A PRELIMINARY EXAMINATION OF BARKLEY'S 1997 HYBRID MODEL OF ATTENTION DEFICIT HYPERACTIVITY DISORDER: A REGRESSION ANALYSIS UTILIZING A HETEROGENOUS GROUP OF ELEMENTARY SCHOOL CHILDREN

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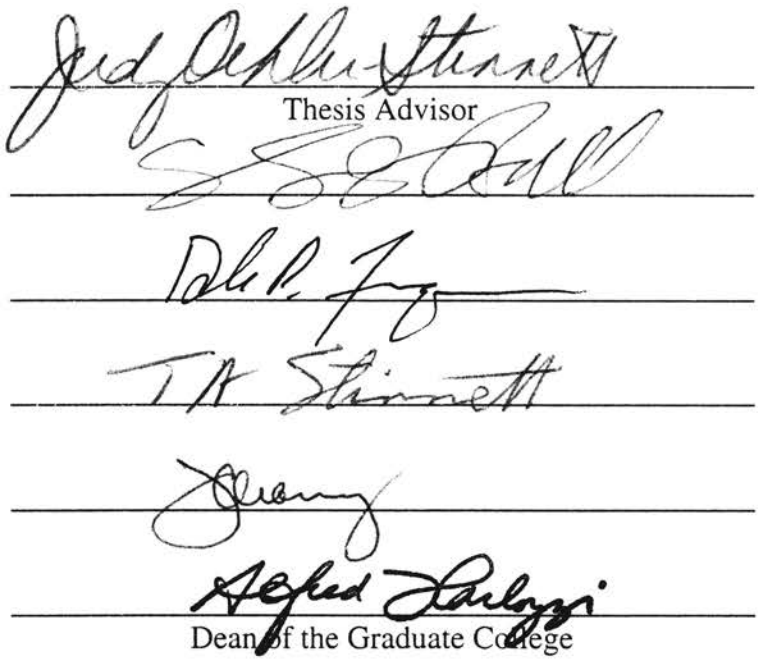

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CHAPTER I

Introduction

The American Psychiatric Association (1994) suggests the prevalence rate of Attention Deficit Hyperactivity Disorder (ADHD) to be 3%-5% of the school age population, and yet to date there have been no empirically based theoretically driven models that have integrated what is observationally, historically, and neurologically known about this disorder. In fact, historically, ADHD has been known by a variety of names, and while descriptors have been similar, causality has never fully been established, allowing imprecise and inconsistent diagnoses and treatment. Barkley (1997) has attempted to bring together various theories regarding this disorder and has derived a model that attempts to account for those symptoms prevalent in ADHD, and thus allow a fuller comprehension of causality, differential diagnosis, and treatment.

Barkley's current model (Figure 1) places Behavioral Inhibition at a central point supportive directly to four other separable executive functions, namely Nonverbal Working Memory, Internalization of Speech (Verbal Working Memory), Self-Regulation of Affect/Motivation/Arousal, and Reconstitution. Each of these four executive functions represents a formerly overt other-directed behavior that has become covert and internalized with a person's development. These functions are further believed to be mediated by the prefrontal regions of the brain, and encompasses explanations of language development (Bronowski, 1977), the functioning of the prefrontal cortex (Fuster, 1989), and ADHD in general (Barkley 1994, 1996).

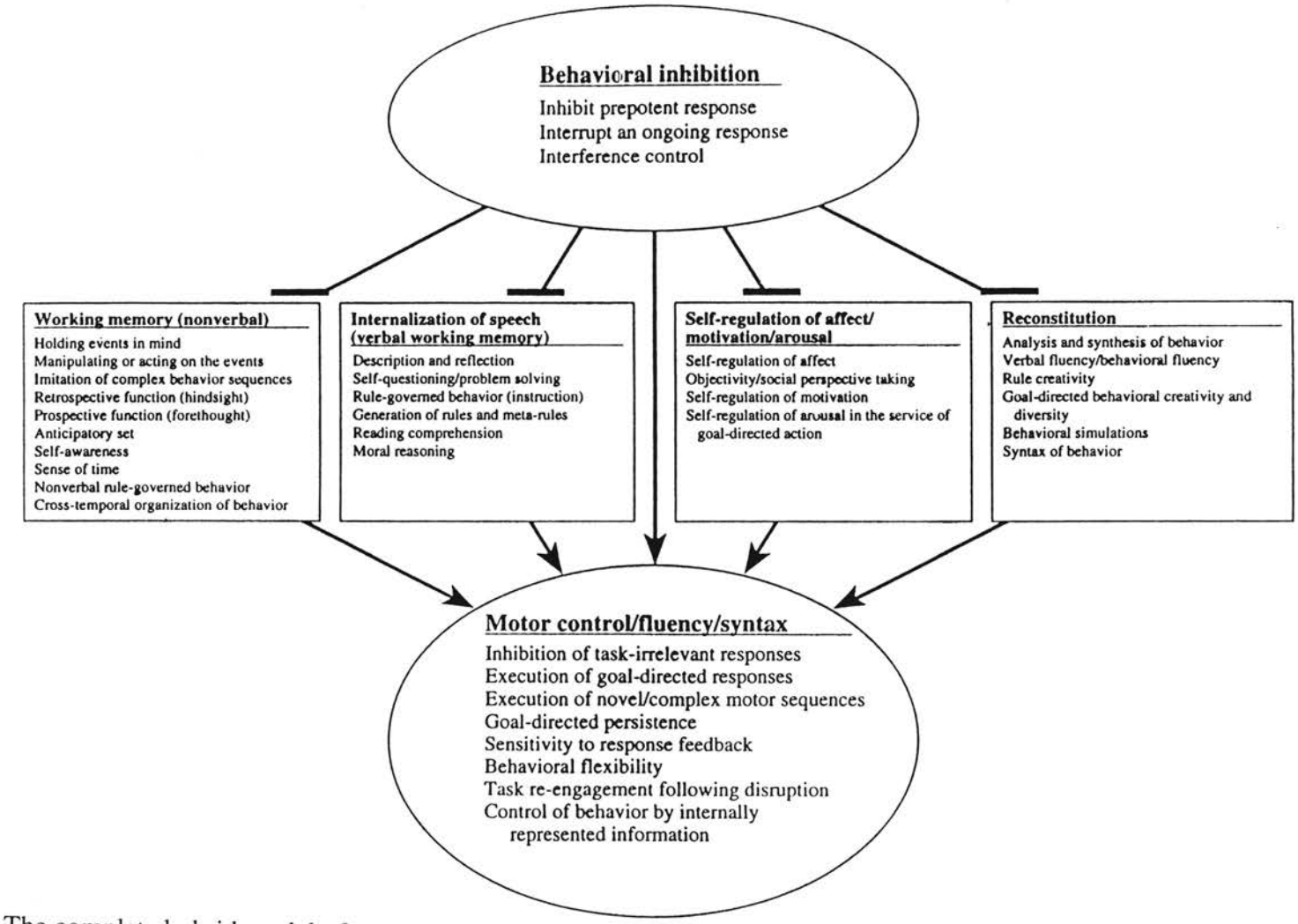

Figure 1. The complete hybrid model of executive functiones (boxes) and the relationship of these four functions to the behavioral inhibition and motor control systems.

Barkley (1996) makes six key assumptions with this model. First, is that behavioral inhibition emerges developmentally prior to the noted executive functions. Secondly, it is assumed that the executive functions occur and interact based upon a developmental timetable. Thirdly, the executive functions are of secondary concern with the behavioral inhibition being primary such that the latter supports the former and allows them to function properly. Fourth, deficits in behavioral inhibition have a genetic and neurodevelopmental origin although its expression is environmentally influenced. The fifth assumption states that feedback from disinhibitory responses results in self-restraint to be lessened, and finally, that this model does not apply to ADHD predominantly inattentive type.

Barkley (1996) further clarifies his model by noting that behavioral inhibition is actually comprised of two related processes. The first is the capacity to inhibit responses which creates a delay in the response to a stimulus, and the second involves the protection from interference by competing events thus allowing goal-directed behavior. Barkley further suggests that it is this process that allows the four executive functions to act effectively in modifying the person's response to a stimulus such that immediate and future consequences are maximized.

The current problem is that this model has yet to be put to the test, to see if it indeed fits the empirical data. If it does, then one's understanding of a child with ADHD becomes altered. With the developmental element in the model, diagnoses would be altered as well to take into consideration that hyperactivity is but an initial manifestation of poor inhibition and self-control, and will with time result in the symptoms of inattention. A continuum of symptoms and their severity will then be able to be outlined.

Therefore, it is within this study that a correlation regression analysis is performed using data collected from 69 elementary age participants. Each was assessed with instruments purported to measure each of the variables that Barkley advances. The children were volunteers from elementary schools from small towns in Oklahoma. Parents were interviewed and were requested to complete two behavioral rating scales. Additionally, each child was individually assessed with two direct measures of memory and cognition. Results of this study suggests a preliminary understanding of Barkley's model, and its meaning in relation to persons with ADHD.

CHAPTER II

Review of Literature

The American Psychiatric Association (1994) suggests the prevalence rate of Attention Deficit Hyperactivity Disorder to be 3%-5% of the school age population and accounts for approximately 40% of referrals to child guidance clinics (Barkley, 1990). Additionally, while ADHD in children has been one of the most extensively studied childhood psychiatric disorders, there are still many problems associated with understanding its causality and assessment. In reviewing literature for this disorder the primary focus was on the development of Barkley's 1997 Hybrid Model of ADHD, the bases for its individual components, and neurological and assessment studies supporting it. Definitions of terms are included within each of the subheadings for ease of reading.

History of ADHD

These children have been known for at least 130 years as noted by Cantwell (1975) in his credit to the German physician Heinrich Hoffman for his description of this syndrome. Barkley (1990) further credits the British physician, G. F. Still in 1902 as describing a cluster of symptoms displayed by twenty children he studied which today might be termed Attention Deficit Hyperactivity Disorder (ADHD). According to Barkley, Still noted that these children were inattentive, impulsive, overactive, and displayed deficits in volitional inhibition and moral control as it pertained to their own behavior. Based on similarities between them and others with brain lesions, Dr. Still

suggested that the cause of these symptoms might be the result of injury to the nervous system, along with an inherited predisposition.

This model of brain damage was affirmed by an outbreak of encephalitis in North America from 1917 to 1918, (Goldstein & Goldstein, 1990). Children who survived the brain infection which resulted in injury to the nervous system once again displayed a cluster of symptoms, which on the surface could be viewed as what, we term today, ADHD. These type of cases encouraged Strauss and Lehtinen (1947) to term children with this cluster of symptoms as being brain-injured, and resulted in diagnoses of Brain-Damaged Child Syndrome, and still later, Minimal Brain Dysfunction (Kessler, 1980). Van Riper (1978) noted that these children have 1) an inadequate ability to regulate or control their behaviors, attention, or emotions, 2) deficient abilities in integrating sensory information as shown by perceptual difficulties involving awareness, sequencing, retention and recall, forming concepts, categorizing, and handling abstraction, 3) a disturbed self-concept, 4) deficient temporal conception, and 5) do not seem to perceive the needs of others. Van Riper also indicated that these children have difficulty in the learning of language due partially to difficulties in temporal sequencing. These symptoms were noted to later translate into academic difficulties and a possible low frustration tolerance.

By the 1950's this same cluster of symptoms was referred to as "Hyperkinetic Impulse Disorder" and believed to be caused by the thalamus not filtering stimuli entering the brain in an adequate manner, resulting in cortical overstimulation (Knobel, Wolman, & Mason, 1959; Laufer, Denhoff, & Solomans, 1957). By the 1960's this cluster of symptoms was termed "Hyperactive Child Syndrome" (Burks, 1960; Chess,

1960), and the DSM-II (American Psychiatric Association, 1968) noted that it was primarily evident in young children, usually waning in adolescence with symptoms inclusive of overactivity, restlessness, distractibility, and short attention span. The term "Hyperkinetic Reaction of Childhood" was then adopted by the American Psychiatric Association (1968).

Douglas (1972) noted that, although termed a "reaction", sustained attention was integral to the diagnostic symptoms. By 1983, Douglas elaborated on the disorder by offering four bases for this disorder. These included deficits in abilities: 1) to inhibit impulsive behavior, 2) to initiate organization, and sustain attention and effort, 3) to adjust arousal levels to meet the demands of a given situation, and 4) an exceptionally powerful tendency to seek immediate reinforcement. Moreover, similar to Still, Douglas noted problems in moral development. In 1980, with the publication of the DSM-III (American Psychiatric Association), the term Attention Deficit Disorder (ADD) was used for this constellation of symptoms. Moreover, it stressed the cognitive and developmental nature of the disorder. Additionally, a distinction was made between two types of ADD - those persons with and those without hyperactivity. Researchers, Carlson (1986), Goodyear & Hynd (1992), suggested that future research may indicate that persons displaying ADHD symptomotology without the hyperactivity may prove to be a separate disorder altogether with a different causality.

In 1987, with the publication by the American Psychiatric Association of the DSM-III-R, the disorder was relabeled ADHD with a single list of criteria covering all three of the major symptoms for diagnosis - hyperactivity, impulsivity, and inattention. ADD (attention deficit disorder without hyperactivity) was listed elsewhere in the manual

with a notation stating that enough research had not been done yet to establish clear diagnostic criteria.

Throughout the 1980's, ADHD research focused on these children's motivation and apparent insensitivity to consequences resulting from their behavior, whether it was reinforcement or punishment (Barkley, 1989; Glow & Glow, 1979; Haenleen & Caul, 1987). Examples of this come from studies by Douglas and Parry (1983, 1994), and Parry and Douglas (1983) which indicate that with continuous reinforcement, children with ADHD were indistinguishable from those without ADHD. In contrast, however, once only partial or no reinforcement was offered, the targeted children with ADHD declined markedly in their performance of the given tasks. Barkley (1981, 1989, 1990) stated that these children could be characterized by the deficits in the manner in which rules and instructions governed their behavior. When rules specifying behavior were given that competed with the current immediate consequences for other behaviors in the setting, the rules did not control behavior as well as in normal children. This led Barkley to hypothesize that behaviors which rules and language initiate and sustain, termed "rule governed" behavior by behaviorists (Hayes, 1989; Skinner, 1953) may be impaired in persons with ADHD.

