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The effects of medication on memory in children diagnosed with ADHD

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Abstract

ADHD is the most commonly diagnosed Axis I mental health disorder in children with prevalence estimates of 3% to 5% of US children. The preponderance of ADHD research has focused on behavioral problems, while a much smaller proportion of research has focused on cognitive aspects. The purpose of this study was to examine stimulant medication effects on memory in children with ADHD. METHOD: Thirty-five children (26 males and 9 females) with the diagnosis of ADHD (subtypes included predominately inattentive, predominately hyperactive, and combined) were mostly obtained from local pediatric clinics. The Wide Range Assessment of Memory and Learning, 2nd Edition (WRAML2) was administered along with the Wechsler Abbreviated Scale of Intelligence (WASI) over 2 sessions, 1 of which the participants were on their prescribed medication, and 1 of which was a placebo condition. Participants and Examiner were blind to condition. CONCLUSION: Contrary to expectation, there was no difference between participant performance when on medication vs. placebo for the WRAML2 subtests (Wilks $\lambda = .66$, $F(15, 19) = .65$, $p > .05$) or WASI subtests (Wilks $\lambda = .81$, $F(4, 30) =$

1.71, $p > .05$). Therefore, stimulant medication had no demonstrable effect on memory performance in children with ADHD. Implications of this finding were discussed.

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Chapter 1

Introduction

"For over 20 years, Attention Deficit Hyperactivity Disorder (ADHD) has been viewed as comprising three primary symptoms, these being poor sustained attention, impulsiveness, and hyperactivity" (Barkley, 1997a, p. 65). Difficulties in these three areas are often broadly classified as difficulties with executive functioning. Executive functioning has been defined as the capacities to engage in independent, purposive, and goal-directed behavior (Busch et al., 2005). These higher-order processes enable us to incorporate feedback and make behavioral adjustments in accordance with environmental demands. Other abilities subsumed under the broad category of executive functioning include attention, planning, organization, initiation, self-monitoring, response inhibition, and generative behavior (Busch et al., 2005). Executive functioning abilities are considered to be critically important for complex human behavior, and their breakdown is thought to commonly result in behavioral or psychiatric impairment (Fisher, Barkley, Smallish, & Fletcher, 2005).

The topic of Attention Deficit Hyperactivity Disorder (ADHD) has been significantly researched. In a simple search of PsychINFO for the terms ADHD from 1998 to the present, there were over 6,000 articles that were found. With the abundance of information concerning ADHD it is difficult to cover all of the research that has been generated, however the most salient research is summarized throughout this chapter.

ADHD is generally considered a lifelong disorder that is not solely a function of a single environmental stressor. As a result, the *Diagnostic and Statistical Manual of Mental Disorders – IV* (DSM-IV; American Psychiatric Association, 2000) specifies that ADHD symptoms must be present early in childhood, must continue for an extensive period of time, and must be displayed in more than one setting. There is currently no compelling evidence that ADHD in adolescents is qualitatively different from the disorder in children, or adults for that matter (Barkley, 2004). Critical in the classification of ADHD is the presence of several subtypes. Based on the two core symptom clusters, the DSM-IV defines three subtypes of ADHD: a primarily hyperactive-impulsive type, a primarily inattentive type, and a combined type (Lahey, et al., 1994). Specifically, those children with the problems of inattention without high rates of impulsivity and hyperactivity tend to show fewer conduct problems and less peer rejection, and are more anxious and shy than those children who are also impulsive and hyperactive. The inattentive subtype also "mainly involve students with academic impairment" (McCormick, 2003, p. 621). The hyperactive and inattentive subtypes may also show differences in the types of attentional processes that are deficient, and the inattentive type shows a different response curve to stimulant medication (Barkley, DuPaul, & McMurray, 1991). The inattentive and distractible behavior distinguishes ADHD from learning disabilities or other psychiatric disorders and does not appear to be a function of the other disorders often comorbid with ADHD (anxiety, depression, or oppositional and conduct problems; Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001a). A study by O'Driscoll et al. (2005) found that children with ADHD combined subtype displayed more difficulties on tasks of executive functioning than children with ADHD inattentive subtype.

ADHD is the most commonly diagnosed Axis I mental disorder in children (Barkley, 1997b). Prevalence estimates vary widely as a function of diagnostic criteria used, but reasonable estimates suggest that 3% to 5% of children nationwide are affected (Barkley, 1997b). Because ADHD accounts for a large proportion of all referrals for pediatric mental health services, at great economic and emotional expense, the development of effective treatments cross the childhood and adolescent years is essential (Hibbs & Jensen, 2005)

Although deficits in attentional abilities and other areas of cognitive functioning are extremely problematic for children with ADHD, much of the research on the disorder has focused on the behavioral problems and the perceived accompanying social disruptions associated with it (DeShazo, Klinger, Lyman, Bush, & Hawkins, 2000). This leaves minimal research regarding the core cognitive and memory impairments associated with the disorder. "Cognitive domains such as verbal working memory, internalized speech, emotional self-control, and cross temporal organization of behavior become progressively more elaborate in adolescents and consequently may be more affected by the disorder than they were in childhood" (Barkley, 2004, p. 40). Many studies that have investigated the cognitive abilities of children with ADHD have promoted the theory that the disorder involves frontal lobe dysfunction (Barkley, 1997b).

Neuropsychological research has suggested that certain regions of the brain may be implicated in the disorder. Deshazo, Klinger, Lyman, Bush, and Hawkins (2000) found that the performance of boys with ADHD on visual cueing tasks was not impaired relative to controls, whereas the performance of the same boys with ADHD on a continuous performance test was significantly impaired. The results suggest dissociation between selective and sustained attention

abilities in children with ADHD and implicate the frontal lobe region as a specific area associated with the impairment.

Impulsivity and inattention are the most reported symptoms of ADHD, however the poor performance of children with ADHD on cognitive tasks cannot be explained exclusively by inhibitory or attention control deficits (Shue & Douglas, 1992), suggesting that this impaired performance may be representative of a higher order cognitive deficit. Research by Pennington and Ozonoff (1996) suggested that children with ADHD may demonstrate difficulties in higher order executive functioning processes such as planning, organization, and problem-solving ability, while inattention and impulsivity may be secondary to these more global deficits. Since ADHD involves deficits in global functions, then impairments in attentional processes and impulse control would also be expected.

ADHD and Academic Performance

Children with ADHD are traditionally academic underachievers, a problem that appears to be distinct to ADHD when compared to other disruptive behavior disorders, such as conduct disorder (Frick et al., 1991). Frick and Lahey (1991) found that as many as 30% of children with ADHD do not achieve academically at the level predicted by their age or IQ. Although this finding may be interpreted as a problematic behavior which then interferes with academic achievement, it may also be that children with ADHD have specific cognitive impairments that hinder learning (Deshazo, 2001).

Children whose, "primary difficulties are with inattention more closely resemble children with learning disabilities in their academic difficulties and associated behavioral difficulties" (Shelton & Barkley, 1994, p. 31). The percentage of children experiencing some delay in the

onset of talking may be somewhat higher for children with ADHD (6% - 35%) than for those without ADHD (2% - 5. 5%; Shelton & Barkley, 1994). While not all children may have deficits in language functioning, the language difficulties that some children with ADHD encounter may be due to their difficulties with higher order cognitive processes. Depending on the definition, approximately 25% to 50% of the children with ADHD will have at least one type of learning disability, either in math, reading, or spelling (Shelton & Barkley, 1994).

Research has suggested that deficits in problem-solving and other cognitive processes are likely linked with the poor academic performance associated with ADHD (McCormick, 2003). For example, in addition to slower computational performance in mathematics, which may be behavioral, children with ADHD also have been shown to score lower on measures of their problem-solving ability in conceptual math (Zentall, Smith, Lee, & Wieczorek, 1994). Specifying these cognitive impairments and their relation to academic achievement is still unknown, however important to begin the subsequent process of identifying the possible causes of underachievement in children with ADHD.

