; 2) AD/HD – Predominately Inattentive Type; 3) AD/HD – Predominately Hyperactive/Impulsive Type; 4) AD/HD – Combined Type with Obsessive/Compulsive features; 5) AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features; and 6) Undifferentiated AD/HD.

AD/HD Combined Type

Amen's research described a "Classic ADD" which is comprised of symptoms relating to inattention in combination with hyperactivity and impulsivity. The present study found a cluster of subjects meeting these criteria, and this subsample was labeled as AD/HD – Combined Type with approximately 56% of cases correctly classified within

this group. Subjects within this cluster showed higher mean scores related to "Hyperactive/Impulsive" and "Inattentive" symptomology. Moreover, the higher the "Inattentive" and "Hyperactive/Impulsive" scores, and the lower the "Limbic", "Ring of Fire" and "Temporal Lobe" symptomology the higher likelihood that the individual was AD/HD – Combined Type.

AD/HD – Predominately Inattentive Type

Amen also reported a subtype of "Inattentive ADD", and the present study found this subtype, labeled as AD/HD – Predominately Inattentive Type with approximately 83% of cases correctly classified. These subjects showed higher mean scores on the symptomology relating to inattention.

A sex difference within this group of AD/HD is commonly reported, with a higher proportion of females than males (Barkley, 1990, Reid, Riccio, & Kelssler, et. al., 2000). However, we did not see this within or sample, as the females were equally distributed across the Inattentive, Combined and Hyperactive/Impulsive types (n = 5, in all groups). Regardless, it is hypothesized that the nature of the type of AD/HD seen in females, is the common reason for lower rates of AD/HD overall seen in more females than in males. It is reported that females tend to be under diagnosed and go untreated (Wolraich, et. al., 1998). The inattentive type of AD/HD, comprised typically of females, is often not referred as their symptom presentation is quieter and more behaved, and related to internalizing behaviors. A higher percentage of these children are referred for academic problems rather than behavioral problems and related to lower rates of

aggression and conduct problems. This type of symptom presentation and the behavioral data, regardless of sex, was found within this subtype.

AD/HD – Predominately Hyperactive/Impulsive Type

Amen does not report a typology related to AD/HD – Predominately Hyperactive/Impulsive Type. Yet, this group was found in the present study to represent a distinct type of AD/HD. This group was seen to display higher mean scores on the symptomology of "Hyperactivity/Impulsivity". The subjects within this group were determined by a higher likelihood of higher mean scores on the "Hyperactive/Impulsive" symptoms in combination with lower mean scores on the "Inattentive" symptomology. Seventy-four percent of this group was correctly classified.

AD/HD – Combined Type with Obsessive/Compulsive features

Amen conceptualized a type of attention deficit disorder in which the individual presents with the "classic" symptoms of AD/HD in addition to symptoms of obsessive thought and compulsive behaviors, and termed it "Overfocused ADD." The present study found this subtype wherein the subjects presented with high mean scores on the "Hyperactive/Impulsive", "Inattentive" and "Overfocused" symptomology, called AD/HD - Combined Type with Obsessive/Compulsive features. Fifty-six percent of the cases were correctly classified into this group. It was also found that the higher the individual scored on the "Overfocused" symptomology, the more likely he or she is classified within this subtype.

The symptom presentation of this group is marked by the “classic” symptomology of AD/HD combined type (inattention, hyperactivity and impulsivity), in addition to symptoms of obsessive thoughts, compulsive behaviors, trouble shifting attention, opposition and argumentativeness. Amen has found within his clinical experience that these individuals tend to respond best to medications that increase the serotonin in the brain (serotonergics) and that this subtype symptomology is often made worse by stimulant medication.