Additional research has indicated these children consistently have problems in inhibiting responses and motor-system control (Barkley, Grodzinsky, & DuPaul, 1992; Schachar & Logan, 1990; Sergeant, 1988; Sergeant & Scholten, 1985). Research also supports the idea that hyperactivity and impulsivity are a single unit, and not separate symptoms as historically had been noted (Achenbach & Edelbrock, 1983; Goyette, Conners & Ulrich, 1978; Lahey et al., 1988). Barkley (1990) renamed this single unit

"disinhibition", which in the DSM-IV (American Psychiatric Association, 1994), became a central distinguishing symptom of ADHD. Therefore, currently, according to the DSM-IV, three types of ADHD exist. These include ADHD inattentive type (ADHD-A), ADHD with hyperactivity/impulsivity (ADHD-HI), and ADHD combined (ADHD-C) which includes inattention as well as hyperactivity/impulsivity.

According to Barkley (Mash, & Barkley, 1996, chap. 2), increasing attention is being centered on ADHD as a problem of behavioral inhibition - an externalizing disorder. While previous research has focused on the sensory or information-processing system, Barkley notes that current studies are focusing on deficiencies in the anterior motor control systems of the brain. Moreover, DuPaul and Stoner (1994), noted concern that additional difficulties with this disorder include a heightened risk for academic failure, poor peer relations, and persistence into adulthood with possible psychopathological behaviors (Gittelman, Mannuzza, Shenker, & Bonagura, 1985; Weiss & Hechtman, 1986). Thus, historically, ADHD has been identified via its symptomotology, including poor attention to task, impulsive behavior, motor overactivity, and an inability to consider consequences of behaviors (Teeter & Semrud-Clikeman, 1997), with much less knowledge regarding its etiology, its qualitative changes occurring throughout development, and its associated cognitive impairments.

Core Symptoms

The core symptoms of Attention Deficit Hyperactivity Disorder are inattention and the hyperactivity/impulsivity unit. Inattention is seen as three specific deficits. These are a deficiency in sustained attention, a deficiency in following through on rules and instructions to the same degree as same age peers, and a deficiency in remaining at play

or on a task as long as one's same age peers. Additionally, inattention is characterized by distractibility if the irrelevant stimuli are embedded within the task itself (Rosenthal & Allen, 1980; Steinkamp, 1980). Furthermore, children with ADHD are more off-task, look away from their assigned activity, persist less in correctly performing boring activities, and once interrupted, are slower and less likely to return to an activity than their peers (Barkley & Ullman, 1975; Corkum & Siegel, 1993; Luk, 1985, Milich & Lorch, 1994; Schachar, Tannock, & Logan, 1993).

When looking at studies involving hyperactive/impulsive behavior, or as used in this paper, disinhibition, research has noted that disinhibited children are significantly more physically active than their same age peers (Barkley & Ullman, 1975; Barkley & Cunningham, 1979, Luk, 1985; Porrino et al., 1983, Zentall, 1985), less mature in controlling motor overflow movements (Denckla & Rudel, 1978), and motor-coordination and sequencing (Barkley, 1996; Barkley, DuPaul, & McMurray, 1990; Breen, 1989; Denckla & Rudel, 1978; Mariani & Barkley, 1997). Additionally, they have a difficult time stopping on-going behavior (Schachar, Tannock, & Logan, 1993; Milich, Hartung, Martin, & Haigler, 1994), talk excessively (Barkley, Cunningham, & Karlsson, 1983), interrupt others' conversations and activities (Malone & Swanson, 1993), display a high number of commission errors on Continuous Performance Tests (Corkum & Siegel, 1993), and are less able to resist immediate temptations and thus delay gratification (Anderson, Hinshaw, & Simmel, 1994; Campbell, Szumowski, Ewing, Gluck, & Breaux, 1982).

Studies indicate that the above symptoms of disinhibition first present themselves at around the ages of three or four, with problems of inattention emerging between five

and seven years of age, or about the same time as formal schooling. Then from early to middle elementary school ages, attention becomes the principle difficulty and remains so throughout the elementary grades with disinhibition symptoms declining (Hart, Lahey, Loeber, Applegate, & Frick, 1995; Loeber, Green, Lahey, Christ, & Frick, 1992). By adolescence, both disinhibition and inattention decline (Fischer, Barkley, Fletcher, & Smallish, 1993).

Overall, Douglas (1983) noted that children with ADHD display a greater variability of task performance than their same age peers. In other words, when multiple trials of a task are performed by controls and children with ADHD, the range of scores around the child's own mean is greater for the child with ADHD, including their reaction time (Chee, Logan, Schachar, Lindsay, & Wachsmuth, 1989; Zahn, Krusei, & Rapoport, 1991). In fact, this variance is suggested by several developers of Continuous Performance Tests to be one of the indicators of ADHD (Conners, 1995; Greenberg & Waldman, 1992).

Deficiencies are also evident in other areas. Cognitive functioning includes problems with working memory and mental computation (Barkley, 1996; Mariani & Barkley, 1997; Zentall & Smith, 1993), applying organizational strategies (Hamlett, Pellegrini, & Conners, 1987; Voelker, Carter, Sprague, Gdowski, & Lachar, 1989; Zentall, 1988), and planning and anticipation (Barkley, Grodzinsky, & DuPaul, 1992; Douglas, 1983; Grodzinsky & Diamond, 1992). Deficits in verbal fluency and confrontational communications are also evident (Grodzinsky & Diamond, 1992; Zentall, 1988), as is the lack of internalizing speech thus making self-direction difficult (Berk & Potts, 1991; Copeland, 1979).

Other areas include difficulty with putting forth effort, volition, and how that effort is distributed (Douglas, 1983; Sergeant & van der Meere, 1994; Voelker, Carter, Sprague, Gdowski, & Lachar, 1989), as well as an inability to comply with restrictive instructions (Barkley, 1985; Danforth, Barkley, & Stokes, 1991; Roberts, 1990; Routh & Schroeder, 1976). Deficiencies in self-regulation so as to inhibit excessive emotional arousal (Barkley, 1996; Cole, Zahn-Waxler, & Smith, 1994; Douglas, 1983; Hinshaw, Buhrmeister, & Heller, 1989), are also evident as are deficiencies in maturity and moral reasoning (Douglas, 1972; Hinshaw, Herbsman, Melnick, Nigg, & Simmel, 1993; Nucci & Herman, 1982; Simmel & Hinshaw, 1993).

Neurological Evidence of ADHD

According to Teeter and Semrud-Clikeman (1997), there have been at least eleven different neuroanatomically-based theories that have attempted to explain underlying causes of ADHD, dating back to 1957 with Laufer, Denhoff, and Solomons' hypothesis of dysfunctional diencephalic structures such as the hypothalamus and thalamus. More recently neuropsychology has defined the core symptoms of ADHD as "executive functions" (Denckla, 1994; Torgesen, 1994). They are thought to be mediated by the frontal cortex and most specifically the prefrontal lobes (Fuster, 1989; Stuss & Benson, 1986). Thus it is believed that ADHD more than likely is a result of a disturbance in the prefrontal lobes (Benton, 1991; Heilman, Voeller & Nadeau, 1991; Levin, 1938; Mattes, 1980).

These functions are believed to allow self-regulation (Barkley, 1996) or inhibition (Teeter & Semrud-Clikeman, 1997) and modification of the probability of subsequent behaviors so as to adjust future consequences (Kaufer & Karoly, 1972; Skinner, 1953).

According to Teeter and Semrud-Clikeman, studies indicate two units, that of motor hyperactivity and that of inattention (Frick & Lahey, 1991; Lahey et al., 1988). The motor hyperactivity is believed to be a result of deficient motor inhibition and places the focus on the frontal and prefrontal areas of the brain. Inattention is thought to be an inability to filter out extraneous stimuli as in sustained and divided attention (Teeter & Semrud-Clikeman). Children with ADHD–Combination (ADHD-C) or ADHD–Hyperactive-Impulsive (ADHD-HI) have been found to have a longer reaction time (Hynd & Willis, 1988; Sergeant & Scholten, 1985) and more difficulty in completing finger sequential tasks and frontal lobe tasks, whereas those with ADHD-Inattentive (ADHD-A) have difficulty with perceptual-motor tasks (Barkley, 1996) and a cognitively sluggish style (Hart, Lahey, Loeber, & Hanson, 1994; Healy et al., 1987). These differences lead one to assume different neurological causes. Teeter and Semrud-Clikeman believe that disruption of any one of the cognitive, motor, or social development systems may hinder the entire system much as Barkley proposes, causing deficiencies. They suggest that an inability to shift sets will affect responses to temporally presented information or vigilance.

Benton (1991) proposes that attention involves two interconnected pathways. The first includes the midbrain reticular activation system for general awareness, and the posterior, inferior medial areas of the frontal lobes to maintain an alert state, both of which contribute to basic mental control. The second system involves the prefrontal lobes which allow the functioning of the executive functions to monitor and regulate complex operations and the higher mental control level such as motor activity, motivation, and abstract thinking. Colby (1991) suggests that the ability to select, sustain, and control

attention may involve the ability to access and direct resources on both sides of the brain as indicated by the widely distributed attentional processes throughout the brain. In other words, the activation of a response in one area may simultaneously require inhibition in another (Posner, 1987). Hynd et al. (1991) believe that this interhemispheric regulation may be compromised in children with ADHD. Teeter and Semrud-Clikeman credit the breakdown in the processing of temporal information as having an impact on tasks which require information processing and reconstruction of the parts into a whole as is seen in classroom academics. Other researchers have detected that children with ADHD experience difficulty in selective and sustained attention while not experiencing problems in orienting or reactive action (Douglas & Peters, 1979; Porges, Walter, Korb, & Sprague, 1975; Sykes, Douglas, & Morgenstern, 1973; Sykes, Douglas, Weiss, & Minde, 1971).

Barkley's 1994 model stressed the interaction of the environment with behaviors, concluding that attentional problems are deficits in facilitating, sustaining, or disengaging responses in relation to the environment. Moreover, attention involves rules and instructions that are associated with the task either explicitly or implicitly, and given that ADHD children have been consistently found to be contingency-governed, the rules inherent in tasks are not effective in interventions with these children. Barkley (1994) and Denckla (1994) suggest differentiating subtypes such as ADHD-C (poor sustained attention, with improved response to novel stimulation), and ADHD-A which show primary problems in focused attention, and appear to be more cognitively driven as opposed to a behavioral disorder.

Additional evidence of a neurological cause of ADHD comes from measures of electroencephalograms (EEG), cerebral blood flow, positron emission tomography (PET) and magnetic resonance imaging (MRI). Early research indicated inconsistencies in findings that most likely were due to small sample size, procedural differences, and defining boundaries of brain regions (Filipek et al., 1997, Hynd et al., 1993). However, recent studies have been more exacting and indicate consistency in the use of electroencephalograms in measuring responses during vigilance tests (Frank, Lazar, & Seiden, 1992; Klorman, Salzman, & Borgstedt, 1988). Results indicate an underresponsiveness to stimulation in the prefrontal region of the brain that is related to poor performance on continuous performance tests. This has been shown to be correctable by stimulant medication (Kuperman, Johnson, Arndt, Lindgren, & Wolraich, 1996). Studies of cerebral blood flow in children with ADHD, when compared with a control group, consistently show decreased blood flow to the prefrontal regions and consequently to the anterior region of the striatum (caudate nucleus) and the limbic system (Lou, Henriksen, & Bruhn, 1984, 1990; Lou, Henriksen, Bruhn, Borner, & Nielsen, 1989; Sieg, Gaffney, Preston, & Hellings, 1995). Furthermore, PET scans have been used to assess cerebral glucose metabolism. Significant correlations have been noted between diminished metabolic activity in the left anterior frontal region and the severity of the ADHD symptoms in adolescents with ADHD (Zametkin et al., 1993). Finally, MRIs have shown in at least two studies that the posterior portion of the corpus callosum, the splenium, is significantly smaller in subjects with ADHD (Hynd, Semrud-Clikeman et al., 1991; Semrud-Clikeman et al., 1994). Very recently, a functional MRI study by Stanford researchers suggested that ADHD is characterized by atypical frontal-striatal

function and behaviorally was seen as impaired inhibitory control in a go/no-go task (Vaidya et al., 1998).

The normal human brain demonstrates a relatively consistent asymmetry, with the right frontal cortical region usually being larger than the left (Giedd et al., 1996). However, various MRI studies have found that subjects with ADHD had a significantly smaller left caudate nucleus, which was consistent with the earlier blood flow studies (Filipek et al., 1997 & Hynd et al., 1993), a significantly smaller right prefrontal cortical region (Filipek et al.), and a smaller right globus pallidus (Castellanos et al., 1994, 1996). Castellanos also found smaller cerebellar volume in ADHD children as well. This may be seen as supporting the hypothesis that the cerebellum may have a role in the motor presetting aspects of sensory perception that derive from planning and other executive functions (Akshoomoff & Courchesne, 1992; Houk & Wise, 1995).