Attention and Inhibition

Attention represents a multidimensional construct. The dimensions impaired in ADHD reflect an inability to sustain attention or persist at tasks, remember and follow through on rules and instructions, and resist distractions while doing so (Bates, Mathias, & Crawford, 2001). By adolescence, this dimension more likely reflects problems with working memory than poor attention (Seguin, Boulerice, Harden, Tremblay, & Pihl, 1999). These difficulties can be more broadly explained by four executive functions: operation of working memory; internalization of self-directed speech; controlling mood, motivation and arousal; and reconstitution (the ability to

break down and recombine behaviors; Bates, Mathias, & Crawford, 2001). These actions are all important because they permit self-regulation in an individual. The attention and regulation given to these concepts is often minimal in children and adolescents with ADHD.

As with attention, inhibition is a multidimensional construct. The problems with inhibition seen in ADHD seem to involve voluntary or executive inhibition of proponent responses. More specifically, teens with ADHD manifest difficulties with restlessness, less ability to stay seated when required, talking excessively, acting impulsively, and interrupting others' activities (Nigg, 2001). In particular, delaying gratification and valuing future over immediate rewards is difficult for the adolescent with ADHD. These inhibitory deficits extend from emotional reactions to provocative social situations and to less tolerance for, and inhibition of, frustration (Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001b).

Recent research shows that the problems with inhibition are first identified (at age 3-4 years) in the hyperactive behavior of preschool children. These symptoms are then compounded by an increase in those related to inattention over the next few years (by age 5-7 years). The symptoms related to sluggish cognitive tempo that characterize the predominantly inattentive subtype arise even later (ages 8-10; Hart, Lahey, Loeber, Applegate, & Frick, 1995). Whereas the symptoms of hyperactivity decline by adolescence, inhibitory problems remain as evidenced by difficulties with self-control, disregard for the consequences of one's impulsive actions, and a diminished valuing of future goals over immediate gratification (Hart et al., 1995).

It is important to note that it has not been consistently established that a diagnosis of ADHD predicts deficient inhibitory control after controlling for various demographic factors such as age and socioeconomic status. Second, tests purportedly measuring impulsivity assess

additional cognitive factors, thereby precluding identification of the specific problematic psychological processes for children with ADHD. Children with ADHD may perform worse on these tasks due to an aversion to long delays, motivational problems, or problems adjusting to different instructions rather than because of poor inhibitory control (Stevens, Quittner, Zuckerman, & Moore, 2002).

ADHD and Executive Functioning

The conceptualization of ADHD as deficits in executive functioning has primarily been supported by neurological and neuropsychological research. For example, research comparing the neuroanatomy of children with and without ADHD show that children with the disorder have decreased blood flow to the frontal lobes (Grodzinsky & Diamond, 1992). Magnetic resonance imaging (MRI) scans have revealed that non-ADHD children have slightly larger right frontal lobes than left; however, children with ADHD tend to lack this asymmetry, which may explain their deficits in sustained attention, a process associated with the right frontal lobe (Hynd, Semrud-Clikeman, Lorys, Novey, & Eliopulas, 1991). Further evidence for executive functioning deficits in ADHD are illustrated by case studies of patients with frontal lesions. These patients often display the hallmark behavioral symptoms of ADHD such as hyperactivity, distractibility, and impulsivity. Thus, several researchers have hypothesized that the behavioral symptoms of ADHD are linked to executive functioning deficits (Barkley, 1997b).

One key aspect of executive functioning that is important in self-regulation is working memory (Chelonis et al., 2002). Working memory is the capacity to hold information in the mind and use it to guide behavior, particularly across time and toward future goals. According to Barkley (1997b), poor behavioral inhibition, as is seen in children with ADHD, should have

resultant deficits in working memory. This hypothesis is in agreement with several proposed models of working memory that suggest attention to a stimulus that is to be remembered is the determinant of success on memory tasks. Research has shown that children with ADHD perform poorly on tasks of working memory, including repetition of digits forwards and backwards, mental arithmetic, the Freedom of Distractibility Scale of the Wechsler Intelligence Scale for Children (WISC-III), and the Tower of Hanoi compared to non-ADHD control children (West, Houghton, Douglas, & Whiting, 2002).

Executive functions are distinct from other mental functions such as sensation, perception, or memory. There is, however, considerable overlap with domains such as attention, reasoning, and problem solving and with certain components of learning and memory (Biederman et al., 2004). While some research does indicate that deficits in executive functioning are regularly found, after a review of the research literature, Halperin & Schulz (2006) found that, "at the group level executive functioning measures do not appear to have the sensitivity or specificity to adequately classify most individuals with ADHD relative to normal controls." Halperin and Schulz (2006, p. 562) go on to say, the specificity of deficits to inhibitory control or executive functions is unlikely because children and adults with ADHD have repeatedly been found to differ from controls on a wide array of 'non-executive' cognitive functions such as motor coordination, perception, language, visuomotor integration, and learning and memory. (p. 563).

Kempton et al. (1999) found that non-medicated ADHD children were impaired on tasks of executive functioning, including planning ability, movement time, attentional set shifting and spatial working memory. These cognitive impairments however, did not occur in medicated

children with ADHD, possibly suggesting that stimulant medication normalizes executive functioning in ADHD.

ADHD and Memory

Cognitive functions that are affected in ADHD also comprise memory processes (Krauel et al., 2007). Recent imaging studies have revealed that ADHD patients show less activation in prefrontal areas during working memory tasks than healthy subjects (Schweitzer et al., 2000). Schon, Hasselmo, Lopresti, Tricarico, and Stern (2004) demonstrated that functional anatomic overlap occurs between active maintenance of object information in working memory and successful encoding into long-term memory in the prefrontal cortex and the limbic system.

Specific memory deficits associated with ADHD have become better understood in recent studies, which tend to show deficits only for tasks that depend on more complex, organizational components of memory (Kaplan, Dewey, Crawford, & Fisher, 1998). Implicit and explicit memory are two forms of memory that have often been contrasted with one another in other clinical and developmental contexts, but implicit memory has not been well-studied in ADHD (Aloisi, McKone, & Heubeck, 2004). Implicit memory refers to an influence or facilitation in performance based on some previous experience in the absence of conscious recollection, whereas explicit memory depends on conscious recollection (Burden & Mitchell, 2005).

Karatekin (2004) found that children with ADHD do not appear to have generalized impairments in working memory, but they may be more prone to specific impairments in working memory related to the ability to divide attention during tasks. This finding supports suggestions that inconsistencies for finding memory differences in ADHD across the literature may stem from a lack of specificity when characterizing memory deficits (Kaplan et al., 1998).

Mealer, Morgan, and Luscomb (1996) found that children with ADHD had more memory difficulties than their peers without ADHD on general memory, but more particularly on visual memory and verbal learning, which are more dependent on active processing and storage of information during the test session. By contrast, the ADHD group performed comparably to the non-ADHD group when stimuli were readily visible during testing (e.g., picture completion, picture arrangement.

In 2002, Stevens et al. found that children with ADHD performed poorer than children without the disorder on working memory task. Children in the ADHD group were able to recall fewer digits than children in the control group when both processing and storing information were required. This finding is consistent with previous research indicating that working memory is a major problem for these children (Mariani & Barkley, 1997). These results carry additional significance because performance on the working memory task was not dependent on skills acquired in specific academic domains, such as reading. Other researchers have also begun to disentangle impairments in working memory from difficulties with reading or mathematical operations (Mariani & Barkley, 1997).

Memory storage and retrieval have been related to executive functioning and children with ADHD have been found to perform poorly on verbal fluency and pair associate tasks (Hoeppner et al., 1997). Kaplan et al., (1998) found that when tested using the Wide Range Assessment of Memory and Learning (WRAML), a test of memory in both the verbal and non-verbal domains, children with ADHD scored lower than age-matched controls on the General Memory Index, which taps both immediate and delayed recall. Dewey et al. (2001) found that using the WRAML2 increased diagnostic acuity when used with other assessment measures.

Sergeant (2000) propose that memory is not an independent cognitive process. Instead, memory function is highly related to allocation of attention and other executive functions related to utilization of efficient rehearsal strategies, as well as activation and motivation.