There is a high incidence of Tourette’s Disorder with AD/HD, and the AD/HD often precedes the onset of Tourette’s Disorder, and the severity of tics may be exacerbated by psychostimulants. Moreover, there is a high incidence of Obsessive/Compulsive Disorder with Tourette’s Disorder (35-50%). Therefore, the distinction of the subjects grouped as AD/HD - Combined type with Obsessive/Compulsive features gives caution to psychologists and physicians with regard to treatment. Vigilance with regard to mode and type of treatment should be given to children who present with the “classic” symptomology of AD/HD who also exhibit the symptoms of obsessive thoughts and compulsive behaviors, as this group may preceed a tourettian/AD/HD syndrome.

AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features

This subtype was found to display high mean scores on the “Hyperactive/Impulsive”, “Inattentive”, “Overfocused”, and “Ring of Fire” symptomology. Amen describes a subtype called “Ring of Fire ADD” wherein the individual presents

with anger, irritability, over sensitivity, moodiness, hyper verbosity and extreme opposition in addition to the "classic" symptoms of AD/HD (inattention and hyperactivity/impulsivity). However, the present study did not see a separate indicator of the "Ring of Fire ADD" but only those symptoms in conjunction with the symptoms of Obsessive/Compulsive Disorder ("Overfocused ADD"). Amen (2001) has noted that many individuals present with symptomology on more than one subtype, and the severity of symptom presentation will indicate the appropriate route of treatment he has outlined for each subtype. However, the subsample comprising this group displayed fairly equivalent mean percentage scores for the "Overfocused" and "Ring of Fire" symptoms. This subtype showed the highest differentiation between the subtypes, and overall, the higher the score on all symptom percentage scores, the more likely the individual was classified within this group. Eighty-eight percent of individuals were found to be correctly classified within this subtype.

The presentation of AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features seem to fit the findings in the literature. Research has consistently found that the presence and severity of over-activity, which differentiates the subtypes of AD/HD outlined in the DSM-IV, has been associated with a higher incidence of anti-social or conduct behaviors (Barkley, 1990, Maedgen & Carlson, 2000, Ostrander, et. al., 1998). Barkley's (1997) behavioral inhibition theory suggests that deficits in emotional regulation represent one significant area that is impaired in children with the Combined type of AD/HD. Therefore, these children are over-reactive in their emotional displays and have poor social interactions. Children with AD/HD – Combined Type also have been shown to have difficulty "switching sets" (a symptom of the

"Overfocused ADD" symptomology) and were less appropriately able to monitor their behavior and change their emotional displays depending upon the environmental cues (Maedgen & Carlson, 2000). Overall, it is likely that although the children diagnosed with AD/HD – Combined type display higher levels of behavioral conduct and emotional difficulties in general, there is a subtype wherein the combination of behavioral conduct problems and emotional difficulties take precedence dependant upon the severity of symptom presentation. Therefore, the AD/HD – Combined Type with Obsessive/Compulsive and Conduct Disorder features group found in the present study may likely be a reflection of severe symptom presentation, as this subsample presented with the highest mean scores across the board.

Undifferentiated AD/HD

This subtype is not identified within Amen's formulations of ADD, but is comprised of a group of subjects who score low on every scale. They scored very low on these scales and did not reach clinical significance. This subtype, although termed Undifferentiated AD/HD, may be a reflection of misdiagnosis, and these individuals may not have AD/HD at all.

The present study did not find evidence of separate subtypes that corresponded to Amen's "Temporal Lobe ADD" or "Limbic ADD". Moreover, the "Temporal Lobe" symptomology was found to be the least significant discriminator of subtype.