Situational & Contextual Factors

Situational and contextual factors affect the severity of symptoms surrounding Attention Deficit Hyperactivity Disorder. Influencing factors include: 1) time of day or level of fatigue (Porrino et al., 1983; Zagar & Bowers, 1983), 2) increasing task complexity or organization (Douglas, 1983), 3) the extent of self-control and restraint required (Barkley & Ullman, 1975; Luk, 1985), 4) the level of stimulation within the setting (Zentall, 1985), 5) the schedule of immediate consequences associated with the task (Barkley, Copeland, & Sivage, 1980; Douglas & Parry, 1983, 1994), and 6) the presence or absence of an adult during the task (Draeger, Prior, & Sanson, 1986; Gomez & Sanson, 1994). Additionally, children with ADHD display the greatest difficulty with behavior in a setting when restraint is necessary (Altepeter & Breen, 1992; Barkley &

Edelbrock, 1987; DuPaul & Barkley, 1992), and when work-related tasks require persistence (Barkley, 1997).

Intellectual Ability Factors

While there has been minimal research in the area of ADHD as it relates to mental retardation, Pulsifer (1996) believes that an individual's intelligence will place limits on one's ability to sustain attention. His neuropsychological review of mental retardation indicates that inattention and short-term memory, among other areas, are dependent on the degree of the mental retardation. At least two studies have inferred that individuals with IQs below 50 may have a qualitatively different form of mental retardation (Rutter, Bolton, et al., 1990; Rutter, Macdonald, et al., 1990). Results from these studies note that genetic defects contribute highly to this populations' retardation along with physical anomalies, and is overrepresented for its position in a normal distribution curve. Additionally, the percentage of significantly positive responders to stimulant medications among children with ADHD symptomology falls off sharply at an IQ of 50 and below (Demb, 1991). Thus, ADHD symptomology at IQs below 50 may qualitatively represent a different form and in fact may not be classified as ADHD at all. Further research in this area is necessary to test this distinction.

Other studies suggest that impulsive-hyperactive behavior and ADHD correlate with diminished IQ, particularly verbal IQ (Halperin & Gittelman, 1982; McGee, Williams, & Feehan, 1992; Sonuga-Barke, Lamparelli, Stevenson, Thompson & Henry, 1994). Studies of hyperactive or ADHD children that did not control for IQ, found them to be significantly lower than control groups in their intelligence, and particularly their verbal intelligence (Mariani & Barkley, 1997; McGee, Williams & Silva, 1984; Moffitt,

1990). Individuals with mental retardation exhibit a global attentional processing deficit due to cognitive and memory assaults (Hopkins et al., 1995), whereas persons with ADHD display attention problems as it relates to mental effort. Moreover, when studies controlled for group differences in verbal IQ, statistical differences between children with ADHD and hyperactive-impulsive behavior, and the control group were no longer significant (Mariani & Barkley, 1997). Castellanos et al. (1994) found that an initially significant correlation between size of the caudate and behavior ratings of hyperactive-impulsive behavior in children with ADHD was no longer significant once IQ was controlled.

In examining Barkley's model, a small but significant relationship could exist between ADHD and IQ, most particularly verbal IQ due to the inhibitory processes and the executive functions linked to them. This is because the latter is likely to be related to working memory, internalized speech, and the eventual development of verbal thought. Studies using both normal samples (Hinshaw, Morrison, Carte, & Cornsweet, 1987; McGee, Williams, & Silva, 1984) and behavior-problem samples (Sonuga-Barke, Lamparelli, Stevenson, Thompson, & Henry, 1994) have found significant negative associations between hyperactive-impulsive behavior and measures of intelligence. However currently, neither the DSM-IV nor the ICD-10 sets a lower IQ limit for the diagnosis of ADHD.

Much of what we know of ADHD has been descriptive and has been without a governing model. In order to directly address this lack of a conceptual model of ADHD and it underlying deficits, Barkley (1997) proposed a unifying theory of ADHD focusing specifically on behavioral inhibition, sustained attention, and executive functions.

Development of Barkley's Model

Gray (1975, 1987) advanced a neuropsychological model that consisted of three interacting arousal systems: the Behavioral Activation System (BAS), the Behavioral Inhibition System (BIS), and the Nonspecific Arousal System (NAS). While the BAS is seen as sensitive to reinforcing stimuli, the BIS is sensitive to threatening stimuli. The BAS activates behavior especially in cases of escape and active avoidance, while the BIS interrupts ongoing activity particularly in response to a threatening environment such that attention may be focused. The BAS is activated by rewarding stimuli, and the BIS by punishing. If activity is increased in either system, the NAS is activated, which mediates the speed and strength of action or inhibition in response to a stimulus. The BAS activity was hypothesized to be associated with positive affect such as hope or relief, while the BIS was associated with negative affects such as fear, anxiety, or frustration. Weakness of the BIS accounts for impulsivity and poor extinction, as well as reduced anxiety in response to cues for potential punishment or failure.

Newman, Patterson, and Kosson (1987) found that when confronted with competing reward and punishment contingencies, disinhibited individuals exhibit response preservation and an inability to learn via passive avoidance (Newman & Kosson, 1986; Newman, Widom, & Nathan, 1985). The proposed response-modulation deficit theory as proposed by Newman and Wallace (1993) involves both the BAS and BIS systems. When both are activated, BIS deficits result in an inability to interrupt BAS ongoing activity.

During this same time period, Quay (1988b) used Gray's theory as the basis of his concept that ADHD is a result of a brain deficit in the Behavioral Inhibition System

(BIS). The Quay/Gray model predicts that persons with ADHD are less sensitive to signals of conditioned punishment, and so the BIS is not activated and the inhibition of behavior does not occur (Milich, Hartung, Martin & Haigler, 1994; Quay, 1988b), with impulsivity the result regardless of reward cues being present (Daugherty & Quay, 1991). Studies combining the Gray/Quay model with Newman's (Schachar & Logan, 1990) supported the hypotheses that a maladaptive BIS is responsible for the inhibitory deficit observed in children with ADHD. Additionally, following this line of reasoning, further support is found for the O'Leary (1985) punishment paradigm where it appears that punishment activates the weak BIS in children with ADHD. O'Leary noted that punishment contingencies were effective in reducing off-task behaviors with these children, even more so than praise (Abramowitz, O'Leary, and Rosen, 1987). Thus, as Quay (1988a) noted, the presence or absence of reward, which activates the BAS, would not affect the behavior of children with ADHD and result in inhibition of responses; however, punishment contingencies would increase the activation of the BIS and result in appropriate inhibition. Furthermore, pharmacological studies are consistent with the theory that a weak BIS is central to the disinhibition of children with ADHD (Tannock, Schachar, Car, Chajczyk, & Logan, 1989; Trommer, Hoeppner, & Zecker, 1991).

Schachar and Logan (1990) published their findings based on Logan's "race" model of inhibition, i.e. there is a central deficit in inhibitory processes in persons with ADHD. The hypothesis states that a stimulus triggers an activating as well as an inhibitory primary response. The two responses then "race" to be executed first. Individuals with ADHD, as proposed by this theory, are thought to have slower inhibitory response initiation as compared to a non-ADHD control group (Schachar, Tannock, &

Logan, 1993). While behavioral inhibition seems to be central to ADHD, no model as of yet is able to account for the other executive function symptoms of ADHD, or for the second core symptom of inattention (Barkley, 1990, 1994, 1996; Barkley, Grodzinsky, & DuPaul, 1992).

Barkley (1981, 1989) advanced his theory of Rule-Governed Behavior which stated that when rules specifying behavior were competing with other actions for immediate consequences, the ADHD children were driven by immediate gratification. Rules, as defined by Skinner (1969), are contingency-specifying stimuli, encompassing a relationship between an event, a response, and the likely consequences. While spoken language comprises much of this stimuli, nonverbal images, signs, symbols, or a given sequence may specify a rule governing behavior as well, as such symbolism expresses a communication as in a line on a map or a mathematical operation (Hayes, Strosahl, & Wilson, 1999; Skinner, 1953). Skinner further noted that language influences behavior in stages, the first being to control others, the second to self-direct with the use of private speech, and the third by creating individual rules via self-directed questions.

In 1997 Barkley proposed a model of ADHD that brought together all of these various components of ADHD. It places behavioral inhibition at a central point in relation to four other separable executive functions, namely Nonverbal Working Memory, Internalization of Speech (Verbal Working Memory), Self-regulation of Affect/ Motivation/Arousal, and Reconstitution. These are thought to be mediated by the prefrontal regions of the brain and are involved in planning, decision making, directed goal selection, monitoring ongoing behaviors, and the utilization of feedback (Gorenstein, 1982; Stuss, 1992). This frontal lobe dysfunction thus undermines the

capacity to plan, monitor, and flexibly shift attention. This explanation encompasses earlier explanations of language development (Bronowski, 1977), the functioning of the prefrontal cortex (Fuster, 1989), and ADHD in general (Barkley 1994, 1996). These four functions are each dependent upon the support of behavioral inhibition to work effectively with a common purpose. Behavioral inhibition allows self-regulation to become progressively under greater control, resulting in the influence of future consequences and maximizing long-term outcomes for the individual. This additionally entails their exigency to be protected from interference. This process produces increased effective prediction and control of one's environment, allowing for more adaptive functioning.

Additionally, the four executive functions have a common characteristic. Each represents a formerly overt other-directed behavior that has become covert and internalized with the person's development. Michon and Jackson (1984) stated that all life self-organizes. In other words, life develops an internal structure that allows the development of a certain independence from an external locus of control. Michon and Jackson suggest that this process has occurred in all species, and is the ability to anticipate certain changes and to make appropriate behavioral adjustments. Barkley (1997) believes that the anticipation of change is essentially the concept of time. The individual becomes future oriented, able to be goal-directed, and intentional. The internalization of speech as noted by Diaz & Berk (1992) is such an example. Language crosses all temporal contingencies in that one must remember and encode the past in both long and short-term memory in planning future verbal and behavioral responses (Fuster, 1995). Fuster believes it is the dorsolateral prefrontal cortex that reconciles this temporal

issue. Hayes (1991) finds support of this concept in Relational Frame Theory in which one responds relationally to a cross temporally established contextual cue, and that the nature of human language is based on these relational frames.

Barkley's model makes six key assumptions (1997). The first of these is that behavioral inhibition emerges first in development, ahead of the four executive functions. Secondly, it is assumed that the executive functions emerge based upon a developmental timetable and are interactive. The third assumption is that behavior inhibition is of primary concern, with the executive functions and their impairment being secondary. Thus, it would stand to reason that if behavioral inhibition improves, then the four secondary executive functions will also improve. The fourth assumption is that there are genetic and neurodevelopmental origins resulting in deficits in behavioral inhibition, with its overt expression strongly influenced by social factors. Fifth is the assumption that there are secondary deficits in self-regulation created by feedback from disinhibitory responses which further causes behavioral inhibition and thus contributes to self-restraint (inhibition) being lessened. Finally, is the assumption that this model does not apply to persons having ADHD predominantly inattentive type (ADHD-A).

The Exclusion of ADHD-Inattentive Type from Barkley's Model

One of the basic assumptions of Barkley's (1997) model is that it does not include ADHD-A. Support for ADHD-C (lack of persistence and distractible attention) being qualitatively different from ADHD-A comes from numerous studies indicating that the inattentive ADHD children seem to have deficits in processing speed and selective attention (Goodyear & Hynd, 1992), a slowed response style and cognitive sluggishness (Fuster, 1997; Goodyear & Hynd) resulting in severe academic problems (Fuster;

Goodyear & Hynd; Hynd et al., 1991; Stanford & Hynd, 1994). Additionally, there is a greater report of confusion, daydreaming, withdrawal, anxiety, somatic complaints, passivity and apprehension (Fuster, 1997). Conversely, children with ADHD-C demonstrate behavioral disinhibition (distractibility and hyperactivity), and deficits in sustained attention (Barkley, 1997; Schaughency & Hynd, 1989).

Neurologically, there appears to be differences as well (Fisher, 1998). In ADHD-A, it appears that there is a deficiency in the parietal area of the brain and right-hemisphere functions (Robaey, Breton, Dugas, & Renault, 1992). Conversely, ADHD-C seems related to left-hemisphere frontal areas and subcortical loops (Filipek et al. 1997; Giedd et al., 1994).

Pharmacologically, ADHD-A also differs in its response to neurotransmitters with only norepinephrine implicated (Cope, 1986). Norepinephrine is the neurotransmitter suspected to influence the ability to selectively pay attention to only what is important. Conversely, serotonin has been found to be an inhibitor of activity and behavior with a low level of serotonin believed to result in impulsivity and aggression (Halperin et al., 1994) as seen in ADHD-C. Dopamine is thought to mediate aspects of intention, with low levels hindering functioning of planning and mental flexibility as seen in ADHD (Robbins & Everitt, 1995). High concentrations are noted in the brain-stem nucleus locus ceruleus and are important in the habituation to irrelevant stimuli (Stuss & Gow, 1992). Based on this information, Barkley excludes ADHD-A from his current model, suggesting that it is in fact, a separate disorder with its own distinctive features, more similar to an internalizing disorder (Barkley, 1990; Barkley, Grodzinsky, & DuPaul, 1992; Goodyear & Hynd, 1992; Hinshaw, 1994; Lahey & Carlson, 1991).

Behavioral Inhibition

Fuster (1995) states that complimentary to attentive focusing is its roots in inhibition. According to Fuster, and earlier Treisman (1964) in the filter theory of attention, to selectively attend it is necessary that all else be suppressed by the nervous system. Barkley (1996) states that behavioral inhibition is actually comprised of two related processes. The first is the capacity to inhibit responses which elicit immediate reinforcement either prior to their initiation, or just after, thereby creating a delay in the response to a given stimulus. The second process involves the protection from interference by competing events, and by extrapolation the response to such events as well as their reinforcement. Self-initiated actions can then occur within the delay, allowing the created goal-oriented behavior.

Because of the protected delay of this prepotent response, Barkley (1996) suggests that it is then possible for the four executive functions to act effectively in modifying the person's eventual response to a stimulus such that immediate and future consequences are maximized. It is the interactive and interreliant functioning of these four components that permit normal self-regulation. (Barkley, 1997). Barkley further suggests that a deficit in any one of these executive functions will produce an impairment in self-regulation in that given area, distinct from a deficit in another one of the functions.