The WRAML subtests all require some type of "on the spot" learning and processing that would be more susceptible to disruption by attention problems than would be other types of cognitive activity (Mealer, Morgan, & Luscomb, 1996). This 1996 study found that participants with ADHD scored significantly lower than the non-ADHD control group on the WRAML, including the General Memory Index, Visual Memory Index, and Learning Index, with the Learning Index displaying the greatest different between groups. At the subtest level, the most noticeable differences took place on the Finger Windows and Verbal Learning; Visual Learning, and Sound Symbol were very close to reaching significance.

Children with ADHD performed poorer on the WRAML, consistently reporting lower scores on subtests including Finger Windows, Verbal Learning, Sentence Memory, and Number Letter Memory (Kaplan et al., 1998). All of these subtests require immediate processing and recall of novel material. The fact that these subtests assess verbal and non-verbal working memory is of interest because other studies have shown that children with ADHD generally have less difficulty processing and retaining information in the non-verbal domain (Webster, Hall, Brown, & Bolen, 1996). It is unclear if the performance of children with ADHD on these tasks is due to deficits in working memory or due to more global deficits. The subtests that seem to cluster around attention and concentration are Number Letter Memory, Sentence Memory and Finger Windows, the same subtests are also associated with working memory (Kaplan et al., 1998). Attentional resources must be allocated to prolonging stimuli within working memory. If

attention is drawn away from stimuli in working memory, the representation may decay before rehearsal strategies allow for a more lasting memory trace to be created. Therefore, attentional processes are integral to working memory functioning.

Memory tasks that are usually selected for psychopharmacological studies are tests such as Pair Associate Learning, Delayed Matching to Sample, or simple recognition tasks for words or figures (Frazier, Demaree, & Youngstrom, 2004). These tests, however, do not permit a careful dissection of the memory process into its several components. The demonstration of a positive stimulant effect on such tests can be interpreted simply in terms of an initial encoding process effect, and it is this component that would be predicted to improve if stimulant memory effects were mediated by simple attentional change or some other, indirect mechanism (Frazier et al., 2004). Improvement in learning in the absence of change in immediate recall or span of apprehension would suggest a drug effect on the storage process and/or the efficiency with which information in retrieved (Evans, Gualtieri, & Amara, 1986). The memory tests above do not discriminate these important factors; however, the WRAML2 incorporates this type of learning and memory.

Other cognitive deficits would also give the appearance of reduced working memory capacity. In particular, children with ADHD appear to have difficulty applying executive functions to manipulate information within the working memory buffer. For example, children and adults with ADHD appear to have more difficulty with memory updating, which is selectively removing information from the working memory buffer to make room for new information (Roodenrys, Koloski, & Grainger, 2001). This would, in effect, limit the working memory capacity by taking up space with information bits that are no longer relevant.

Experimental evidence suggests that the capacity of working memory in children with ADHD is intact and that deficits in working memory function are more related to deficits in the attentional/executive function components modulating the function of working memory (Deshazo, 2001). This component of the memory system can accommodate approximately seven individual bits of information at a time. Once a stimulus has entered the working memory store, it begins to decay after approximately 30 seconds unless its memory trace is prolonged by utilizing a mnemonic or rehearsal strategy (Roodenrys et al., 2001). Barkley (1997b) has proposed that children with ADHD have difficulty with this prolongation process. Mehta, Goodyer, and Sahakian (2004) found that methylphenidate improved performance on tasks of working memory, visual search, and attentional-set shifting.

ADHD and Medication

Stimulant medication, particularly methylphenidate (MPH), is the most common treatment for the management of ADHD. Studies estimate that 2.8% of elementary school-aged children are taking medication for the management of ADHD with stimulants representing 99% of the medications prescribed (Goldman, Genel, Bezman, & Slanetz, 1998). Several hundred control studies have been conducted on MPH and support its effectiveness in the management of major symptoms of ADHD (Barkley, DuPaul, & Conner, 1999). Research has suggested that between 72% and 94% of children with ADHD respond positively to a single stimulant when multiple doses are tried (Barkley, Conner, & Kwasnik, 2000). Nevertheless, there is substantial inter-individual variability in drug response. Some children respond best at the lowest dose of (2.5 – 5 mg) and deteriorate in their behavior with increasing dosage, while others show a peak response at the highest dose (Rapport, DuPaul, Stoner, & Jones, 1986). Still others seem to show

a curvilinear type of response with optimal responding occurring in the middle dose ranges (Barkley et al., 2000). Moreover, 25% (or perhaps more depending on the study) of ADHD children placed on a single stimulant medication, such as MPH, may show no positive response at all, and 3-5% may have an adverse behavioral reaction (Rapport, Donney, DuPaul, & Gardner, 1994). Moreover, research on the use of psychostimulants in patients with ADHD without hyperactivity showed a high rate of non-responders and no evidence of long term effects on academic achievement and learning. It is not clear whether these results apply to patients with predominately inattentive ADHD (McCormick, 2003).

The positive effects of MPH on attention and social behavior have been demonstrated through teacher ratings, parent report, direct observation of classroom behavior, and clinic based test of attention and impulse control (DuPaul, Anastopoulos, Kwasnik, Barkley, & McMurray, 1996). Methylphenidate is a stimulant drug related to amphetamine that acts to increase the synaptic concentration of dopamine and noradrenaline (catecholamines) by blocking their reuptake (Seeman & Madras, 1998). "Drug-related improvements also occur in other domains of behavior, including aggression, handwriting, academic productivity and accuracy, persistence of effort, working memory, peer relations, emotional control, and participation in sports" (Barkley, 2004).

Although neuropsychological studies of ADHD have consistently found impairments on tests of executive function, there is still debate about the precise nature of such impairments (Pennington & Ozonoa, 1996). For example, some studies using the Wisconsin Card Sorting Test (WCST) have reported deficits in attentional set shifting in children with ADHD (Gorenstein, Mammato & Sandy, 1989) while others have found no such impairments

(Grodzinsky & Diamond, 1992). In addition, while studies of ADHD report poor performance on measures of impulsivity or response inhibition on the Continuous Performance Test (CPT) (Corkum & Siegel, 1993), on the Go-No-Go test (Shue & Douglas, 1992) and on time slowness for Trails B (Shue & Douglas, 1992), others found no impairments on these tests (Grodzinsky & Diamond, 1992). Furthermore, some researchers have reported impairments of visuospatial processing (Grodzinsky & Diamond, 1992) while others have found no impairments in these functions (Korkman & Pesonen, 1994). Finally, two studies have found impairments in planning ability, measured with the Tower of Hanoi task and the Wisconsin Card Sorting Test (WCST) (Weyandt & Willis, 1994). However, in ADHD, stimulant medication has been found to improve performance on tests of executive function, especially when they are highly structured measures of attention or vigilance such as reaction time or continuous performance tests (Mehta et al., 2000). These paradoxical findings suggest that children with ADHD may require "over-focusing and perseveration" to perform within normal limits on tests which require sustained and organized effort.

Spencer et al. (1996) reported that randomized controlled short term (less than 12 weeks) trials reported improvement in about 65–75% ADHD patients on MPH versus 5–35% on placebo. Historically, one of the main drawbacks of the immediate release forms of MPH was the abbreviated duration of action. Due to its short term action, MPH had to be administered two to three times daily. This constraint necessitated administering the medication during the school which potentially created problems with peers and may have increased medication non-compliance (Deshazo, 2001).

Longer acting MPH has been designed to overcome the drawbacks of short acting MPH. The Ritalin-Slow Release (SR) represented an attempt for increasing MPH's duration of action. However, Ritalin-SR may have been less efficacious in a number of ways (Novartis, 2006). In one study the SR preparation was noted to have slower onset of therapeutic action than the immediate release form of MPH (Pelham, Sturges, & Hoza, 1987). Swanson et al. (1999) noted a loss in its initial effectiveness during the afternoon rating periods. Explanations underlying SR's diminished effectiveness may be attributed to a number of pharmacokinetic factors which included the delayed release of MPH, the lack of a steep absorption-phase and a flattened plasma curve concentration after the establishment of peak concentrations (Birmaher, Greenhill, Cooper, Fried, & Maminski, 1989). Northup, Gulley, Edwards, and Fountain (2001) found results indicating that there is not necessarily any particular dose-response relationship between disruptive behavior and academic performance at the individual level. The optimal dose for behavior change may have minimal, or even a detrimental, influence on the child's cognition or learning (Hoeppner et al., 1997), or may result in adverse side effects at higher doses, such as the "zombie effect," characterized by affective blunting, dysphoria, and social withdrawal (Teeter & Semrud-Clikeman, 1995).