The findings of the present study must be considered within the confines of certain limitations. The current investigation was performed using subjects referred from a primarily suburban setting. Because the use of the limited sample restricts external validity, similar procedures should be applied to a larger and more heterogeneous independent sample for replication. Additionally, although the present study found six subtypes of AD/HD, the classification was based upon Amen's conceptualization of AD/HD. His research is based upon SPEC findings and this investigation used behavioral data to classify subjects. The sole use of behavioral checklist data is a weakness in the present study. Although psychologists are not likely to have access to brain imaging techniques, future studies may wish to draw upon a broader set of measures, especially those which confer and correlate with brain imaging techniques. Better diagnostic clarification and a higher validity in prediction of AD/HD subtypes could be seen if children are classified according to quantitative assessments tools. Research in the area of QEEG has provided insight into subtyping of AD/HD. Moreover, further investigation of the subtypes of AD/HD employing behavioral data in conjunction with QEEG analysis would provide more diagnostic and clinical clarification with regard to the symptom presentation of the diagnosis of AD/HD. Also the QEEG data could be substantiated if used in conjunction with neuropsychological measures of attention and concentration, incorporating laboratory-based symptom measures making use of actigraph, which measures activity level based on the number of movements per unit of time, as well as continuous performance tests, which measure inattention and impulsivity. A multi-method approach to investigating the subtypes of AD/HD would also increase the ability of the clinician and researcher to appropriately clarify and

diagnose the separate types of AD/HD. Laboratory-based symptom measures are purported to not be susceptible to the types of information biases seen in behavioral ratings (Marks, et. al., 1999). Clinical ratings may be susceptible to halo effects, in which other behavioral disturbances (e.g. defiant behaviors) inflate the perception of AD/HD symptomology (Abikoff, Courtney, Pelham, & Kolewicz, 1993, Marks, et. al., 1999).

Overall, the present investigation has found the three subtypes of AD/HD (Combined Type, Predominately Inattentive Type and Predominately Hyperactive/Impulsive Type) as outlined and described in the DSM – IV, and supported by a plethora of research. The other subtypes found, AD/HD - Combined Type with Obsessive/Compulsive feature and AD/HD - Combined Type with Obsessive Compulsive and Conduct Disorder features can be explained on three levels. First, these other subtypes found may indeed reflect different subtypes of AD/HD, which can be identified and differentiated by their profile of symptomology or symptom presentation on behavioral checklist data, such as the CBCL. Second, they may reflect simply a co-morbid diagnosis group. It is reported that a substantial proportion of children with AD/HD referred to clinics also have Oppositional Defiant Disorder or Conduct Disorder. There is a higher prevalence of Mood and Anxiety Disorders in children with AD/HD as well. Often a co-morbid diagnosis is given. Third, they may reflect severity and progression of AD/HD symptom presentation that can be seen within the dimensions of a cause-effect relationship. For example, a child may present with AD/HD – Combined Type and as the disorder progressively interferes with social and academic functioning, emotional and behavioral difficulties manifest. The child may

have difficulties in school and at home due to the AD/HD, which in turn results in emotional difficulties, sulking, stubbornness, argumentativeness, worry thoughts, obsessive thoughts, compulsive behaviors and disobedience. This in turn, after continued attempts by the child to ineffectively manage and cope with the difficulties of the AD/HD, contributes to their symptom presentation to progress to a more severe dysfunction characterized by a disorder of conduct.

If there are separate diagnosable subtypes of Attention Deficit/Hyperactivity Disorder, this warrants more distinct diagnostic clarification within assessment strategies to provide individuals with more specific and successful treatment protocols. The broader based assessment as well as research protocols, should then rely not only on behavioral checklist data, but behavioral data and information from all sources (teachers, parents and the child), in conjunction with a full assessment of personality, emotionality and cognitive functioning to form more precise diagnostic clarification. Additional research with this conceptualization in mind will be needed and it may provide clinicians with a valid and more specific course of treatment.

APPENDIX A

DIAGNOSTIC CRITERIA FOR ATTENTION/DEFICIT HYPERACTIVITY DISORDER

DIAGNOSTIC CRITERIA FOR ATTENTION/DEFICIT HYPERACTIVITY DISORDER

A. Either (1) or (2)

(1) *Inattention*

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

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

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

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

(e) often has difficulty organizing tasks and activities.