Behavioral inhibition is the ability to inhibit prepotent responses, the ability to interrupt an ongoing response, and interference control. Taken together, these allow the creation of a delay in responding during which the other executive functions can occur (Barkley, 1997). Developmentally and evolutionarily it appears to have emerged prior to the executive functions in that it allows for the survival of the species as it prohibits the

execution of purposeless or unproductive responses in the attainment of goals (Fuster, 1980). Behavioral inhibition is not causal, but supports and allows the other four executive functions to act. Based on Bronowski's (1977) theory, delayed responding provides the basis for separation of affect, prolongation, internalization, and reconstitution. Separation of affects allows one to evaluate events rationally and logically, whereas prolongation is the ability to extend the effect of the stimulus for comparison with one's memory (hindsight and foresight) and may also be referred to as working memory. Internalization of language allows an individual to reflect and form rules and practical instructions. This development of rule-governed behavior allows individuals to become less variable in their responses as maturation occurs. Finally, reconstitution is the analysis or decomposition of a stimulus and then the synthesis of these parts in new ways such that creative problem solving occurs. This analysis and synthesis would seem to have evolved last. This process is similar to Bloom's Taxonomy of comprehension, application, analysis, synthesis, and evaluation (Bloom, Englehart, Furst, Hill, and Krathwohl, 1956).

Barkley (1997) states that the Taxonomy of Inhibition of prepotent responses refers to an individual's ability to keep from acting on an event, especially when there is a conflict between immediate and future consequences. He posits that the ability to interrupt an ongoing response is critical to self-regulation in that if feedback signals the ineffectiveness of a behavior then an individual needs to be able to self-monitor and interrupt the behavior. This is seen in an individual who appears to be sensitive to errors and is flexible enough to alter behavior accordingly. Barkley suggests that the final inhibitory process is interference control. This is especially important during the delay in

responding, as it is during this particular time frame that one is most vulnerable to external and internal sources of interference (Fuster 1980, 1989). As internal and external change does not cease during this delay, it may be disruptive to the individual if not held in check. Barkley suggests that the more similar the events or changes are to that being processed by the executive functions, the more difficult it is to protect those functions from disruption.

Deficient inhibitory control is noted by impulsive behaviors such as: responding before a task is understood, answering before sufficient information is available, allowing attention to be captured by irrelevant stimuli (i.e. distractibility), or failing to correct obviously inappropriate responses (Shachar & Logan, 1990). Research comparing hyperactive children with children diagnosed with a variety of disturbances on a stop-signal paradigm has shown that children with ADHD exhibit deficient inhibitory control (Oosterlaan & Sergeant, 1996; Shachar & Logan). Disinhibition seems to be related to variable response processes due to fluctuations in the ability to inhibit distractions or a failure to allocate resources effectively (Oosterlaan & Sergeant), and an inability to control and direct attention to the demands of a task (Teeter & Semrud-Clikeman 1997). Thus disinhibition is central to ADHD (Loge, Staton, & Beatty, 1990), and may in fact be its hallmark (Barkley, 1990).

Working Memory (Nonverbal)

Barkley's 1994 model of Behavioral Inhibition noted the first of the four executive functions as "Prolongation/Working Memory". However, his 1997 hybrid model altered and expanded this area. This variable of the theory entails only nonverbal working memory, and also is the umbrella for several other areas as noted in the diagram

(see Figure 1). This executive function covers all sensory-motor behaviors (event, response, and outcome), especially in connection with covert visual imagery and covert audition. The ability to internalize this information is then used to guide behavior cross-temporally. This executive function allows one to hold an event in mind so as to use it to control a response (Goldman-Rakic, 1995). It allows one to covertly reactivate sensory images of the past, the number and complexity expanding with one's development, so as to manipulate the event as necessitated.

According to Barkley (1997), subsumed under this umbrella are the following areas: imitation and vicarious learning, hindsight, forethought, anticipatory set, self-awareness, sense of time, cross-temporal organization of behavior, and nonverbal rule-governed behavior. The first of these involves the capacity to hold a mental representation of the targeted behavior to be imitated. The individual must not only learn what to do, but when it is appropriate, and what the consequences might be. Bandura's (1973) Social Learning Theory suggests that this behavior is then maintained through social reinforcement. It is through this vicarious learning that adaptive performance is made possible. Additionally, with an individual's development, the ability to sequence longer and more complex behaviors becomes feasible (Barkley).

Hindsight as noted by Bronowski (1967/1977) and Fuster (1989) is the ability to re-image past events inclusive of all senses - sight, sound, smell, taste, and touch. It allows for the prolongation of their existence as an aid in determining current appropriate behavioral choices. Fuster further clarified this with the sense of time. It is the ability to bring forward from the past into the present, and requires a delay in action for this to occur. Such recall requires the correct temporal sequencing of the past events within the

working memory to allow accurate consideration (Fuster; Godbout & Doyon, 1995). Additionally, according to Bronowski (1967/1977) the reactivation in working memory of past events appears to activate the motor response patterns associated with those events. It is through this mechanism, which allows the reactivation and prolongation of a past event sensorally, motorically, and somatically (affective and motivational) that a priming occurs should similar markers occur in the future. A bias is thus created with a temporal connection between hindsight and forethought (Barkley, 1997)

Fuster (1989) defined anticipatory set as a priming of a set of motor responses directed toward the future based on recall of the past. This requires an ongoing comparison of the entire sequence of events, past and present. This function is believed to occur in the right prefrontal regions of the brain (Goldberg & Podell, 1995). It is through this process that feedback indicates a discrepancy between the current external situation and the internal desired outcome, as well as an evaluation of the plan to achieve that outcome.

Within this framework, Barkley (1997) suggests that the feedback must be held in working memory long enough to allow the correcting and refining of the internally represented plan, so as to alter behavior in order to achieve the goal. Therefore, a sensitivity to feedback and a flexibility of behavioral responses is required. Self-awareness as used here allows the simulation and testing out of imagined events and behaviors as well as possible consequences (Dennett, 1995; Gregory 1987); the ability to preselect responses prior to their initiation follows from an awareness of oneself, a sense of internalized locus of control, and an ability to prepare for the future. Working memory thus aids in the development of self-awareness (Kopp, 1982).

Several researchers have suggested that the ability to sequence events in working memory allows one to experience a sense of time (Bronowski, 1967/1977; Michon, 1985), and first begins to emerge between five and seven years of age (Speece & Brent, 1984). This perception permits the analysis of those sequences for patterns of recurrence, which in turn allow for the prediction of future patterns. This ability to process temporal information requires attention within the working memory system (Barkley, 1997; Michon & Jackson, 1984).

Fuster (1989) suggested that the main function of the prefrontal cortex is the cross-temporal organization of behavior. Barkley (1997) goes on to suggest that the ability to organize the past, present, and future should increase with development as the prefrontal cortex matures. When correlated with his model, Barkley suggests that differences among individuals of the same age are partly a function of their differences in capacity for behavioral inhibition and working memory as noted by their preparatory behaviors.

A delay in responding requires one to retain a mental representation of the stimulus event (Bronowski, 1977). This prolonged mental representation is thus dependent upon the ability to inhibit a response. This is a developmental process begun in infancy (Diamond, 1990; Diamond, Cruttenden, & Niederman, 1994; Goldman-Rakic, 1987) and forms the basis for working memory. It allows the holding of mental information while acting upon it (Fuster, 1989). Once the information has been acted upon via a response, this provisional memory is removed from working memory. However, it is possible for these mental representations to be stored in long-term memory. This allows its retrieval at some point in the future when necessary to better

consider a response to another event. This may be termed either "hindsight" (Bronowski) or "retrospective function" (Fuster). In order for this process to take place, events must be coded by temporal order as it is the ability to retain events sequenced by time that enables the "subjective estimation of time" (Michon, 1985). In other words, it allows for the prediction of future events based on past patterns of events. Thus, a person is able to create an anticipatory plan of action (Fuster). This may be seen as "forethought" (Bronowski) or "prospective function" of working memory (Fuster). Based upon this understanding, Green, Frye, and Meyerson (1994) advanced the concept that from this sense of the future emerges the ability to place more value upon future consequences than immediate ones. They further suggest that this is a lifelong developmental process.

Barkley's model brings to the forefront the critical role of working memory in maintaining one's intentions to act as a link between inattention and disinhibition. These "intentions" or plans guide the construction and execution of complex chains of goal-directed actions over time (Fuster, 1989). This creates response persistence and allows a person's capacity to sustain attention for extended periods of time in an effort to obtain a future goal. James (1890/1992) noted that it is this prolongation of mental events that underlies human determination and self-discipline. Thus, humans can organize responses/behaviors cross-temporally due to the ability to prolong mental representations, thereby allowing working memory, hindsight, forethought, a sense of time, and an anticipatory set to occur. It involves the linking of events, responses, and their consequences. Barkley (1996) hypothesized that this occurs within and as a consequence of working memory and prolongation, resulting in self-regulation relative to time.

Language too, according to Barkley (1996) plays a key role in this endeavor. Developmentally, the ability to use language to express cognition and time references increases with age. Moreover, any effect of disinhibition on working memory will diminish an individual's subjective sense of time, and thereby one's reliance of hindsight or forethought in behavior governance. Anticipatory or predictive sets are then diminished, thus reducing the ability for cross-temporal organization of complex behavior toward a future goal as is seen with individuals with ADHD. Barkley believes that the greater the delay to which separates the event, response, and consequence of a behavior, the more difficult the task will be for persons with ADHD.

Internalization of Speech (Verbal Working Memory)

Initially, speech is used for communication with others. But as time advances beyond the preschool years, behavioral inhibition progresses. The ability to delay responses allows language to additionally be turned inward as a means of reflection (self-directed description) and also to regulate one's own behavior (Berk & Potts, 1991; Bronowski, 1977; Vygotsky, 1978, 1987). Between ages six to ten a developmental process ensues with self-directed speech beginning publicly, proceeding to sub vocalization, and finally to being private (Berk & Potts; Kopp, 1982).

According to Barkley (1996), this occurs as a result of general and rule specific language (behavior-specifying stimuli), achieving increased stimulus control over motor behavior, thereby providing a greater capacity for self-control, planfulness, and goal-directed behavior. Hayes, Strosahl, and Wilson (1999) believe that the increase of internalized speech has a positive correlation with increased self-knowledge. Skinner (1974) suggested, "Self-knowledge has a special value to the individual himself. A

person who has been 'made aware of himself' is in a better position to predict and control his own behavior" (p. 31). Barkley appears to support this as he suggests that this internalization of speech also encompasses response internalization. Thus speech becomes privatized, thereby creating the means for the verbal thought process involved in self-directed behavior (Berk & Potts, 1991; Vygotsky, 1987).

Barkley (1997) suggests that verbal working memory (self-speech) along with nonverbal working memory may contribute to three other mental abilities. These include delayed performance of a current instruction containing a future reference (rule-governed behavior), reading comprehension, and moral reasoning. Reading comprehension has a significant relationship to working memory (Swanson & Berninger, 1995) within the prefrontal lobes (Frisk & Milner, 1990) perhaps as a result of the necessity of holding in mind what is read so as to obtain maximum comprehension (Barkley, 1997).

The area of rule-governed behavior can best be seen in that with the developmental increase in privatization of language comes increased control over motor behavior (Berk, 1992, 1994; Berk & Potts, 1991; Vygotsky, 1978; Luria, 1961). Barkley (1997) explains that rules are contingency-specifying stimuli, specifying a relationship between an event, a response, and a consequence. Language is integral to this in that Bronowski (1967/1977) stressed that self-directed speech guides behavior or problem solving by description, reflection, and creation of new rules. The ability to imagine and make plans is based on one's ability to visualize alternatives, and then make a choice between them (Bronowski). Barkley suggests that it allows the sustaining of behavior across gaps in time, and the ability to create new and novel hierarchically organized behaviors. Hays (1989) and Cerutti (1989) note that rule-governed behavior allows for

reduced variability in responses to events and is less affected by immediate contingencies. Additionally, where immediate contingencies compete in a given situation, the development of the rule-governed behavior takes precedent and allows persistence in the face of low or absent immediate reinforcement. Skinner (1969) suggested that rule-governed behavior is likely to be associated with less emotion as immediate contingencies do not have the same effect, and behavior appears conscious, and deliberate, as opposed to reactive and impulsive.

Moral reasoning is the internalization of community norms and morals. It focuses on how one ought to behave cross-temporally (Berk, 1992; Hayes, Gifford, & Ruckstuhl, 1996; Kohlberg, Yaeger, & Hjertholm, 1968). Cross-temporal behavioral control arising from working memory in the executive functions contributes to the development of moral reasoning (Kochanska, DeVet, Goldman, Murray & Putnam, 1994; Kohlberg, 1963). According to Barkley's (1997) quote of Darwin (1871/1992), "A moral being is one who is capable of comparing his past and future actions or motives, and of approving or disapproving of them."(p. 311).

Self-Regulation of Affect/Motivation/Arousal

Motivation theories include Murray's (1938) concept of need, in which depending on the exigencies and which is most dominant at the time, approach or avoidance behaviors will be activated. Maslow (1954) looked at unsatisfied need as central to motivation in that the external opportunities to fill the need motivate the individual. Both of these are examples of Trait Theories where motivation is seen as the traits within an individual concurrent with situational factors.

Other theories include Kohlberg's (1969) Theory of Moral Development in which one's motivation to intervene on behalf of another or seek out reciprocity is based on one's moral development; as well as Epistemic Motivation which states that one is motivated by the need to seek out information and knowledge so as to organize, simplify, and make more predictable the environment. This includes Kruglanski's theory (1989) in which the need for closure and the need for validation act as motivating forces. Feltz & Mugno (1983) took this a step further to suggest that self-efficacy is influenced by perceptions of arousal, and that this arousal correlates with motivation to complete a goal or task. Cervone's (1989) study found that persons with positive self-efficacy were more likely to persist toward goal attainment.