Since ADHD medication is taken orally, absorption and distribution occur more slowly and the peak onset of drug action is usually around one hour (Julien, 2001). Just as the rates of absorption and distribution of a drug impact the onset and peak of a drug's behavioral effects, the half-life of a drug is also correlated with the duration of behavioral effects. The drug's half-life generally refers to the amount of time required to eliminate half of a drug from the body (Julien,

2001). There is some variance with respect to the half-lives and subsequent durations of action of the drugs commonly used to treat ADHD.

Another question with respect to timing has to do with the frequency of changing conditions. Most traditional clinical trials that have used rating scales as endpoints rely on no sooner than weekly phase changes without repeating conditions (Evans et al., 1986). Other studies, however, have evaluated the effects of different doses of medication by changing doses on a daily basis and repeating conditions (Northup, Fusilier, Swanson, Roane, & Borrero, 1997). Unfortunately, the literature offers little guidance as to which of these approaches is more advantageous. Given the pharmacokinetic profiles of the commonly used medications, there is no pharmacological reason why different doses or even drugs could not be evaluated in a fairly rapid fashion, perhaps even daily (Deshazo, 2001). It is likely that the outcome measures selected will influence, to some degree, the rapidity with which dose changes can be evaluated. Standardized rating scales and general clinical impressions which are not necessarily anchored to quantifiable changes in behavior may require more time for the raters to integrate judgments across time, whereas direct observation may be assessed in a more rapid fashion (Kollins, 2004).

Chapter 2

Methods

Participants

The sample consisted of 35 children. Participants satisfied a traditional DSM-IV diagnosis for ADHD and were taking prescribed medication for this condition (see DSM-IV criteria below). Diagnoses were made by professionals including pediatricians, master's level mental health therapists, and nurse practitioners. Diagnoses were verified by the author using a symptom checklist based on DSM-IV criteria (see Appendix A). Forty-one participants responded to the study; 6 were disqualified from the study because they were not taking prescribed medication for ADHD.

DSM-IV Criteria for ADHD

A. Either 1 or 2:

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

   Inattention.

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

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

   c) Often does not seem to listen when spoken to directly.

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

e) Often has difficulty organizing tasks and activities.

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

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

h) Is often easily distracted by extraneous stimuli.

i) Is often forgetful in daily activities.

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

Hyperactivity.

a) Often fidgets with hands or feet or squirms in seat.

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

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

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

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

f) Often talks excessively.

Impulsivity.

g) Often blurts out answers before questions have been completed.

h) Often has trouble awaiting turn.

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

B. Some hyperactive-impulsive symptoms that cause impairment were present before age 7 years.

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

D. There must be clear evidence of significant impairment in social, school, or work functioning.

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

Based on these criteria, three types of ADHD are identified:

1. ADHD, *Combined Type*: if both criteria A1 and B1 are met for the past 6 months.
2. ADHD, *Predominantly Inattentive Type*: if criterion A1 is met but criterion B1 is not met for the past six months.
3. ADHD, *Predominantly Hyperactive-Impulsive Type*: if Criterion B1 is met but Criterion A1 is not met for the past six months.

American Psychiatric Association (DSM-IV-TR), 2000

Participants were required to be between the ages of 9 and 12-years. The age range was restricted to 9-12 due to the significant cognitive changes that occur between the ages of 5-8, and the significant biological changes that occurs after the age of 12 (primarily for males). This design was utilized to limit the possible noise a broad age range may have added to the study. The children were recruited from Tigard, OR and surrounding communities through recommendations from pediatricians, nurse practioners and other mental health providers. The providers presented the participants with a flyer from the author, which briefly explained the study and how to contact the author in order to participate (Appendix B).

The inclusionary criteria for participants included: (a) English as a primary language; (b) meeting the diagnostic criteria for Attention Deficit Hyperactivity Disorder as defined by the DSM-IV (see criteria above). The child may present with any subtype of ADHD including: hyperactivity/impulsivity, inattention, or combined type; (c) taking prescribed medication for ADHD symptoms for at least three months with minimal side effects as reported by parent and child; (d) confirmation from the parent that their child may discontinue the use of his/her stimulant medication for a period of at least 72 hours; (e) having not been diagnosed with a significant neurological disorder such as autism, epilepsy, cerebral palsy, or recent head injury with any loss of consciousness.

Due to the limited ethnic diversity of Tigard and the surrounding area, the majority of the participants were Caucasian. However, there is no reason to expect ethnicity to be a relevant variable in this study, as the primary measure has shown no significant differences between principal ethnic groups (Sheslow & Adams, 2003). The demographic characteristics of age,

gender, and ethnicity of the children who participated are displayed in Table 1. The average age of participants was 11.0 (*SD* = 1.00, Skewness = -.749, Kurtosis = -.406) with the youngest participant 9-years-old, and the oldest participant 12-years-old.

Table 1

Frequency Distributions of Demographic Variable (N = 35)

Variable	Frequency	Percentage
Gender		
Male	26	74.3
Female	9	25.7
Age		
9	4	11.4
10	5	14.3
11	13	37.1
12	13	37.1
Total Sample Ethnicity		
Caucasian	31	88.6
Hispanic	4	11.4

The ADHD diagnostic categories of the participants in the study are presented in Table 2. As can be noted, the smallest ADHD subgroup, the hyperactive subtype, comprised 11% of the 35 participants, while approximately a quarter of the participants presented with a diagnosis of the inattentive subtype of ADHD (26%). The majority of the sample was diagnosed with ADHD combined type (64%). Only a fraction of participants presented with a co-morbid diagnosis (6%). Of the two participants with co-morbid diagnoses, one was diagnosed with Depressive Disorder, NOS, while the other was diagnosed with Adjustment Disorder with Depressed mood.

Table 2

Frequency Distributions of ADHD Profiles

Variable	Frequency	Percentage
Diagnosis		
ADHD Hyperactive	4	11.4
ADHD Inattentive	9	25.7
ADHD Combined Type	22	63.9
Emotional Diagnosis		
Present	2	5.7
Absent	33	94.3
Medication		
MPH	25	71.4
Adderall	8	22.9
Concerta	1	2.9
Strattera	1	2.9
Dosage		
5 mg	26	74.3
10 mg	9	25.7

Co-morbid diagnoses were obtained from the parents who were made aware of the additional diagnoses by their health care provider (the first was diagnosed by a pediatrician, the second by a master's level mental health therapist). Also in Table 2 is found the prescribed medications used by the participants. The most common dosage of the participant's medication was a 5 mg dosage (74%), while the additional participants were prescribed dosages at 10 mg (26%). These figures represent the amount of medication taken per dose; they do not necessarily represent the total milligrams ingested per day.

Both male and female participants were accepted for participation, however research shows that the prevalence of ADHD is higher in males than in females (4:1 in community samples; 9:1 in clinical samples; Barkley, 1997b). The proportion of males to females in the present study was approximately 3:1.

Instruments

The Wide Range Assessment of Memory and Learning, 2nd Edition (WRAML2). All participants were administered the Wide Range Assessment of Memory and Learning Second Edition (Sheslow & Adams, 2003).The WRAML2 is an individually administered test battery designed to assess memory ability. It was designed to be used for clinical assessments of memory, including evaluation of immediate and/or delay recall as well as differentiating between verbal, visual or more global memory deficits. (Sheslow & Adams, 2003). The WRAML2 consists of six core subtests, seven delayed memory tasks, two subtests designed to assess working memory, and four recognition memory subtests (see Figure 1). The core subtests yield three indexes including verbal memory, visual memory, and attention/ concentration (each with a mean of 100 and a standard deviation of 15). These three indexes combine to form the General Memory Index.