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

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

(h) is often easily distracted by extraneous stimuli.

(i) is often forgetful in daily activities.

(2) *Hyperactivity*

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

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

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

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

(e) is often "on the go" or often acts as if "driven by a motor".

(f) often talks excessively.

Impulsivity

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

(h) often has difficulty awaiting turn.

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

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

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

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

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

APPENDIX B

AMEN'S SUBTYPE SYMPTOM CHECKLIST QUESTIONNAIRE

AMEN'S SUBTYPE SYMPTOM CHECKLIST QUESTIONNAIRE

Subtype I: Classic ADD

1. Often fidgets with hands or feet or squirms in seat.

2. Often leaves seat in classroom or in other situations in which remaining seated is expected.

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

4. Often has difficulty playing or engaging in leisure activities quietly.

5. Is often "on the go" or often acts as if "driven by a motor".

6. Often talks excessively.

7. Often blurts out answers before questions have been completed.

8. Often has difficulty waiting turn.

9. Often interrupts or intrudes on others (e.g., butts into conversations or games).

Subtype II: Inattentive ADD

1. Often fails to give close attention to details or makes careless mistake in schoolwork, work, or other activities.

2. Often has difficulty sustaining attention in tasks or play activities.

3. Often does not seem to listen when spoken to directly.

4. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions).

5. Often has difficulty organizing tasks and activities.

6. Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as paperwork, schoolwork or homework).