Theories of Achievement Motivation include Atkinson's (1974) theory that places perceived success, or expectancy to achieve the goal, multiplied by the perceived value of the success as commensurate to the tendency for one to approach the task. One instrument, the Teacher Rating of Academic Achievement Motivation scale, combines the approaches of trait motivation with academic motivation in measuring the tendency to approach, accomplish, and master academic tasks (Oehler-Stinnett, Boykin, Matlock, Frissell, and Nickell, 1998). However, the theory which appears to most closely resemble Barkley's current model is that of Kuhl's (1984, 1987). His model includes the differentiation of choosing an action to complete a task in the motivational process, and its actual execution. In other words, choice to act is not equivalent to the execution of the action. In fact when an action must be protected from a competing action tendency as in a Stop-Go situation, volitional processes become key for its implementation. Kuhl further postures seven specific types of processes necessary for the implementation of an

intention. These include 1) Selective Attention in which all irrelevant aspects are ignored, 2) Encoding Control in which specific pertinent information to the moment has greater focus, 3) Emotion Control where emotions that are not conducive to the attainment of the goal are held in check, 4) Motivational Control where a new motivational process is implemented in the face of a stronger tendency so as to allow the desired goal to gain greater strength via remembered expectancies and positive incentives necessary for motivational action, 5) Environmental Control which uses social pressure as well as the removal from the environment anything that might need to be avoided or would prove to be a distraction from the intention, 6) Parsimonious Information Processing so as to assure eventual action, and 7) Coping with Failure in a manner that allows detachment from the unattained goal such that the process can begin again. It becomes evident in reviewing Barkley's theory that he has been influenced by aspects of these and other theories of motivation as it relates specifically to self-regulation of affect.

Barkley (1996) stated that the development of self-regulation of affect in children is a result of behavioral inhibition. While the emotion is still experienced, the response to it is delayed, as is any motor behavior associated with it. This delay enables the individual to have enough time to engage in self-directed behaviors that will ultimately modify both the eventual response as well as the emotional reaction that accompanies it. Bronowski (1977) termed this "separation of affect" and is thought to permit greater objectivity in the determination of an eventual response to an event. Fuster (1989) suggested that not only is affect managed by the development of self-regulation, but so is drive and motivation. This would then permit one the possibility to learn to bring about the motivational state required to initiate and maintain goal-directed behavior (Barkley).

If the above model is applied to ADHD, then it is possible to assume that persons with ADHD should display greater emotional expression in response to events as well as less objectivity in the selection of a response to an event. The individual with ADHD should also by inference display diminished social perspective as the emotional reaction isn't delayed long enough to take the view and needs of others into account, and finally to display a lessened ability to induce arousal and a personal drive state so as to achieve goal-directed behavior. In support of this is a recent study by Braaten (1999) where boys with ADHD were found to exhibit more externalizing manifestations of sadness, anger, and guilt than boys without ADHD but with less intensity. Moreover, they were less able than controls to identify and match their emotions to that of a child in a story, thus indicating less social perceptions. Finally, results indicated that they were less responsive to external consequences.

Barkley (1996) also suggested that it is possible that social perceptions might also be affected by working memory deficits. This might be the case in that working memory must keep several events in mind at the same time so as to evaluate each as well as a group. It follows that those persons with ADHD appear less mature due to deficiencies in their behavioral inhibition. As a result they may remain far more dependent upon external situations to determine their motivational state.

Heckhausen (trans. 1991) defines extrinsic motivation as originating from without the individual, and intrinsic motivation as that which originates within the person and is self-reinforcing. Additionally, it has been shown that it is within the prefrontal cortex, particularly the ventral and medial areas that initiative, intent, or motivation are derived. (Fuster, 1989; Damasio, 1994, 1995, Stuss, Gow, & Hetherington, 1992), as well as

emotional hyperreactivity and affect (Stuss, Gow, & Hetherington). Moreover, these same areas are associated with self-inhibition, and working memory. These are necessary to allow the holding of information so as to allow the organizing of a plan of action (Barkley, 1997). Neuroimaging studies have shown that this area is effected in persons with ADHD-HI and ADHD–C, although gender, age, and variable being measured, alter the results to some degree (Ernst et al, 1995, Filipek et al., 1997, Giedd, et al., 1994, Hynd et al., 1991, Vaidya et. al., 1998, Zametkin et al., 1993).

Furthermore, ADHD-HI or ADHD–C individuals do not appear to differ from controls when immediate and continuous rewards are employed as a means of external motivation (Barkley, 1989). It is when this reinforcement is reduced or a delay between the action and the reinforcement is introduced, the ADHD children's performance is decreased as compared to the controls (Parry & Douglas, 1983). Barkley (1997) contends that it is not a lessened sensitivity to the reinforcement, which has had mixed results in research (Barber, Milich, & Welsh, 1996; Haenlein & Caul, 1987) but one of an inability to bridge the temporal delay that results in a decrease in performance.

Reconstitution

Bronowski (1977) stated that language represents objects, actions, and their properties. It thus provides a means, through internalized speech, to take the world apart and recombine it in creative ways for a certain range of possible contingencies (Fuster, 1980). Barkley (1996, 1997) suggests that a delay in responding, as permitted by behavioral inhibition, allows time for events to be mentally disassembled, information extracted then recombined, and a response prepared. This preparatory period allows the adjustment of the sensory and motor apparatus before each event, such that relevant

information will be optimally received, and the probable sensory systems for response sets can be readied. The necessary analysis and synthesis represent a given behavior or a sequence of behaviors that separate and recombine frequently in a hierarchical organization (Barkley; Fuster, 1989). Bronowski spoke of verbal fluency as evidence of this reconstitution, with Barkley extending this to behavior fluency. Thus, when a goal is presented, the reconstitutive function works upon the archive of behavior sequences to flexibly and creatively generate one that will allow attainment of the goal. Fuster suggested the involvement of the dorsolateral prefrontal cortex as there is an increase of neuron discharge just before cues and responses in delay tasks. Additional research indicates that lesions to the prefrontal cortex disrupt this capacity to properly sequence behavior (Fuster, 1980, 1989; Godbout & Doyon, 1995; Milner, 1995).

Motor Control/Fluency/Syntax

The final component of Barkley's (1997) hybrid model involves motor control, fluency, and syntax which behavioral inhibition directly and indirectly effects. It involves the inhibition of task-irrelevant responses, the execution of goal-directed responses as well as novel or complex motor sequences, goal-directed persistence, sensitivity to response feedback, behavioral flexibility, task re-engagement following disruption, and control of behavior by internally represented information. According to Barkley's model any deficiency in any of the aforementioned areas should be visible in the planning and execution of motor actions. Difficulties in the development, planning, and execution should be apparent in fine and gross motor behaviors, as well as in more complex and lengthy goal directed behavior. With a child's normal development, behavior should

increase in deliberateness, reasoning, and future-orientation. Barkley summarizes by stating:

> "Throughout the execution of goal-directed behaviors, working memory permits the feedback from the last response(s) to be held in mind (retrospective function) so as to feed forward (prospective function) in modifying subsequent responding, thereby creating a sensitivity to errors, and behavioral flexibility. Just as important, when interruptions in this chain of goal-directed behaviors occur, the individual is able to disengage, respond to the interruption, and then reengage the original goal-directed sequence because the plan for that goal-directed activity has been held in mind despite interruption. Thus inhibition sets the occasion for the engagement of the four executive functions, which then provide considerable greater control over behavior by the internally represented information they generate". (p. 193)

Instruments

The following is an explanation of instruments used in this study. They are grouped according to the variable being assessed within Barkley's model. Each was selected based upon Barkley's definition of each variable in an effort to obtain the most pure measure of each, and then verified by a personal communication (R. A. Barkley, June 28, 1999). The two exceptions to the personal communication are Reconstitution and Motor Control/Fluency/Syntax. Reconstitution was noted as being a measure of verbal fluency and inventiveness in the personal communication of which a firm measure did not seem to exist. Therefore, the measure selected was one based upon the

researcher's interpretation of the definition noted in his model (Barkley, 1997). The other, Motor Control/Fluency/Syntax, was not discussed with Dr. Barkley as to the best type of outcome measure. Therefore, once again, the researcher's choice of instrument was based upon the definition of the variable in his model (Barkley).

Behavioral Inhibition

Behavioral Inhibition as defined by Barkley (1997), "refers to three interrelated processes: (1) inhibiting the initial prepotent response to an event; (2) stopping an ongoing response or response pattern, thereby permitting a delay in the decision to respond or continue responding; and (3) protecting this period of delay and the self-directed responses that occur within it from disruption by competing events and responses (interference control)" (p. 47). The direct measure of this variable was the commission error scores from the Conners' Continuous Performance Test.

Quay (1997) states that the best test of "pure" disinhibition is a stop-signal task which necessitates a participant to interrupt an ongoing motor response to a target. Behavioral Inhibition requires attention to sustain focus so as to be selective and effortful in responses over a period of time. According to Gray (1987), it is the behavioral inhibition system located in the septo-hippocampal system and its connections to the frontal cortex whose output results in the cessation of ongoing behavior, an increase in nonspecific arousal, and a focusing of attention on relevant environmental cues. It measures a higher complex form of attention following Luria's description (1973).

The Conners' Continuous Performance Test (CPT) is a computer program designed to measure sustained attention. In the standard mode used for this study, respondents were required to press a key whenever a stimulus letter appeared on the

monitor. The exception to this was the letter "X", in which the child was required to withhold a response. The course of the administration of approximately 14 minutes is divided into six blocks of time, with three sub-blocks of twenty trials. The stimuli were presented in intervals between one and four seconds. Among measurements derived for each child was a Commission Error Score. Commission errors indicate the number of times the child responded to non-target letters. The score is based on the number of incorrect responses to the total number of presented non-target stimuli. Scores are converted to standard T-scores with a mean of 50 and a standard deviation of 10. Thus, scores of 60 or above represent potential problems with behavioral inhibition. The standard version of the Conners' CPT was normed on a total of 1190 children and adults to assess the percentage of false negatives and false positives. Of these, 230 were clinical cases, in which differential diagnosis of ADHD resulted in only 8.3% being false negative, with 14.1% being false positive. Of the general population differential diagnosis with the Conners' CPT resulted in 12.9% being false positives. While separate results were not available for commission errors, Barkley suggested commission errors as perhaps one of the best methods of assessing Behavioral Inhibition.

Working Memory (Nonverbal)

According to Gazzaniga, Ivry, & Mangun (1998) working memory is a construct which is indicative of those processes that are currently within one's cognition. They further state that sustaining representations during a delay period is accomplished by sub regions within the lateral prefrontal cortex. Nonverbal working memory is the ability to hold events in one's mind and to be able to manipulate or act on the event (Barkley, 1997). The Children's Memory Scale (CMS) is a comprehensive instrument of nine

subtests in three domains (Cohen, 1997). The domains include measures of visual/nonverbal learning and memory, auditory/verbal learning and memory, and attention/concentration in children ages 5 to 16. The CMS was normed on 1,000 normally-functioning children in 10 age groups with race/ethnicity based on those group proportions as obtained from the U.S. 1995 census.

The CMS visual/nonverbal subscale was Delayed Dot Locations was selected to represent visual delayed nonverbal working memory. It has an internal consistency reliability average of .74 across all ages with an average standard error of measurement of 1.56. The task presents the child with an array of dots over three learning trials in which the goal is to learn their spatial locations. This is followed by the presentation and recall of a single distractor array and a delay. The child is then requested to recall the dot array presented earlier. It purports to measure the child's ability to retain new nonverbal material in working memory and then respond in a prescribed manner after an interference task and a timed delay (Cohen, 1997).

According to Bronowski (1967/1977) and Fuster (1989) it is the ability to reactivate these images and then prolong their existence within working memory such that past history comes forward and allows a guide for current responses that is the essence of hindsight. Additionally, this process primes responses and thus bias their selection for future events, or as labeled by Bronowski and Barkley (1997), forethought occurs. Fuster (1980) noted that delayed response tasks (such as in the Delayed Dot Location subtest) may be the best example of a test for assessing working memory as the participant must mentally represent a prior event. Thus a sense of time becomes paramount.

Internalization of Speech (Verbal Working Memory)

Internalized speech refers to the development of privatized speech such that behavior becomes increasingly under its control (Barkley, 1997). According to Berk and Potts (1991) and following Vygotsky's theory of private speech development (1987), it begins as speech uttered out loud and other directed, then self-directed and accompanying an ongoing action by age five, then proceeding through stages until it has evolved to a point of being completely subvocalized and involves regions of the prefrontal cortex which are noted for speech planning and response inhibition (Ingvar, 1993; Ryding, Bradvik, & Ingvar, 1996). Internalization of speech or verbal working memory may further be defined as the ability to describe and reflect, the ability to self-question and problem solve, the ability to follow oral instructions, the effective generation of rules/meta-rules, reading comprehension (Swanson & Berninger, 1995), and moral reasoning.

One of the Auditory/Verbal subscales of the Children's Memory Scale was utilized as a direct measure of portions of this variable. The Auditory/Verbal Working Memory subtest of the CMS used was Delayed Stories which requires a child to reflect on, recall, and describe meaningful and semantically related verbal material. This appears to best measure Barkley's variable as it requires the retention of verbal material across delay intervals, with a concomitant demand for organizing the material in a manner so as to more easily restate the material when called upon to do so. The average internal consistency for Delayed Stories, as measured by Cronbach's alpha coefficient, is .75 (Cohen, 1997).