The WRAML2 was standardized using a sample of 1,200 individuals ranging in age from 5-90 (Sheslow & Adams, 2003). The reliabilities of the three core indexes range from .85 to .93 for children between the ages of 9 to 12 years. The reliabilities of the six core subtests ranges from .78 to .95 for children between the ages of 9 to 12 years. The reliabilities of the optional subtests range from .72 to .96 for children between the ages of 9 to 12 years. The WRAML2

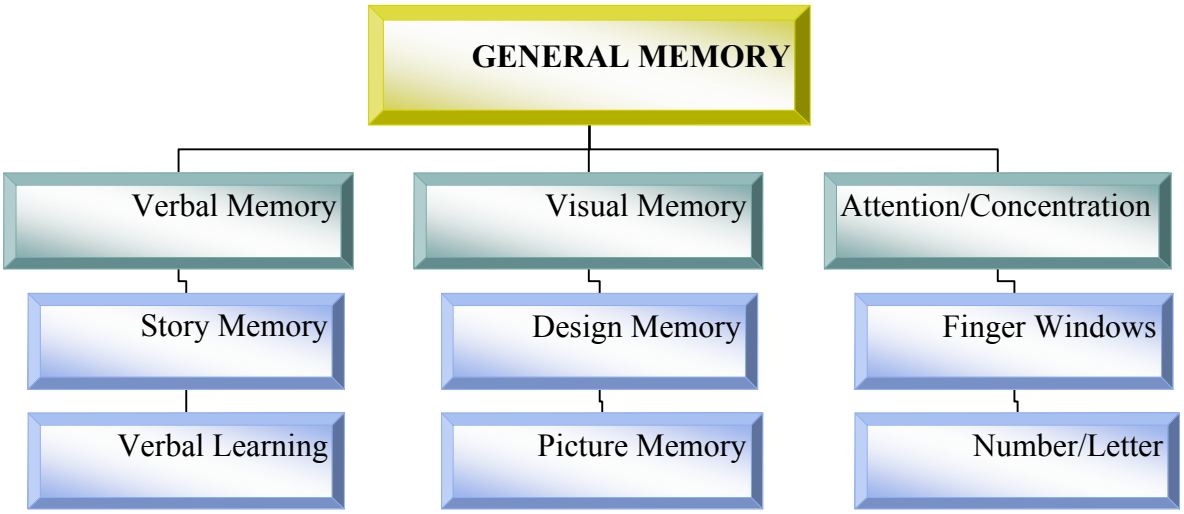

Figure 1. The three core WRAML2 indexes and their contributing subtests.

used Cronbach's coefficient alpha to assess the internal consistency reliabilities for all of the subtests and indexes. The median coefficient found across the norm sample ranged from .86 to .93, with a median of .93 for the General Memory Index. Table 3 provides the person and item separation reliabilities for the WRAML2.

The Verbal Memory Index subtests include Story Memory and Verbal Learning. The Story Memory subtest requires the examinee to listen to, and then recall as many parts of two stories as can be remembered. The Verbal Learning subtest is a list-learning task. The examinee is read a list of 16 words which is followed by an immediate free-recall trial. Three additional list presentation/recall trials follow (Sheslow & Adams, 2003).

The Visual Memory subtests include Design Memory and Picture Memory. Design Memory consists of five different cards with geometric designs. Each card is presented for a five-second exposure, followed by a 10-second delay. The examinee is then asked to draw what he/she remembers. For the Picture Memory subtest, the examinee is shown four common but

Table 3

Person and Item Separation Reliabilities for WRAML2 Subtests

	Person Separation Reliabilities	Item Separation Reliabilities
Core Subtest		
Story Memory	.94	.99
Design Memory	.92	1.00
Verbal Learning	.88	.99
Picture Memory	.85	1.00
Finger Windows	.91	1.00
Number Letter	.90	1.00
Optional Subtest		
Verbal Working Memory	.85	.99
Symbolic Working Memory	.87	1.00
Sentence Memory	.92	1.00
Delay Recall Subtests		
Story Memory Delay Recall	.93	.99
Verbal Learning Delay Recall	.73	.99
Recognition Subtests		
Story Memory Recognition	.78	.99
Design Memory Recognition	.56	.99
Picture Memory Recognition	.60	.99
Verbal Learning Recognition	.58	.98

visually complex scenes (e.g., a classroom) for 10 seconds. Following each scene, a similar but alternate scene is presented and the examinee is asked to identify elements that have "been moved, changed or added" (Sheslow & Adams, 2003).

The Attention/Concentration subtests include Finger Windows and Number-Letter. The Finger Windows subtest requires the examinee to duplicate a demonstrated sequence of visual locations on an 8x10 plastic card. The Number-Letter subtest requires the examinee to repeat a

sequence of single digits and letters that are verbally presented. For both the Finger Windows and Number-Letter subtests, the sequence to be replicated by the participant gradually becomes longer and more challenging.

There are three optional subtests for the WRAML2. Requiring less rote memory than the Number-Letter subtest, the Sentence Memory requires the examinee to repeat a series of longer and longer sentences read by the examiner. On the Verbal Working Memory subtest, participants 9-12 years of age listen to a list of words, some of which are animals and some of which are not. Initially, participants are asked to repeat all of the words, recalling the animal words first followed by the non-animal words in any order. The examinee is then asked to complete a more difficult task that requires him/her to recall the animals in order of their typical size (smallest to largest), followed by all the non-animal words in any order. Symbolic Working Memory requires the examinee to actively manipulate information presented prior to recall, over two levels of difficulty. For the first level, the examiner randomly dictates a series of numbers and asks the examinee to point to the numbers dictated in correct numerical order on a stimulus card. For the second task, a random number and letter series is dictated and the examinee is asked to point to the dictated numbers followed by the dictated letters, each in correct order on number and alphabet cards.

The WRAML2 also includes delayed recall and recognition subtests. Story Memory Delay Recall requires the examinee to again recall details of the two short stories read about 15 minutes earlier in the session. The Story Memory Recognition subtest allows the examinee to provide details of the stories using a 3-item, multiple choice format. The Verbal Learning Delay Recall subtest requires the examinee to recall the list of words the examiner read over the four

trials the last one of which occurred about 15 minutes earlier in the session. Thereafter, the Verbal Learning Recognition subtest requires the examinee to respond with a "yes" or "no" to indicate if a word read by the examiner was recognized from the original list. Design Memory Recognition requires the examinee to respond with a "yes" or "no" when presented with previously seen geometric shapes from the Design Memory subtest. Picture Memory Recognition requires the examinee to respond to "yes" or "no" options on the Picture Memory Recognition Form based on whether the examinee believes the pictured element was previously seen on one of the four original or alternate picture stimuli used on the core Picture Memory subtest (Sheslow & Adams, 2003). Table 4 categorizes the core, optional, delay recall, and recognition subtests.

Table 4

WRAML2 Optional, Delay Recall, and Recognition Subtests

Core Subtests	Delayed Recall Subtests	Recognition Subtests	Optional Subtests
Story Memory	Story Memory Delay Recall	Story Memory Recognition	
Verbal Learning	Verbal Learning Delay Recall	Verbal Learning Recognition	
Design Memory		Design Memory Recognition	
Picture Memory		Picture Memory Recognition	
Finger Windows			
Number-Letter			
			Sentence Memory
			Verbal Working Memory
			Symbolic Working Memory

Wechsler Abbreviated Scale of Intelligence (WASI). The Wechsler Abbreviated Scale of Intelligence (WASI; Zhu, 1999) is an abbreviated IQ measure that is composed of four subtests and can be administered to participants ages 6-89. The subtests of the WASI include: Vocabulary, Similarities, Block Design, and Matrix Reasoning. Scores earned on the Vocabulary and Similarities subtests can be combined to yield a Verbal IQ; scores on the Block Design and Matrix Reasoning subtests can be combined to yield a Non-Verbal IQ; all four subtests combine to yield a Full Scale IQ. "The subtests were chosen for their strong association with general cognitive abilities and for their relationship to constructs of intelligence, such as the verbal and performance and crystallized and fluid dichotomies" (Zhu, 1999). Figure 2 shows the four subtests of the WASI that contribute to the Estimated Full Scale IQ.