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

8. Is often easily distracted by extraneous stimuli.

9. Is often forgetful in daily activities.

10. Excessive daydreaming.

11. Often complains of being bored.

12. Often appears to be apathetic or unmotivated.

13. Frequently tired, sluggish or slow moving.

14. Frequently spacey or internally preoccupied.

Subtype III: Overfocused ADD

1. Excessive or senseless worrying.

2. Disorganized or superorganized.

3. Oppositional, argumentative.

4. Strong tendency to get locked into negative thoughts, having the same thought over and over.

5. Tendency toward compulsive behavior.

6. Intense dislike for change.

7. Tendency to hold grudges.

8. Trouble shifting attention from subject to subject.

9. Difficulties seeing options in situations.

10. Tendency to hold own opinion and not listen to others.

11. Tendency to get locked into a course of action, whether or not it is good for the person.

12. Needing to have things done a certain way or you become very upset.

13. Others complain that you worry too much.

Subtype IV: Temporal Lobe ADD

1. Short fuse or periods of extreme irritability.

2. Periods of rages with little provocation.

3. Often misinterprets comments as negative when they are not.

4. Irritability tends to build, then explodes, then recedes, often tired after a rage.

5. Periods of spaciness or confusion.

6. Periods of panic and/or fear for no specific reason.

7. Visual changes, such as seeing shadows or objects changing shape.

8. Frequent periods of de ja vu (feelings of being somewhere before even though you never have).

9. Sensitivity or mild paranoia.

10. Headaches or abdominal pain of uncertain origin.

11. History of head injury or family history of family violence or explosiveness.

12. Dark thoughts, may involved suicidal or homicidal thoughts.

13. Periods of forgetfulness or memory problems.

Subtype V: Limbic ADD

1. Moodiness.

2. Negativity.

3. Low energy.

4. Frequent irritability.

5. Tendency to be socially isolated.

6. Frequent feelings of hopelessness, helplessness or excessive guilt.

7. Lowered interest in things that are usually considered fun.

8. Sleep changes (too much or too little).

9. Chronic low self-esteem.

Subtype VI: Ring of Fire ADD

1. Moodiness.

2. Easily distracted.

3. Too many thoughts.

4. Hyperactive.

5. Hyperverbal.

6. Oppositional.

7. Aggressive.

8. Hypersensitivity to light, sound, taste or touch.

APPENDIX C

DISRUPTIVE BEHAVIOR RATING SCALE-PARENT FORM

AD/HD RATING SCALE-IV

DISRUPTIVE BEHAVIOR RATING SCALE-PARENT FORM

AD/HD RATING SCALE-IV

1. Fails to give close attention to details or makes careless mistakes in his/her work.
2. Fidgets with hands or feet or squirms in seat.
3. Has difficulty sustaining his/her attention in tasks and fun activities.
4. Leaves his/her seat in classroom or in other situations in which seating is expected.
5. Doesn't listen when spoken to directly.
6. Seems restless.
7. Doesn't follow through on instructions and fails to finish work.
8. Has difficulty engaging in leisure activities or doing fun things quietly.
9. Has difficulty organizing tasks and activities.
10. Seems "on the go" or "driven by a motor".
11. Avoids, dislikes, or is reluctant to engage in work that requires sustained mental effort.
12. Talks excessively.
13. Loses things necessary for tasks and activities.
14. Blurts out answers before questions have been completed.
15. Is easily distracted.
16. Has difficulty awaiting turn.
17. Is forgetful in daily activities.
18. Interrupts or intrudes on others.

APPENDIX D

SUBTYPE SYMPTOM ITEM CONSENSUS LIST

SUBTYPE SYMPTOM ITEM CONSENSUS LIST

Subtype I: Classic ADD (Hyperactive/Impulsive) Item Consensus List

{DBRS Item Number}

(CBCL Item Number)

* denotes item not matched by consensus

1 {2} Fidgets with hands or feet or squirms in seat.

2 {4} Leaves his/her seat in classroom or in other situations in which seating is expected.

3 {6} Seems restless.

4 {8} Has difficulty engaging in leisure activities or doing fun things quietly.

5 {10} Seems “on the go” or “driven by a motor”.

6 {12} Talks excessively.

7 {14} Blurts out answers before questions have been completed.

8 {16} Has difficulty awaiting turn.

9 {18} Interrupts or intrudes on others.

Subtype II: Inattentive Item Consensus List

1 {1} Fails to give close attention to details or makes careless mistakes in his/her work.

2 {3} Has difficulty sustaining his/her attention in tasks and fun activities.

3 {5} Doesn’t listen when spoken to directly.

4 {7} Doesn’t follow through on instructions and fails to finish work.

5 {9} Has difficulty organizing tasks and activities.

6 {11} Avoids, dislikes, or is reluctant to engage in work that requires sustained mental effort.

7 {13} Loses things necessary for tasks and activities.

8 {15} Is easily distracted.

9 {17} Is forgetful in daily activities.

10 (17) Day dreams or gets lost in his/her thoughts

11*

12*

13 (54) Overtired.

(102) Underactive, slow moving, lacks energy.

14 (80) Stares blankly.

Subtype III: Overfocused Item Consensus List

1 (112) Worries.

2 (99) Too concerned with neatness or cleanliness.

3 (3) Argues a lot.

(23) Disobedient at school.

4 (9) Can’t get his/her mind off certain thoughts; obsessions.

5 (66) Repeats certain acts over and over; compulsions.

6*

7 (88) Sulks a lot.

8*

9*

10 (86) Stubborn, sullen, or irritable.

11*

12*

13*

Subtype IV: Temporal Lobe Item Consensus List

1 (95) Temper tantrums or hot temper

2 (37) Gets in many fights.

3*

4*

5 (13) Confused of seems to be in a fog.

6 (29) Fears certain animals, situations, or places other than school.

(31) Fears he/she might think or do something bad.

7 (70) Sees things that are not there.

8*

9 (34) Feels others are out to get him/her.

(89) Suspicious.

10 (56b) Headaches.

(56f) Stomachaches or cramps.

11 Report history.

12 (18) Deliberately harms self or attempts suicide.

(91) Talks about killing self.

(97) Threatens people.

13*

Subtype V: Limbic Item Consensus List

1 (87) Sudden changes in mood or feelings.