Self-Regulation of Affect/Motivation/Arousal

According to Ekman & Davidson (1994) arousal is affected by motivational and emotional factors. Self-regulation of affect may best be seen as a lack of emotional lability. By being able to delay one's immediate emotional responses, one is able to control and regulate a behavioral response. In the same vein, a child that is able to keep aroused in a readiness state but not so much as to be overwhelmed, is more likely to handle decision-making in a more informed manner (Newman & Wallace, 1993). The ability to consider other social perspectives (Barkley, 1997) is directly related to the ability to hold the event in mind while looking at it from a variety of perspectives. Furthermore, it allows a greater sense of objectivity. Self-regulation of arousal according to Barkley should be viewed as being in the service of goal-directed actions. Motivation is effected by the ability to retain one's goal in mind, to be able to subvocalize self-encouragement, and the ability to use rule-governed behavior so as to permit the bridging of delays in reinforcement and permit the persistence of goal-directed behavior (Barkley).

In an effort to measure this variable of Barkley's model, Self-Regulation of Affect/Motivation/Arousal, an indirect measure was used, the Conners' Rating Scales-Revised Emotional Lability subscale. This subscale appears on the Parent Rating Scales-Long form. Internal Consistency as measured by Cronbach's alpha coefficient for Conners' Global Index – Emotional Lability ranged from .67 to .80 depending upon gender and age. The median alpha was .73.

Reconstitution

Reconstitution is analysis and synthesis of verbal (Bronowski, 1977) and nonverbal (Barkley, 1997) fluency, and can be seen in the flexible ability to rapidly and

accurately assemble diverse units of language and motor behaviors. It requires the ability to construct novel, complex, and sequential responses from one's repertoire of response units so as to obtain a goal. Barkley suggests that Reconstitution may be seen in verbal fluency and behavioral fluency, analysis and synthesis of behavior, rule creativity, goal-directed behavioral creativity and diversity, syntax of behavior, and the use of behavioral simulations. Thus the ability to delay a response allows one to covertly create and test response options prior to selection of one (Dehaene & Changeux, 1995).

- The measurement of this variable was obtained via the Planning subscale of the Cognitive Assessment System (CAS). Planning provides cognitive control, utilization of processes and knowledge, intentionality, and self-regulation to achieve a desired goal. Behavior is observed in the child creating plans of action, applying the plan, verifying if it conforms to the goal, and using this feedback to modify his/her actions as needed. Decisions must be made about how to solve novel tasks. The internal consistency as measured by Cronbach's alpha is high at .85 (Naglieri & Das, 1997).

Motor Control/Fluency/Syntax

Motor Control/Fluency/Syntax are motor responses that ultimately are available to an individual once behavioral inhibition is in place supporting the four executive functions. Motor responses take on goal-directed relevancy as well as the ability to perform complex, novel, and hierarchically organized goal-directed behaviors which may be altered upon response feedback. Moreover, once interrupted, one should be able to return to the activity and pick-up where one left off, having retained cross-temporally the original goal.

The indirect measure for this variable was derived from the Behavior Assessment System for Children (BASC) Adaptive Skills Composite on the parent rating scale. The Adaptive Skills items rate the child on task-irrelevant responses, and general motor overflow. The Adaptability scale purports to include temperament variables, attention/distractibility, behavioral flexibility, and activity level. It appears to correlate with early academic achievement as its items assess the child's ability to adjust to changes in routine, and the ability to shift from one task to another as required. Thus it appears to be a good measure of this variable in terms of appropriate behavior flexibility and goal directed persistence such as required in academic achievement. Internal consistency ranges from .91 to .93 for ages 6 to 14 (Reynolds & Kamphaus, 1992).

Statement of the Problem

As pathological states are variations from normal states (Barkley, 1997), Barkley's model had first to begin with normal psychological functions as they result in self-regulation and executive neuropsychological functions because it is these very functions that support self-control. The research clearly indicates that ADHD is more a deficit of behavioral inhibition than of attention, and that it is this disinhibition that results in a disruption of the four executive functions that lead to self-regulation. The child with ADHD is less regulated and thus governed by internal processes and aspects of time, and thus sources of control have shifted as a consequence of having this disorder. However, to this point, this hybrid model remains a theory and has not been tested. If in fact, it is accurate, then hyperactivity is but an initial manifestation of poor inhibition and self-control, and will with time result in the symptoms of inattention which persist longer. Additionally, it will allow for a continuum of symptoms that alter in their severity due to

the developmental nature of the theory base. As such, assessments, diagnosis, and the overall understanding of ADHD become altered. The treatment becomes one of working with the element of time as well as stimulant medications. The theory becomes not only a stepping stone to a better understanding of what is and what is not ADHD, but of overall neurophysiology.

Purpose of the Study

This relationship study was conducted in an attempt to gain insight into the variables proposed by Barkley's 1997 Hybrid Model of ADHD as they are related to the complex outcome variable of Motor Control/Fluency/Syntax. If there is a high correlation of each of these variables with the criterion outcome variable, then a prediction based on a combination of those variables will be more accurate than a prediction using only one. Assessment instruments were selected based on measures suggested by Barkley (1997; personal communication, June 28, 1999) as the purist indicators of each of the variables. As ADHD is usually first diagnosed within the onset of formal schooling, it is this elementary school age population that was targeted.

Research Questions

Because this is the first such study, and the model suggests that all variables are equal, research questions were advanced in lieu of hypotheses.

1. Is there a relationship between Behavioral Inhibition and Motor control/fluency/syntax?
2. Is there a high correlation relationship between Nonverbal Working Memory and Motor control/fluency/syntax?

3. Is there a relationship between Internalization of Speech (verbal working memory) and Motor control/fluency/syntax?
4. Is there a relationship between Self-Regulation of Affect/Motivation/Arousal and Motor control/fluency/syntax?
5. Is there a relationship between Reconstitution and Motor control/fluency/syntax?
6. Are Behavioral Inhibition, Nonverbal Working Memory, Internalization of Speech, Self-Regulation of Affect/Motivation/Arousal, or Reconstitution predictive separately or as a group of Motor Control/Fluency/Syntax?

CHAPTER III

Method

This chapter provides an overview of the methods used in this study. Participants, design, procedure and statistical analysis are discussed.

Participants

There were sixty-nine kindergarten through seventh grade males and females participated in the study. While only one was in kindergarten, fifteen were in the first grade, fourteen were in second, thirteen in third grade, fifteen in the fourth grade, four in fifth, five in sixth, and two in seventh grade, The median grade was third. Of these children, forty were male and twenty-nine were female. Their ages ranged from six to thirteen, with a mean age of 8.83 years, and a standard deviation of 1.79. Of the sixty-nine students, two classified themselves as African American, fifty-seven as Caucasian, three as Asian, five as Hispanic, four as Native American, and four as Other. The children were from a small town in the Southwest and the surrounding rural communities. At the time of the study, parent report indicated that none had been diagnosed with mental retardation, nor displayed any evidence of a psychotic disorder or overt neurological disorder (e.g. epilepsy, closed-head injury). Table 1 summarizes the participation information.

Table 1

Demographic Information and Frequency

Gender	Frequency	Gender Percent
Male	40	58
Female	29	42
Total	69	100

Age	Frequency	Age Percent
6	6	8.7
7	14	20.3
8	10	14.5
9	15	21.7
10	11	15.9
11	7	10.1
12	5	7.2
13	1	1.4
Total	69	100

Grade	Frequency	Grade Percent
K	1	1.4
1	15	21.7
2	14	20.3
3	13	18.8
4	15	21.7

5	4	21.7
6	5	7.2
7	2	2.9
Total	69	100

Ethnicity	Frequency	Ethnicity Percent
Caucasian	57	82.6
African-American	2	2.9
Asian/Pacific Islander	1	1.4
Native American	2	2.9
Hispanic	3	4.3
Other	4	5.8
Total	69	100

Procedure

Recruitment

Children were recruited via flyers placed at the local elementary schools, the Oklahoma State University Reading and Math Center, and on university bulletin boards. Children were asked to spend a full day at the clinic undergoing a comprehensive multifaceted assessment. They were allowed breaks as needed and an hour lunch off-site. Parental permission was obtained along with child assent.

Assessment

Parents were interviewed (see Appendix A) to gather medical and developmental information regarding their child/children, and then given the Behavior Assessment

System for Children - Parent Rating Scale (BASC-PRS) and Conners' Rating Scales-Revised (Long Form) to complete and return at the time they picked-up their child for lunch. The parents were then asked to leave, and the children were administered the comprehensive battery of tests. The instruments were counterbalanced and encompassed cognitive ability, memory, and attentional functions. Instruments were selected based on suggestions made by Barkley regarding executive functions in his book (1997) as well as personal communication (June 28, 1999), and were administered individually by trained graduate students. Following the assessments, reports of the test results were written and mailed to the parents along with a letter thanking the parents and the child for their participation in the study, and a number to call if a further explanation of the results was desired.

Design/Data Analysis

The 69 participants were administered a comprehensive assessment using a measure of each of Barkley's model's components being tested. It included structured interviews, parent behavior rating scales, a clinical test of memory, and a cognitive assessment instrument.

This relationship study was conducted to test the theoretical hypotheses concerning the variables Barkley believes to be predictors of the outcome variable, Motor control/fluency/syntax. A correlation regression was completed, to determine variable relationships and if any might be possible predictors. Additionally, if several predictor variables correlated well with the outcome criterion, then a prediction based on this combination would be more accurate than a prediction using only one variable. This was

followed by a stepwise regression so as to ascertain which of the variables determined the greatest variance in the results.

CHAPTER IV

Results

The statistical analyses of the participants' performance on the six measures are the focus of this chapter. Resulting correlation coefficients and regression analyses will be presented. The means and standard deviations of the assessment instruments utilized in this study are in Table 2.

Table 2

Descriptive Statistics Using Adaptability as the Measure for Motor Control/Fluency/Syntax

	Mean	Standard Deviation
1. BASC – Parent Adaptability Composite	48.04	11.02
2. Conners' CPT Commission Errors	46.02	12.31
3. CMS-Delayed Dot Location	11.54	2.64
4. CMS-Delayed Stories	11.43	3.64
5. CRS-R Emotional Lability Subscale	56.64	13.31
6. CAS – Planning Composite	103.48	17.19

In order to determine whether, and to what degree a relationship exists between the six variables noted in Barkley's 1997 model, a correlation analysis was performed. Results in Table 3 indicate that Reconstitution, Internalization of Speech (Verbal Working Memory), and Self-regulation of Affect/Motivation/Arousal (Verbal Working

Memory) were significantly correlated with Motor Control/Fluency/Syntax. Self-regulation of Affect/Motivation/Arousal was also related to Internalization of Speech (Verbal Working Memory) and Reconstitution. Additional findings include a significant relationship between Working Memory (Nonverbal) with Internalization of Speech (Verbal Working Memory). Additionally, when residuals were assessed for possible outliers, any case ± 2 was examined. The range extended from –2.425 to 2.000, with only four cases being questionable. However, upon close examination, results indicated no significant outliers, thereby determining that all cases should remain as part of this study. Moreover, an examination of the Skewness (.264 to .277) and Kurtosis (-.755 to -.003) indicated that the data fits a normal distribution.

Table 3

Correlations of the Six Variables of Barkley's 1997 Hybrid Model

	1	2	3	4	5	6
1. Motor Control/Fluency/Syntax	1.00	112	.225	*.314	***.475	*.267
2. Behavioral Inhibition		1.00	-.108	.195	.097	-.094
3. Working Memory (Nonverbal)			1.00	*.277	.164	.193
4. Internalization of Speech (Verbal Working Memory)				1.00	.368	.183
5. Self-Regulation of Affect/Motivation/Arousal					1.00	*.266
6. Reconstitution						1.00

Note. Motor Control/Fluency/Syntax as measured by BASC-Parent Adaptability Scale

*p<.05 **p<.01 ***p<001

As the correlation analysis indicated that relationships existed between the variables, a regression analysis was performed in order to determine how well the independent variables might explain the dependent variable, Motor Control/Fluency/Syntax. All variables were subsequently entered in the order in which they appear in Barkley's model which is theoretically structured and assumes a developmental progression. Results are noted in Tables 4 and 5. The adjusted R^2 indicates that 23% of the variance associated with Motor Control/Fluency/Syntax as measured by adaptability is accounted for by these predictor variables. The overall F is significant thereby indicating that these variables are significant as predictors of the dependent variable, Motor Control/Fluency/Syntax.

Table 4

Regression with all Variables Entered Model Summary

Model	Variables Entered	R	R^2	Adjusted R^2	Std. Error of Estimate	R^2 Change
1	Behavioral Inhibition Working Memory (Nonverbal) Internalization of Speech Self-regulation Reconstitution	.531	.282	.225	9.70	.282

Note. Dependent Variable: Motor Control/Fluency/Syntax as measured by the BASC Adaptability Composite

Table 5

Regression Coefficient – All Variables Entered

Variables Entered	Standardized Coefficients Beta	To Enter t	Sig	Overall F	Sig
(Constant)		3.317	.002	4.943	.001
Behavioral Inhibition	.118	1.040	.002		
Working-Memory (Nonverbal)	0.375	-3.176	.471		
Internalization of Speech	.081	.726	.244		
Self-regulation	.133	1.177	.400		
Reconstitution	.103	.848	.400		

Furthermore, as Behavioral Inhibition occurs first in Barkley's theoretical model as a necessary support to the other four independent variables, the second regression analysis consisted of forcing this variable first. However, results in Tables 6 and 7 indicate that Behavioral Inhibition accounts for essentially none of the variance in Motor Control/Fluency/Syntax, with the contribution of the other variables accounting once again for 23% of the variance. Thus the four variables, Reconstitution, Working Memory (Nonverbal), Self-regulation of Affect/Motivation/Arousal, and Internalization of Speech would be stronger predictors as a group of Motor Control/Fluency/Syntax than Behavioral Inhibition alone. Moreover, Self-regulation is the strongest predictor of the dependent variable within the second model ($t = 3.126$, $p = .002$).