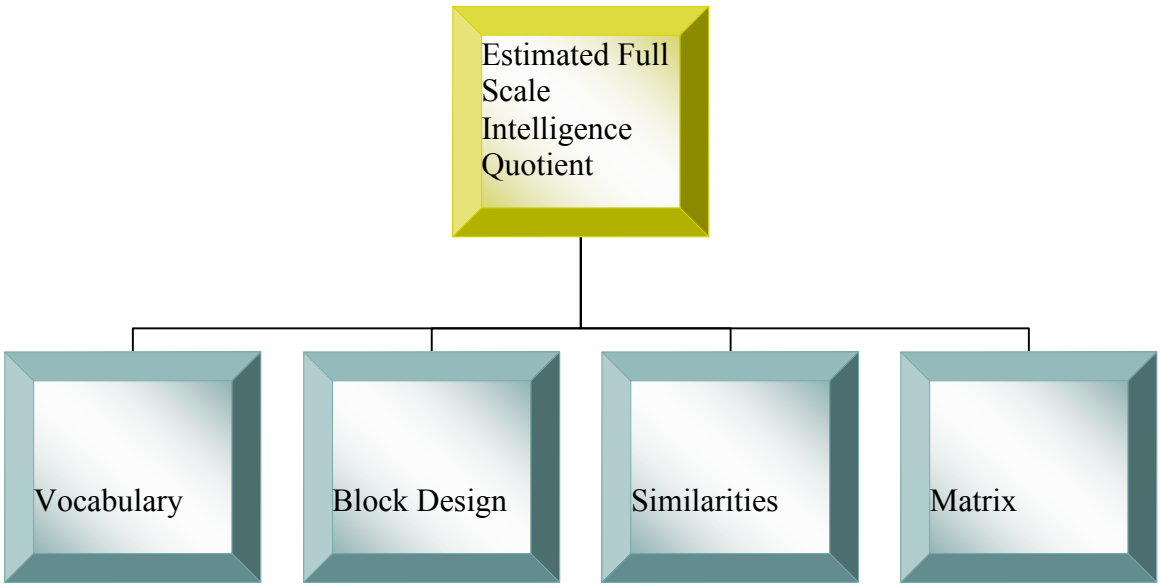

Figure 2. The WASI Full Scale IQ and its contributing subtests.

The Vocabulary subtest consists of items that are similar to the Vocabulary subtests of the WISC-IV and the WAIS-III. For each, the examiner asked the examinee to define a word. The Block Design subtest consist of thirteen modeled or printed patterns that the examinee must replicate using two-colored cubes. The Similarities subtest requires the examinee to explain the similarity between two common objects or concepts. Matrix Reasoning, involves a series of patterns that the examinee must determine the relationship being depicted, and then choose of the five options provided finishes the analogy (Zhu, 1999). Each of the WASI's subtests presents items in increasing order of difficulty and the subtest is discontinued when a ceiling rule is met.

The four subtests Cronbach's coefficient alpha reliabilities reported on a child's sample, range from .86 to .93 for Vocabulary, from .81 to .91 for Similarities, from .84 to .93 for Block Design, and from .86 to .96 for Matrix Reasoning (Ryan & Brown, 2005).

Across the 11 age groups of the children's sample, the Cronbach's coefficient alpha reliabilities for the IQ scales range from .92 to .95 for both the Verbal Intelligence Quotient (VIQ) and Performance Intelligence Quotient (PIQ), and from .95 to .97 for the FSIQ. (Zhu, 1999).

On average, the FSIQ of the WISC-III and the WASI differ by less than one point (Zhu, 1999).

Continuous Performance Test (CPT-II). The Continuous Performance Test (CPT-II; Conners, 2000) is a vigilance task that requires the participant to remain attentive to changing stimuli presented on a computer screen and to respond by pressing a key when specific stimuli appear. The CPT-II is designed to be cognitively demanding and sensitive to the detection of inattentive and impulsive symptoms of ADHD (Edwards et al., 2007). In 2003, Epstein et al. found the CPT-II measures predicted the presence of most all of the ADHD symptoms listed by the DSM-IV. As such, these T-scores provide an index of how deviant an individual's score

pattern is from a nonclinical sample, and whether the obtained results match a clinical or nonclinical sample.

The participant's performance is converted into a T-score. The T-score is then scored against the CPT-II interpretation guidelines, which can be found in Table 5. The overall index score uses discriminate functions to assess the likelihood that an examinee's responses fit those given by individuals with ADHD (Weis & Totten, 2004). The split-half reliability correlations ranged between .73 and .95. The measures of CPT II had a highly satisfactory test-retest correlation coefficient.

Table 5

Guidelines for Interpreting CPT-II T Scores and Percentiles

T Score	Percentile	Guideline
65+	90+	Markedly atypical
60-64	85-89	Moderately atypical
55-59	70-84	Mildly atypical
45-54	31-69	Within the average range
40-44	15-30	Good performance
Under 40	Under 15	Very good performance

The standard protocol of the CPT-II test uses a short training exercise prior to the administration of the full test to ensure that the respondent fully understands the task. After the training exercise, the test administration is begun; it is a requirement of the standardized procedure that an examiner remains present (Conners & MHS Staff, 2000). CPT-II respondents are required to press a computer space bar or click a mouse whenever any letter except the letter 'X' appears anywhere on the computer screen. The inter-stimulus intervals (ISIs) are 1-, 2-, and 4-seconds with a display time of 250 milliseconds. The CPT paradigm is a test structure consisting of blocks, each containing 20 trials (letter presentations). The presentation order of the different ISIs varies between blocks (Conners & MHS Staff, 2000). The administration time of the CPT-II is approximately 14 minutes.

Procedure

This study followed the ethical guidelines of the American Psychological Association and approval was obtained from the Internal Review Boards (IRB) of George Fox University before the study commenced. Thereafter, the author provided local pediatric health care providers with flyers (Appendix B) which outlined the study and provided contact information for the author. Parents of potential participants contacted the author by phone prior to the study and oral consent and the initial appointment time for testing was obtained. The author then assessed the participants' eligibility for the study by asking each parent about their child's diagnoses, their prescribed medication, and reviewed the exclusionary criteria. The parent was asked to both bring the child's medication to the first session and have the child discontinue his/her use of psychostimulant medication for a period of 72-hours. Parents and participants

were informed that participation was voluntary and withdrawal may occur at any time. An appointment time was made for the initial session of testing.

Half of the participants were randomly placed in the medication – placebo sequence and half in the placebo – medication sequence. Consequently, there were two evaluation sessions (i.e., Session 1 and Session 2) and the context of each can be found in Table 6. Session 2 was scheduled for 72 hours after Session 1 to attempt to control the amount of time the medication had been out of the participant's system. Random sequencing was done with the assistance of an Excel random number generator. The random number generator used the total number of participants and randomly split them into two groups with participants in the first group being placed in the medication-placebo sequence and the participants in the second group placed in the placebo-medication sequence.

Table 6

Activities Associated with Each Testing Session

Session 1	Session 2
Signed consent form (parent); Collected medication. Participant ingests medication.	Participant ingested placebo capsule in envelope.
Parent and participant completed the ADHD checklist.	Parent and participant provided additional background information.
The participant completed the CPT-II.	The participant completed the CPT-II.
The participant completed half of the WASI.	The participant completed other half of the WASI.
The participant completed half of the WRAML2.	The participant completed other half of the WRAML2.
Made an appointment for session two.	Child received participation prize.

When the parent and participant arrived for Session 1, the parent provided the examiner with a pill of the participant's psychostimulant medication. The medication and placebo were placed into identical opaque capsules. The placebo capsules contained gelatin. A master's level therapist, a separate individual from the examiner and the author, placed the medication in the capsules and gave the child the capsule that corresponded to the treatment condition they had randomly assigned to. The additional capsule was placed into an envelope for Session 2. This preserved the double blind study, which requires that neither the examiner nor the participant were aware of the medication sequence. During this time the parents were asked to read and sign the consent form (see Appendix C). Parents and participants were informed that the participants are joining in a study that gives the researcher information about the child's memory. After the parent had signed the consent form, he/she and his/her child were escorted by an examiner to a testing room. The examiner, with the assistance of the parent, then used the ADHD symptom checklist that is comprised of DSM-IV diagnostic criteria to confirm the child's ADHD diagnosis (see Appendix A). No participants were disqualified at this time as they all met the DSM-IV diagnostic criteria, however six were disqualified during the initial phone screening process.