2 (86) Stubborn, sullen, or irritable.

3 (102) Underactive, slow moving, or lacks energy.

(54) Overtired.

4*

5 (111) Withdrawn, doesn't get involved with others.

6 (52) Feels too guilty.

7*

8 (100) Trouble sleeping.

(76) Sleeps less than most kids.

(77) Sleeps more than most kids during the day and/or night.

9 (35) Feels worthless or inferior.

Subtype VI: "Ring of Fire" Item Consensus List

1 (57) Physically attacks people.

(95) Temper tantrums or hot temper.

(97) Threatens people.

2*

3 (87) Sudden changes in mood or feelings.

4*

5*		
6	(16)	Cruelty, bullying, or meanness to others.
7	(93)	Talks too much.
8	(41)	Impulsive or acts without thinking.
9*		
10	(7)	Bragging, boasting.
11*		
12*		
13	(45)	Nervous, highstrung, or tense.
	(50)	Too fearful or anxious.

Table 1

Means and Standard Deviations of Cluster Sample 1

(n=79)

M (SD)

	Cluster 1 (n=18)	Cluster 2 (n=7)	Cluster 3 (n=12)	Cluster 4 (n=19)	Cluster 5 (n=12)	Cluster 6 (n=11)
Hyperactive/ Impulsive	34.37 (14.08)	73.56 (19.66)	67.49 (15.81)	81.14 (12.51)	85.40 (11.56)	30.23 (14.92)
Inattentive	68.92 (10.49)	77.28 (18.02)	80.01 (11.99)	55.22 (15.98)	56.42 (10.98)	32.86 (7.70)
Overfocused	21.91 (6.44)	61.92 (8.73)	42.59 (14.28)	27.78 (8.67)	56.50 (9.43)	19.89 (13.19)
Temporal Lobe	8.32 (7.35)	37.76 (5.77)	16.97 (9.65)	8.26 (6.08)	16.96 (8.89)	5.06 (3.43)
Limbic	7.78 (6.47)	43.57 (10.69)	18.75 (10.03)	7.89 (7.13)	22.08 (5.42)	7.45 (7.02)
Ring of Fire	14.17 (11.91)	60.71 (10.18)	24.58 (5.82)	26.58 (12.70)	46.25 (8.56)	12.73 (8.47)
	25.91 (23.29)	59.13 (15.79)	41.73 (26.70)	34.48 (28.67)	47.27 (25.21)	18.04 (11.67)

Table 2

Means and Standard Deviations of Cluster Sample 2

(n=80)

M (SD)

	Cluster 1 (n=20)	Cluster 2 (n=9)	Cluster 3 (n=4)	Cluster 4 (n=23)	Cluster 5 (n=6)	Cluster 6 (n=18)
Hyperactive/ Impulsive	58.89 (8.86)	25.47 (20.68)	62.50 (13.50)	85.71 (7.15)	19.79 (6.14)	89.13 (9.00)
Inattentive	61.67 (12.83)	25.42 (12.41)	82.50 (8.66)	60.78 (7.88)	55.28 (21.15)	72.57 (9.00)
Overfocused	30.83 (10.11)	11.73 (7.57)	51.43 (8.35)	33.32 (10.04)	35.17 (10.34)	57.37 (10.62)
Temporal Lobe	11.05 (7.13)	3.18 (3.76)	35.70 (17.03)	10.56 (7.87)	13.72 (6.16)	27.79 (8.28)
Limbic	18.75 (11.68)	2.22 (2.64)	65.00 (10.00)	15.22 (8.59)	24.17 (8.61)	35.00 (9.85)
Ring of Fire	25.00 (12.98)	8.33 (7.91)	53.75 (17.02)	33.70 (12.27)	22.50 (9.87)	58.89 (11.19)
	34.36 (21.14)	12.73 (10.44)	58.48 (15.66)	39.88 (28.59)	28.44 (14.91)	56.76 (22.87)