Table 6

Regression – Forced Behavioral Inhibition

Model	Variables Entered	R	R^2	Adjusted R^2	Std. Error of Estimate	R^2 Change
1	Behavioral Inhibition	.112	.013	-.002	11.03	.013
2	Reconstitution	.531	.282	.225	9.70	.269
	Working Memory (Nonverbal)					
	Self-regulation					
	Internalization of Speech					

Note. Dependent Variable: Motor Control/Fluency/Syntax as measured by the BASC Adaptability Composite.

Table 7

Regression Coefficients – Forced Behavioral Inhibition

Model	Variables Entered	Standardized Coefficients Beta	t	Sig.
1	(Constant)		8.391	.000
	Behavioral Inhibition	.112	.923	.359
2	(Constant)		3.317	.002
	Behavioral Inhibition	.081	.726	.471

Reconstitution	.133	1.177	.244
Working Memory (Nonverbal)	.118	1.040	.302
Self-regulation	.375	3.126	.002
Internalization of Speech	.103	.848	.400

Note. *Dependent Variable: Motor Control/Fluency/Syntax as measured by BASC Adaptability Composite

A stepwise regression was specified next to determine which of the independent variables were most powerful in the prediction of Motor Control/Fluency/Syntax. Results as noted in Tables 8 and 9 indicate that Self-regulation of Affect/Motivation/Arousal explains 21% of the total 23% variability in Motor Control/Fluency/Syntax. Moreover, as it is clear from the previous regression analysis that Behavioral Inhibition adds nothing to the variance, the remaining 2% of the 23% is best accounted for by the three remaining variables, Working Memory (Nonverbal), Internalization of Speech, and Reconstitution. Moreover, the correlation between Self-regulation of Affect/Motivation/Arousal and Motor Control/Fluency/Syntax is significant ($t = .442$, $p < .0005$) indicating that Self-regulation of Affect/Motivation/Arousal is the greatest predictor of Motor Control/Fluency/Motivation as measured in this study.

Table 8

Stepwise Regression – Variables Entered

Model	Variables Entered	Method	R	R^2	Adjusted R^2	Std. Error of Estimate	R^2 Change
1	Self-Regulation	Stepwise (Criteria: Probability -of-F-to-enter <= .050, Probability -of-F-to-remove >= .100)	.475	.226	.214	9.77	.226

Table 9

Stepwise Regression Coefficients

Model	Variables Entered	Standardized Coefficients Beta	t	Sig.
1	(Constant)		13.742	.000
	Self regulation	.475	4.42	.000

Note. *Dependent Variable: Motor Control/Fluency/Syntax as measured by BASC Adaptability Composite

Moreover, although not a central question of this study, and even though Barkley's model does not differentiate between genders, males are often over identified in the diagnosis of ADHD. Therefore, gender differences as related to Barkley's model

were analyzed post hoc. Results indicated no significant correlational differences between genders, However, for males, Internalization of Speech (Verbal Working Memory) was significantly related to Motor Control/Fluency/Syntax ($\underline{r}$ = -.492, $\underline{p}$ < .01), whereas for females, Reconstitution was significantly related to Motor Control/Fluency/Syntax ($\underline{r}$ = .386, $\underline{p}$ < .05).

Finally, because the outcome of ADHD-HI or ADHD-C is often seen in the schools where sustained mental effort is required so as to execute a goal directed response, and as the cognitive measures were low in their relationship with Motor Control/Fluency/Syntax as measured by the Adaptability scale of the BASC, an academic achievement instrument was used to measure Motor Control/Fluency/Syntax. Academic achievement is the short and long term goal within the school, a major system within which a child spends much of his formative years. Additionally, according to Barkley's theory (1997) it is approximately at the onset of formal schooling that inattention first begins to appear in conjunction with the already apparent behaviors indicative of disinhibition. Academic achievement requires sustained and selective attention so as to reach the desired goal of work completion and increased knowledge. The Kaufman Test of Educational Achievement-Brief Form (KTEA) was administered as the post hoc assessment measurement for Motor Control/Fluency/Syntax in lieu of BASC's Adaptability Composite. The means and standard deviations of the instruments utilized in this portion of the study are in Table 10.

Table 10

Descriptive Statistics Using Academic Achievement as the Measure of Motor/Control/Fluency

	Mean	Standard Deviation
1. Motor Control/Fluency/Syntax	100.60	16.18
2. Behavioral Inhibition	46.20	12.08
3. Working Memory (Nonverbal)	11.47	2.68
4. Internalization of Speech	11.43	3.60
5. Self-regulation	55.47	13.25
6. Reconstitution	102.64	17.14

The KTEA is an individually administered measure of school achievement for children and adolescents in grades one through twelve. Its median internal consistency as measured by Cronbach's alpha for grades one through seven, the target grade levels of this study, is .94. Results of this second correlation analysis indicated a significant relationship between Motor Control/Fluency/Syntax (as measured by Academic Achievement) and Internalization of Speech (Verbal Working Memory) ($r = -.394$, $p < .001$), Self-regulation of Affect/Motivation/Arousal ($r = .272$, $p < .05$), and Reconstitution ($r = .435$, $p < .001$). These results account for a significant 29% of the variance with Motor Control/Fluency/Syntax as measured by the KTEA.

Furthermore, as a follow-up to this analysis, Behavioral Inhibition was entered first into the regression equation, with the other four variables following as had been completed previously while using the BASC Adaptability Composite as the measurement of the criterion variable. The Adjusted R^2 indicates that Behavioral Inhibition accounts

for essentially none of the variance of Motor Control/Fluency/Syntax as measured by the KTEA for academic achievement, with the full 29% of the variance still being contributed by the other four variables.

Finally, a stepwise regression was specified next to determine which of the independent variables were most powerful in the prediction of the dependent variable, Motor Control/Fluency/Syntax. Results indicate that Internalization of Speech (Verbal Working Memory) entered first, accounting for 20% of the variance in Motor Control/Fluency/Syntax as measured by the KTEA for academic achievement. Reconstitution entered next, accounting for an additional 12% variance, for a total variance accounted for of 32%. Both variables were significant at $p < .0005$.

CHAPTER V

Discussion

Overview

Attention Deficit Hyperactivity Disorder accounts for approximately 40% of the child clinic referrals (Barkley, 1990) and 3%-5% of the school age population. While it is one of the most extensively studied disorders, a clear understanding of its causality and means of assessment is still problematic. With his 1997 hybrid model, Barkley has attempted to bring together various theories and research to derive a model that attempts to account for those symptoms prevalent in ADHD, and thus allow a fuller comprehension of causality, differential diagnosis, and treatment.

Barkley's current model places Behavioral Inhibition at a central point in relation to four other separable executive functions, namely Working Memory (Nonverbal), Internalization of Speech (Verbal Working Memory), Self-regulation of Affect/Motivation/Arousal, and Reconstitution. Each of these four executive functions represents a formerly overt other-directed behavior that has become covert and internalized with a person's development. According to Barkley's current model, Behavioral Inhibition is necessary and supportive of the other four variables. Additionally, all five variables produce a direct effect on the final outcome of Motor Control/Fluency/Syntax.

This study is unique in that it is the first to look at Barkley's model as a whole, how each of the five variables correlate with the more complex variable of Motor Control/Fluency/Syntax, and if as a group these variables provide greater prediction of Motor Control/Fluency/Syntax than each individually. In this manner greater meaning is given to the model, as well as indicating avenues of future research. Additionally, the examination of these relationships was accomplished with the use of instruments suggested by the definition of each of these vararіables as noted by a personal communication (June 28, 1999) with Dr. Barkley, and his work (Barkley, 1997).

Six research questions were advanced as the bases for this study. The first five questioned the relationships between the variables of Barkley's 1997 Hybrid Model of ADHD. Results indicated that three variables, namely Reconstitution, Internalization of Speech (Verbal Working Memory), and Self-regulation of Affect/Motivation/Arousal were found to have a statistically significant relationship with Motor Control/Fluency/Syntax. A second finding revealed a statistically significant relationship between Internalization of Speech (Verbal Working Memory) and three other variables. These three include Working Memory (Nonverbal), Self-regulation of Affect/Motivation/Arousal and Reconstitution.

The final research question spoke to the use of the model's variables as a prediction of Motor Control/Fluency/Syntax, the criterion variable, as measured by the parent's perception of their child's adaptability. The analysis indicated that the five predictive variables accounted for 23% of the variance of Motor Control/Fluency/Syntax, with Self-regulation of Affect/Motivation/Arousal accounting for a significant 21% of

that variance. The other variables, with the exclusion of Behavioral Inhibition, accounted for only an additional 2%.

On the other hand, when academic achievement was used to measure the criterion variable in a post hoc analysis, the five predictor variables when entered together accounted for 29% of the variance with Motor Control/Fluency/Syntax. However, in a stepwise regression, Internalization of Speech (Nonverbal Working Memory) accounted for 20%, with the addition of Reconstitution accounting for an additional 12% of the total variance.

Finally, when the predictor variable Behavioral Inhibition was forced to enter first, while using either adaptability or academic achievement as the measure of the criterion variable, in neither analysis did Behavioral Inhibition as measured by CPT commission scores account for any variance of Motor Control/Fluency/Syntax. It is possible that while theoretically necessary to support the other executive functions, as well as having a direct effect on the criterion variable, functionally it is subsumed under each predictor variable of the model. Also, while this may be the case for a population fitting a normal distribution such as the one used in this study, Behavioral Inhibition may occur as a functionally separate variable based on an individual's psychopathology.

Thus, if ADHD is defined by both adaptability as perceived by the parent, as well as academic achievement, three variables of the five predictors as noted by Barkley in his 1997 model may be used to aid in the prediction of Motor Control/Fluency/Syntax, the criterion variable. These include Internalization of Speech (Verbal Working Memory), Self-regulation of Affect/Motivation/Arousal, and Reconstitution. The two notable exceptions to this, are the predictor variables, Behavioral Inhibition and Working

Memory (Nonverbal). Behavioral Inhibition is the developmental cornerstone of Barkley's model that indirectly supports the other predictor variables, as well as directly affecting the outcome criterion Motor Control/Fluency/Syntax. In this study, Behavioral Inhibition did not add to the variance. It may be however, that commission errors may not be the best assessment instrument for this variable, and that a more pure measure of a Stop-Signal task as suggested by Barkley (personal communication, June 28, 1999) would result in very different findings. In addition, Working Memory (Nonverbal) significantly correlated with Internalization of Speech (Verbal Working Memory) but did not enter at any point as a significant predictor variable. It may be possible that both variables involved in working memory should perhaps be a single variable, Working Memory, as measured in two separate manners – the nonverbal and the verbal components. This would limit the number of variables in Barkley's model to three predictors, Working Memory, Self-regulation, and Reconstitution, and a single outcome criterion Motor Control/Fluency/Syntax as measured by both adaptability and academic achievement. Additionally, it appears wise to measure each of the three predictor variables in two separate manners. Working Memory as nonverbal and verbal, Self-regulation as emotional lability and perhaps an academic motivation measure, and Reconstitution as measured by planning and verbal fluency.

Moreover, the results, when taken together clearly indicate that the three variables most predictive of Motor Control/Fluency/Syntax are Internalization of Speech (Verbal Working Memory), Self-regulation of Affect/Motivation/Arousal, and Reconstitution depending upon whether adaptability or academic achievement is used to measure the

outcome variable. Additionally, each was strongly related to each other indicating an overlap of processes.

Other post hoc findings indicate that both males and females exhibited significant correlations between Self-regulation of Affect/Motivation/Arousal and the outcome criterion variable, Motor Control/Fluency/Syntax. However, males additionally indicated a significant relationship between the outcome criterion variable and Internalization of Speech (Verbal Working Memory), whereas for females, Reconstitution was significantly related to Motor Control/Fluency/Syntax. Other than these findings, no other significant gender differences were found. While further research is needed to adequately explain the two significant areas, it may be that the variables that have a tendency to be weaker or slower to develop as indicated by gender, are the very areas in which ADHD would first be noted. However, it is likely, that as age increase, differentiation via such variables, if in fact proven to be possible, may fade due to the proposed developmental nature of these variables. It is also possible that cross-validation with a larger number of participants will prove this finding null and void. However, it is likely due to gender differences in development, that this finding will hold and need to be taken into consideration for differential diagnosis, as well as the teaching of coping skills in educational planning.

In examining the results from another viewpoint, neuroimaging studies as noted in the literature review have indicated that symptoms of ADHD-HI and ADHD-C may be linked to frontal areas of the brain, such as in the prefrontal cortex (anterior to the motor area of the frontal lobe), thought to be involved in personality, insight, and foresight (Nolte, 1999), and the frontal striatal structure of the basal ganglia, known as the caudate nucleus and putamen, which are known to be involved in motor control (Vaidya et al.,

1998). Supporting this second finding is Sergeant and van der Meere's (1990) study indicating that the deficit among persons with ADHD appears to be in the motor control stage rather than the response choice stage, or preparedness to act stage (Oosterlaan & Sergeant, 1995; van der Meere, Gunning, & Stemerdink, 1996). Thus, the variable of Self-regulation of Affect/Motivation/Arousal, at least in part, appears to be centered in the same areas of the brain as Motor Control/Fluency/Syntax. This may help to explain the low but significant relationship between these two variables.

On the other hand, areas involved in Internalization of Speech (Verbal Working Memory) and Reconstitution seem to be less exact. Difficulties with Reconstitution research are numerable. Bronowski (1977) stated that language represents objects, actions, and their properties and provides a means to take the world apart and recombine it in novel ways (Fuster, 1980). This analysis and synthesis by language was extended by Barkley (1997) to include behavior fluency. Barkley (1996, 1997) suggests that a delay in responding, as permitted by behavioral inhibition, allows time for events to be mentally disassembled, information extracted then recombined sequentially, and a response prepared for attainment of a goal. Research suggests the involvement of the dorsolateral prefrontal cortex as there is an increase of neuron discharge just before cues and responses in delay tasks, and that lesions to the prefrontal cortex disrupt this capacity to properly sequence behavior (Fuster, 1980, 1989; Godbout & Doyon, 1995; Milner, 1995). Thus, the small but significant relationship of these two variables with Motor Control/Fluency/Syntax, may be the result of their connection to the prefrontal cortex in the terms of resequencing behavior. Therefore, as Self-regulation of Affect/Motivation/Fluency decreases, there appears to be less delay in Motor

Control/Fluency/Syntax in which Reconstitution can take place. Additionally, as Barkley suggests, it is possible that the latter may not be a separate variable at all, but rather a more advanced developmental stage of nonverbal and verbal working memory. To date, there has not been enough research to support a model with or without Reconstitution as a separate entity.