After completion of the ADHD checklist, the parent was asked to sit in a waiting area while the participant completed the assessments. The participant first completed the CPT-II. After completion of the CPT-II the participant then completed half of the WASI (see Table 7).

Table 7

Content of Each WASI Subtest Groupings that was Administered on Medication and Placebo.

Test Session 1	Test Session 2
Vocabulary	Similarities
Matrix Reasoning	Block Design

The participant then completed half of the WRAML2 (see Table 8). The time from ingestion of the medication or placebo to the completion of half of the WASI in Session 1 was approximately 45 minutes. This gave enough time for the medication to take affect before beginning the WRAML2.

Table 8

Content of Each of WRAML2 Subtest Groupings that was Administered on Medication Placebo.

Test Session 1	Test Session 2
Story Memory	Verbal Learning
Story Memory Recall	Verbal Learning Recall
Story Memory Recognition	Verbal Learning Recognition
Design Memory	Picture Memory
Design Memory Recognition	Picture Memory Recognition
Finger Windows	Number-Letter
Symbolic Working Memory	Working Memory
Sentences	

Upon arriving for Session 2, the participant took the remaining capsule from the individual envelope designated from Session 1, which contained either the medication or placebo depending on the treatment group to which the participant was assigned. After ingestion of the capsule, the parent and participant were escorted to a testing room where the examiner collected additional background information (e.g., age, sex, diagnostic subtype, educational level, and dosage of medication) that was not obtained during the initial phone interview (see Appendix D). The examiner also collected additional data concerning the participants ADHD symptomology from both the parent and participant (see Appendix E).

The participant then completed the CPT-II for a second time. After completion of the CPT-II, the participant completed the additional half of the WASI and the additional half of the WRAML2. The time from ingestion of the second capsule, to completion of the WASI in Session 2 was approximately 45 minutes. Again, this allowed time for the medication to become active. Information on the typical ADHD medication can be found in Table 9. After the completion of the WRAML2 in Session 2, the participant completed their participation in the study. The participant was then given their token for participation. Tokens included two $10 gift certificates to Blockbuster, one for each session. The parents also received a $10 gas gift card.

One doctoral student from George Fox University assisted the author in data collection. The author and examiner administered the WRAML2 and WASI, while the author alone administered the CPT-II to the participants on dates arranged by the author. The author and examiner had successfully completed a course in cognitive assessment in which they received formal training and demonstrated proficiency with the administration of the WRAML2. The

Table 9

ADHD Medications, Half-lives, Peak Action, and Duration of Action.

Medication	Half-Life	Peak Action	Duration of Action
Adderall	1-3 hrs	1-2 hrs	4-10 hrs
Adderall XR	7-9 hrs	1-4 hrs	9 hrs
Concerta	1-3 hrs	1-3 hrs	4-8 hrs
Ritalin	1-3 hrs	1-3hrs	4-6 hrs
Ritalin SR	1.5-5 hrs	1-4 hrs	5 hrs
Strattera	5 hrs	1-2 hrs	12-24 hrs

Note: The information obtained for Table 9 was adapted from Witcher et al. (2003); Kollins (2004); Deglin & Vallerand (2005). Adderall XR stands for extended release; Ritalin SR stands for slow release.

author also held a review session with the assisting examiner to ensure knowledge of the WRAML2, WASI, and the CPT-II. Both the author and the examiner scored the protocols they administered. The scored protocols were then reviewed by the other to assess for any scoring or tabulation errors.

Shafritz, Marchione, Gore, Shaywitz, and Shaywitz (2004) used a 72-hour period of time during which the participant could not be on their medication before participating in their study. They reported that, "we attempted to control for medication history by ensuring that participants were medication-free for at least 72 hours before testing; this does not eliminate possible long-term modulation of neural functioning stemming from methylphenidate use." Therefore, both

sessions were scheduled after the participant had not ingested his/her medication for at least 72 hours. At the beginning of both sessions, the author asked the parent if it has been at least 72 hours since their child last ingested their psychostimulant medication.

Chapter 3

Results

To test Hypotheses 1 through 15, a multivariate repeated measures analysis of variance (MANOVA) was used for the 15 subtests of the WRAML2, which served as dependent variables; session (on medication; on placebo) served as the between groups independent variables. To test hypotheses 16-19, a separate repeated measures MANOVA was conducted including standard scores from the four subtests of the WASI as dependent variables, and session (on medication; on placebo) as the between group independent variables. WRAML2 subtest performance was represented by scaled scores, with the standardization sample mean of 10 and a standard deviation of 3. For the WASI, the subtest means are represented as T scores, with a standardization mean of 50 and standard deviation of 10. Subtests in a domain were counterbalanced with treatment condition, such that some participants completed specific subtests while in the medication condition and others completed specific subtests while in placebo condition. Please refer to the methods section for details on counterbalancing of the conditions.

Contrary to the research hypotheses, there was no overall performance difference between participants on medication and those on placebo for subtests of the WRAML2 (Wilks $\lambda = .66$, $F(15, 19) = .65$, $p > .05$). Nor were there an overall difference between participants on medication and those on placebo for the subtests of the WASI (Wilks $\lambda = .81$, $F(4, 30) = 1.71$, p

> .05). The analyses from the MANOVA are reported below as they relate to each of the hypotheses. Table 10 shows the performance across both conditions for all participants..

Table 10

Performance in Medication and Placebo Conditions

Order	Mean	Std. Deviation	Effect Size	N
		WRAML2 Subtests		
Story Memory				
Medication	9.00	1.372		18
Placebo	9.06	1.819		17
Total	9.03	1.581	-.040	35
Story Recall				
Medication	8.83	1.543		18
Placebo	9.24	1.715		17
Total	9.03	1.618	-.250	35
Story Recognition				
Medication	9.06	1.474		18
Placebo	9.47	1.807		17
Total	9.26	1.633	-.249	35
Design Memory				
Medication	8.44	1.381		18
Placebo	8.76	1.888		17
Total	8.60	1.631	-.194	35
Design Memory Recognition				
Medication	8.61	1.577		18
Placebo	8.82	1.629		17
Total	8.71	1.582	-.131	35
Finger Windows				
Medication	7.56	1.580		18
Placebo	8.35	1.935		17
Total	7.94	1.781	-.447	35

Table 10. *Performance in Medication and Placebo Conditions. (Continued)*

Order	Mean	Std. Deviation	Effect Size	N
Symbolic Working Memory				
Medication	8.33	1.455		18
Placebo	8.59	1.938		17
Total	8.46	1.686	-.151	35
Sentence Memory				
Medication	11.17	1.948		18
Placebo	10.88	1.728		17
Total	11.03	1.823	.157	35
Verbal Learning				
Medication	8.78	1.665		18
Placebo	9.18	1.944		17
Total	8.97	1.790	-.220	35
Verbal Learning Recall				
Medication	8.72	1.565		18
Placebo	8.76	1.300		17
Total	8.74	1.421	-.020	35
Verbal Learning Recognition				
Medication	9.11	1.568		18
Placebo	8.82	1.510		17
Total	8.97	1.524	.189	35
Picture Memory				
Medication	9.06	1.955		18
Placebo	9.18	2.007		17
Total	9.11	1.952	-.061	35
Picture Memory Recognition				
Medication	8.89	1.367		18
Placebo	9.12	1.409		17
Total	9.00	1.372	-.166	35
Number Letter				
Medication	9.22	1.801		18
Placebo	8.94	1.345		17
Total	9.09	1.579	.176	35

Table 10. *Performance in Medication and Placebo Conditions. (Continued)*

Order	Mean	Std. Deviation	Effect Size	N
Verbal Working Memory				
Medication	8.22	1.437		18
Placebo	8.29	1.160		17
Total	8.26	1.291	-.054	35
		WASI Subtest		
Vocabulary				
Medication	52.61	4.629		18
Placebo	52.88	3.638		17
Total	52.74	4.118	-.064	35
Matrix Reasoning				
Medication	52.06	5.116		18
Placebo	54.35	3.952		17
Total	53.17	4.668	-.501	35
Similarities				
Medication	52.17	4.926		18
Placebo	51.94	4.100		17
Total	52.06	4.478	.051	35
Block Design				
Medication	52.39	4.002		18
Placebo	53.53	4.460		17
Total	52.94	4.207	-.269	35

Note: WRAML2 = Wide Range Assessment of Memory and Learning, 2nd Edition. WASI = Wechsler Abbreviated Intelligence Scale.