Table 3

Disciminant Function Analysis Summary

Λ = .03016; F (30, 338) = 15.768, p<.05

n=95

Subtype Scores	Λ	Partial-Λ	F-remove (5,84)	p-level	Tolerance	1-Toler. (R^2)
Hyperactive/ Impulsive	.070	.430	22.279	.000	.887	.113
Inattentive	.070	.434	21.913	.000	.961	.039
Limbic	.038	.797	4.270	.002	.793	.207
Ring of Fire	.037	.814	3.851	.003	.755	.245
Overfocused	.036	.846	3.057	.014	.697	.303
Temporal Lobe	.035	.851	2.941	.017	.812	.188

Table 4

Chi-Square Tests with Successive Roots Removed

Roots Removed	Eigenvalue	Cannonical R	Λ	χ^2	df	p-level
0	4.138	.897	.030	308.100	30	.000
1	1.704	.794	.155	164.071	20	.000
2	0.986	.705	.419	76.532	12	.000
3	0.150	.361	.832	16.152	6	.013
4	0.045	.207	.957	3.838	2	.147

Figure 1

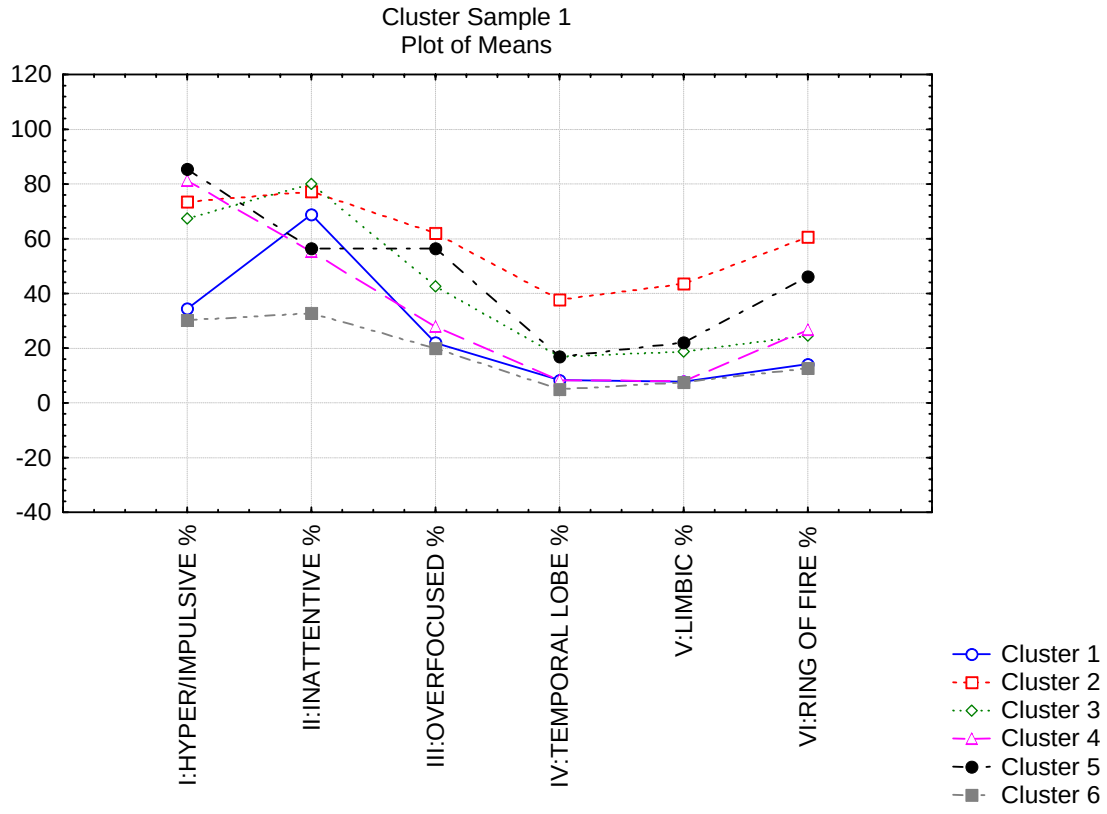
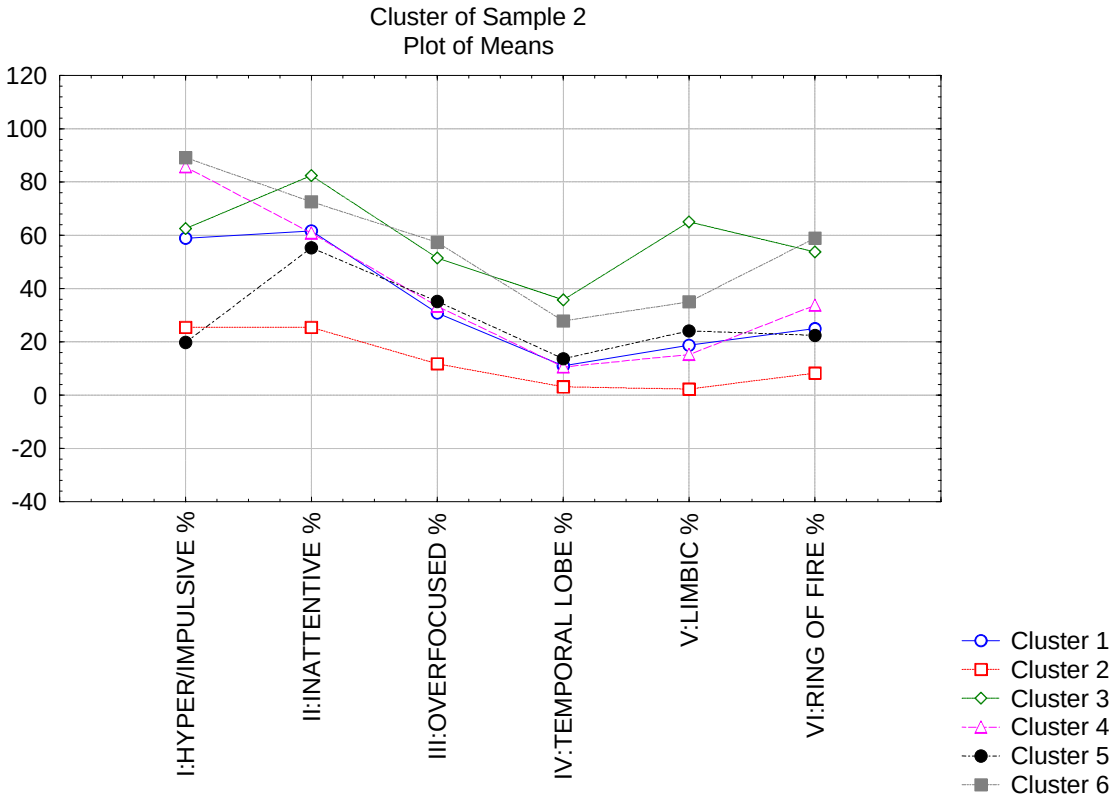

Cluster Sample 1
Plot of Means
120
100
80
60
40
20
0
-20
-40
I:HYPER/IMPULSIVE %
II:INATTENTIVE %
III:OVERFOCUSED %
IV:TEMPORAL LOBE %
V:LIMBIC %
VI:RING OF FIRE %
Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5
Cluster 6

Figure 2


Cluster of Sample 2
Plot of Means
120
100
80
60
40
20
0
-20
-40
I:HYPER/IMPULSIVE %
II:INATTENTIVE %
III:OVERFOCUSED %
IV:TEMPORAL LOBE %
V:LIMBIC %
VI:RING OF FIRE %
Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5
Cluster 6

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