Furthermore, neurological understanding of Internalization of Speech (Verbal Working Memory) must be drawn from inferences from what is known about speech/language centers such as Wernicke's area in the posterior portion of the superior temporal gyrus of the left hemisphere (Nolte, 1999) and observational studies of children with and without ADHD (Berk & Landau, 1993; Berk & Potts, 1991, Landau, Berk, & Mangione, 1996). The neurological areas suggested may indicate one reason that the correlation with Motor Control/ Fluency/Syntax is not as great as Self-regulation of Affect/Motivation/Arousal, as at least partially, a different part of the brain is involved. Additionally, it falls earlier developmentally in Barkley's model, and as such may coordinate decreasingly as the child gets older.

One other variable, Behavioral Inhibition, as measured, did not significantly correlate with Motor Control/Fluency/Syntax nor with any other variable. Barkley's (personal communication, June 28, 1999) stated that while commission errors, may in his opinion, be one of the better measures, it does not necessarily get at the core of the variable. This would include delayed gratification, resistance to temptation, and inhibition of a true prepotent response. If other instruments were available to assess this area, Barkley would suggest a true Stop-Signal task. Therefore, it may be that these

singular measures used in this study did not address either the core or the breadth of this particular variable.

Summary

This study explored the correlation of each of Barkley's hypothesized variables and their relation to Motor Control/Fluency/Syntax. It has supported the significant relationship between three of Barkley's predictor variables, Internalization of Speech (Verbal Working Memory), Self-regulation of Affect/Motivation/Arousal, and Reconstitution with Motor Control/Fluency/Syntax as measured by parents' perception of a child's adaptability. Moreover, when academic achievement was used as the assessment measure, the same variables proved to have significant relationships with Motor Control/Fluency/Syntax. Therefore, two different measures of the outcome criterion variable, one direct and one indirect, focusing on two different areas in the criterion variable, resulted in the same three variables being significant Moreover, regression measures indicate that all variables as proposed by Barkley other than Behavioral Inhibition, as measured, account for 23% to 32% of the variance with Motor Control/Fluency/Syntax, depending upon if this latter variable was measured by a child's adaptability or academic achievement, and as such provide a good basis for prediction.

As measured by commission errors on a CPT, Behavioral Inhibition did not indicate a significant relationship with Motor Control/Fluency/Syntax, nor did it add anything to the variance when entered. It is possible that in a normal population such as the one used in this study, Behavioral Inhibition must be presumed to be functioning appropriately if the other four predictor variables are significantly related to the criterion. The problem arises in trying to determine just how to measure its supportive role,

whether it should be seen as a separate variable, and why it did not have a significant relationship with Motor Control/Fluency/Syntax.

In addition, the behavioral aspects of ADHD as developed by Barkley in his model appear to suggest a continuum of diagnosis, dependent upon the number of variables affected and to what degree. This study tentatively supports this concept in that the predictor variable accounting for most of the variance with the outcome criterion variable when measured by adaptability is Self-regulation of Affect/Motivation/Arousal. When one is emotionally labile, the ability to perform higher cortical operations is disturbed and as such will affect Reconstitution. Nor would it allow Internalization of Speech to function at its optimum since this also involves higher cortical performance. Furthermore, even when academic achievement was used to measure the outcome criterion, Internalization of Speech entered first followed by Reconstitution. However, both of these were significantly correlated with Self-regulation. Thus, although Self-regulation did not enter into the stepwise regression, the interrelationships would still hold.

Finally, while the assessment of Barkley's model necessarily required the examination of a population fitting a normal distribution, the results lead one to question that if in a clinical population it is possible that the number of variables not optimally functioning might prove critical, and thereby determine the severity of the observable manifestations of ADHD on a possible continuum. Additionally, the question arises whether it is possible for later developing variables in this model to optimally function if previous ones are not.

Limitations of the Study

There are several limitations of this study that require that the results be interpreted as a preliminary analysis of Barkley's 1997 model, and not generalized beyond that point. As with the development of any model that hopes to aid in the understanding of psychopathology, it is necessary to determine what could be described as "normal". Therefore, as this model first attempts to operationalize this paradigm as it relates to the application of Barkley's theory, the population of children used in this study fit a normal distribution. As such, findings should not be generalized to a clinical population. Additionally, the ages of the participants crossed a range of developmental abilities with each age group not studied individually. As such, this does not allow one to draw conclusions regarding the developmental aspects of Barkley's model. Moreover, the number of participants was relatively small, and as such additionally limits the ability to generalize. Finally, by way of examining the participants, gender was not a factor in the original proposal of this study, therefore no effort was made to guarantee the same number of males and females at each age. Since no significant correlational differences were found between the genders, it may be that this is not a factor in interpretation even though males and females did differ each in one area in terms of a significant relationship between one of the predictor variables and Motor Control/Fluency/Syntax.

Additional limitations focus on the instruments chosen to measure each variable. . The study, as originally designed, included two behavioral scales, the Conners' Rating Scale and the Behavior Assessment System for Children, both completed by the same responder. Notably, it is these two areas that were significantly correlated in the analysis, with the Conner's accounting for a significant portion of the variance with the criterion

variable. While, the addition of the post hoc analysis using academic achievement as the measure of the criterion variable instead of the BASC Adaptability Composite, resulted in similar findings, using two indirect measures with the same responder as the only measures of two variables, may in fact still have confounded the original results. Additionally, it is possible that other instruments might be better able to assess a given variable. While instruments used were in fact scrutinized by Dr. Barkley via a personal communication, the instruments were also the result of availability. Given greater options, Dr. Barkley may have suggested alternate measures. Furthermore, only one measure was used to assess each variable. As such only a portion of the defining variables subsumed under the main predictor and criterion variables could be addressed. Thus, not all defining areas were measured. It is possible that multiple measures of each variable might provide a more complete assessment and thus alter results significantly.

Suggestions for Future Research

As this was the first study to address Barkley's model as a whole, and as such must be viewed as a preliminary investigation, further research is needed to bring additional meaning and possible modification to the model. Because of the proposed developmental aspect of Barkley's model, additional research is needed to explore this particular avenue by way of a large number of participants in each group of children, as well as adolescents, and finally adults. This life-span approach would be beneficial to our understanding of not only Barkley's model, but ADHD in general. Additionally, further analysis is needed to clarify if gender differences do or do not exist. Particular attention should be noted specifically in the relationships between Internalization of Speech (Verbal Working Memory) and Reconstruction as they relate to Motor

Control/Fluency/Syntax in terms of gender differences as found in this study. Moreover, cross-validation studies are needed, as well as comparisons of clinical versus control populations.

Research is also needed in the areas of the individual variables. Barkley questions if Reconstruction is actually a separate variable or if it should be subsumed under another area such as working memory. This study was not conclusive in its distinguishing Reconstruction as a variable unto itself, and as such additional research is needed to examine this construct more thoroughly. Additionally, this study did not support Behavioral Inhibition as having a significant relationship with Motor Control/Fluency/Syntax. It is possible however, that additional research using a more pure measure of a Stop-Signal task might shed a different interpretation of Barkley's model. Otherwise, Behavioral Inhibition as a separate variable should be excluded from the model. The other variable in question is Working Memory (Nonverbal) which appears to significantly correlate with Internalization of Speech (Verbal Working Memory), but not with the criterion variable. Nor does it appear to add significant variance to Motor Control/Fluency/Syntax. As such, it might best be viewed as a single Working Memory unit with Internalization of Speech.

Other areas to be explored include the addition of a variety of instruments direct and indirect to measure each variable so as to provide a more in-depth analysis of each area, and a refining of the definition of each variable. At this point, Barkley lists a total of 37 variables subsumed under the six primary variables, a number too large to adequately validate. Thus a refining of the definition of each variable is necessary. Finally, modification of the model based on this preliminary study, and the use of a structural

equation analysis with a larger population, would allow a determination as to whether Barkley's model as currently structured is supported.

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APPENDIX A

CONSENT FORM

Parent Consent Form Research

USE OF DIRECT MEASURES OF ATTENTION, LEARNING AND MEMORY IN DIAGNOSIS AND INTERVENTION PLANNING FOR CHILDREN WITH ATTENTIONAL DIFFICULTIES

Dear Parent:

We are asking you to allow your child to participate in a research study designed to measure attention, learning, and memory. We are interested in determining which measures most accurately describe children's attention and behavior, and how measures of attention relate to measures of learning, memory and achievement. The results of the study will have direct benefits to your child as results will be available to you in order to assist you in understanding your child's strengths and weaknesses. If you choose, results may also be shared with school personnel to aid in designing interventions which should be more relevant and beneficial.

We will ask you and your child's teacher to complete some behavior rating scales. Your child will be assessed with a comprehensive psychoeducational battery consisting of continuous performance tests (direct, computerized measures of attention), memory, learning, achievement motivation, and behavior scales.

Sessions will take place at Willard Hall on the OSU campus. Sessions would be scheduled after school unless you request a day appointment. Because of the comprehensiveness of the study, it will take at least four hours for test completion, which will be broken across at least two test sessions as needed. All testing will be done by trained graduate assistants in school or counseling psychology, under the supervision of the supervising professor.

Your child's participation is strictly voluntary. Both your consent and your child's assent will be obtained, and you or your child may choose to withdraw from the study at any time. Information from the study will be kept in strict confidence. You may contact me, Dr. Judy Oehler-Stinnett, at Willard Hall, School of Applied Health and Educational Psychology, Oklahoma State University at 405-744-9448 at any time if you have additional questions or you may call 434 Willard at 405-744-9450.

By signing below, I indicate that I have read and fully understand this consent form. I sign it freely and voluntarily. I agree to allow my child, myself, and my child's teacher to participate in this study as described above. I certify that I have personally explained all elements of this form to the participate or his/her representative before requesting them to sign it.

Parent's Name (Please Print)_____
Child's Name (Please Print)_____
Parent's Signature_____ Date_____
Child's Signature_____ Date_____

Please return to your child's school or to 434 Willard

APPENDIX B

INTAKE QUESTIONNAIRE

PARENT INFORMATION SHEET (Please Print)

Child's Name: _____Date of Birth_____

Address_____

Parent's Name_____(Please print) Ethnic Origin_____

Mother's Phone Number (Day)_____(Evening)_____

Father's Phone Number (Day)_____(Evening)_____

Child's School_____City_____

Name of Teacher_____

Current Grade (if tested during school year) or grade just completed_____

Is your child on any medication of **any** kind (allergies, Ritalin, antidepressants, etc.) Y/N

Name of Medication & Dosage_____

Times of medication administration (a.m., noon, afternoon, evening?)_____

Was your child's delivery normal? Y/N

If you answered no, explain please (forceps, caesarian, abnormal length of labor, etc.)

_____

Were developmental milestones within normal limits? Y/N

Age sat up?_____Crawled?_____Walked alone?_____Talked?_____

Reason you wished your child to be part of this research project?_____

_____

_____

_____

Highest Educ Level-Mother HS__GED__College 1,2,3,4 Grad__ .

Father HS__GED__College 1,2,3,4 Grad__ .

APPENDIX C

IRB APPROVAL

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Date: June 13, 2000 IRB #: ED-99-101

Proposal Title: "A PRELIMINARY EXAMINATION OF BARKLEY'S 1997 HYBRID MODEL OF ATTENTION DEFICIT HYPERACTIVITY DISORDER: A REGRESSION ANALYSIS UTILIZING A HETERGENOUS GROUP OF ELEMENTARY SCHOOL CHILDREN"

Principal Investigator(s): July Oehler-Stinnett
Cynthia Boykin

Reviewed and Processed as: Modification

Approval Status Recommended by Reviewer(s): Approved

For title change only

Signature:

Carol Olson

Carol Olson, Director of University Research Compliance

June 13, 2000
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

Cynthia L. Boykin

Candidate for the Degree of

Doctor of Philosophy

Thesis: A PRELIMINARY EXAMINATION OF BARKLEY'S 1997 HYBRID MODEL OF ATTENTION DEFICIT HYPERACTIVITY DISORDER: A REGRESSION ANALYSIS UTILIZING A HETEROGENOUS GROUP OF ELEMENTARY SCHOOL CHILDREN

Major Field: Applied Behavioral Studies

Biographical:

Education: Graduated from Cupertino High School, Cupertino, CA in June 1972; received Bachelor of Arts degree in Psychology with a concentration in Child Development and a Minor in Biology from Western Washington University, Bellingham, Washington in May 1976, Cum Laude; received Master of Arts degree in Learning Disabilities and Psychometry with additional accreditation in Mental Retardation from Oral Roberts University, Tulsa, Oklahoma in May 1985, with Honors. Completed the requirements of the Doctor of Philosophy with a major in Applied Behavioral Studies, emphasis School Psychology at Oklahoma State University in July 2000.

Experience: Employed by Oklahoma State University, School of Applied Health and Educational Psychology as a Teaching Associate, Research Associate and Graduate Associate. Employed as a Psychological Associate by Psychological Service Center, Reading and Math Center. and Marriage and Family Clinic. Psychometrist and Special Education Teacher at Jenks Public Schools. Currently completing Doctoral internship at Quality Living, Inc., Bellevue, Nebraska.

Professional Memberships: American Psychological Association, National Association of School Psychologists