Hypotheses

Hypothesis 1. Participants diagnosed with ADHD will score higher on the Story Memory subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for Story Memory, ($F(1, 33) = .01$, $p > .05$). Contrary to the hypothesis, Story Memory performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 2. Participants diagnosed with ADHD will score higher on the Story Memory Recall subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Story Memory Recall subtest, ($F(1, 33) = .53$, $p > .05$). Contrary to the hypothesis, Story Memory Recall performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 3. Participants diagnosed with ADHD will score higher on the Story Memory Recognition subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Story Memory Recognition subtest, ($F(1, 33) = .56$, $p > .05$). Contrary to the hypothesis, Story Memory Recognition performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 4. Participants diagnosed with ADHD will score higher on the Design Memory subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Design Memory subtest, ($F(1, 33) = .33$, $p > .05$). Contrary to the hypothesis, Design Memory performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 5. Participants diagnosed with ADHD will score higher on the Design Memory Recognition subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for Design Memory Recognition subtest, ($F(1, 33) = .15$, $p > .05$). Contrary to the hypothesis, Design Memory Recognition performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 6. Participants diagnosed with ADHD will score higher on the Verbal Learning subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for Verbal Learning subtest, ($F(1, 33) = .43$, $p > .05$). Contrary to the hypothesis, Verbal Learning performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 7. Participants diagnosed with ADHD will score higher on the Verbal Learning Recall subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for Verbal Learning Recall subtest, ($F(1, 33) = .01$, $p > .05$). Contrary to the hypothesis, Verbal Learning Recall performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 8. Participants diagnosed with ADHD will score higher on the Verbal Learning Recognition subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for Verbal Learning Recognition subtest, ($F(1, 33) = .31$, $p > .05$). Contrary to the hypothesis, Verbal Learning Recognition performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 9. Participants diagnosed with ADHD will score higher on the Picture Memory subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Picture Memory subtest, ($F(1, 33) = .03$, $p > .05$). Contrary to the hypothesis, Picture Memory performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 10. Participants diagnosed with ADHD will score higher on the Picture Memory Recognition subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Picture Memory Recognition subtest, ($F(1, 33) = .24$, $p > .05$). Contrary to the hypothesis, Picture Memory Recognition performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 11. Participants diagnosed with ADHD will score higher on the Finger Windows subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Finger Windows subtest, ($F(1, 33) = 1.79$, $p > .05$). Contrary to the hypothesis, Finger Windows performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 12. Participants diagnosed with ADHD will score higher on the Number Letter subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Number Letter subtest, ($F(1, 33) = .27$, $p > .05$). Contrary to the hypothesis, Number Letter performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 13. Participants diagnosed with ADHD will score higher on the Symbolic Working Memory subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Symbolic Working Memory subtest, ($F(1, 33) = .20$, $p > .05$). Contrary to the hypothesis, Symbolic Working Memory performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 14. Participants diagnosed with ADHD will score higher on the Verbal Working Memory subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Verbal Working Memory subtest, ($F(1, 33) = .03$, $p > .05$). Contrary to the hypothesis, Verbal

Working Memory performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 15. Participants diagnosed with ADHD will score higher on the Sentence Memory subtest of the WRAML2 in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Sentence Memory subtest, ($F(1, 33) = .21$, $p > .05$). Contrary to the hypothesis, Sentence Memory performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 16. Participants diagnosed with ADHD will score higher on the Vocabulary subtest of the WASI in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Vocabulary subtest, ($F(1, 33) = .037$, $p > .05$). Contrary to the hypothesis, Vocabulary performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 17. Participants diagnosed with ADHD will score higher on the Matrix Reasoning subtest of the WASI in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Matrix Reasoning subtest, ($F(1, 33) = 2.2$, $p > .05$). Contrary to the hypothesis, Matrix Reasoning performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 18. Participants diagnosed with ADHD will score higher on the Similarities subtest of the WASI in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Similarities subtest, ($F(1, 33) = .02$, $p > .05$). Contrary to the hypothesis, Similarities performance was non-significant for psychostimulant medication and placebo conditions.

Hypothesis 19. Participants diagnosed with ADHD will score higher on the Block Design subtest of the WASI in the psychostimulant medication condition than when they are in the placebo condition.

There were no significant differences evidenced across treatment conditions for the Block Design subtest, ($F(1, 33) = .64$, $p > .05$). Contrary to the hypothesis, Block Design performance was non-significant for psychostimulant medication and placebo conditions.

Chapter 4

Discussion

The present study was an investigation to assess if the use of psychostimulant medication would result in higher scores on measures of memory and intelligence among participants with ADHD. The results of the analyses showed that psychostimulant medication did not significantly alter performance on measures of verbal or visual memory, nor on verbal or visual measures of intelligence compared to placebo conditions.

In the current study, the medicated ADHD children were receiving an individually prescribed dose of stimulant medication. Previous research has found that improvements in cognitive functioning are seen in a dose-dependent linear curve (i.e., low doses effect cognitive aspects more significantly than higher doses (2.5-5; Hoeppner et al., 1997). It could be argued that medication dose influenced performance in this study (i.e., if the dosages were too high to effect cognitive processes and solely treated behavior symptoms; Kempton, 1999). The present study utilized varied dosages (both 5 and 10 mg) along with various types of prescribed medications. It is possible that by not examining one specific type and/or dosage of psychostimulant medication the study was impacted in unknown ways.

A subjective scale was provided for parents (see Appendix D) to rate their children on different areas including: the child's overall behavior (1 = *very poor* to 10 = *very good*), the child's level of distractibility (1 = *not distractible* to 10 = *very distractible*), the child's activity

level (1 = *not active* to 10 = *very active*), and the parent's perception on the effects of their child's medication (1 = *not effective* to 10 = *very effective*). Means for the parent ratings were as followed: Behavior (mean: 6.5; *sd* = 1.42); Distractibility (mean: 7.8; *sd* = 1.65); Activity level (mean: 7.2; *sd* = 1.57); Effect of medication (mean: 7.0; *sd* = 1.53). Per the parent's report, it appears that the psychostimulant medication has been moderately effective in treating their children's symptoms of distractibility and hyperactivity. While the medication seems to be addressing the behavioral concerns of the children's ADHD symptoms, it seems to be doing little to help memory or IQ processes as research indicates that cognitive processes are often found helpful at low doses (2.5 - 5 mg; Pliszka et al., 2006).

The current study found that results of 12 of the 14 subtests of the WRAML2 and 3 of the 4 subtests of the WASI were higher in the placebo condition. Of the 19 subtest procedures utilized, 15 (78.95%) had lower levels of performance associated with the medication condition. While some of the 15 subtests differences were small, and none statistically significant, nonetheless, when subhected to a chi-square analysis, the number of subtests with lower medication performance across the 19 subtests was found to be greater than would be expected by chance ($\chi^2(1) = 8.78, p < .01$). Therefore, there is a trend suggested that medication is not helpful, and might, in fact, even be subtly antagonistic to recall.

While most of the CPT-II data were lost, data pertaining to Table 5 were salvageable. This data suggest that, according to the CPT-II ADHD symptom severity scores, the participants in the study fell within the average range of ADHD symptom severity. The participants in the medication condition for Session 1 yielded a mean CPT-II symptom severity score of 51.31 (*sd* = 8.04); while the placebo condition for Session 1 yielded a mean of 51.94 (*sd* = 8.11). Likewise

the results of medication condition for Session 2 yielded a mean CPT-II symptom severity score of 50.42 (*sd* = 8.17); while the placebo condition for Session 2 yielded a mean of 54.99 (*sd* = 6.79). It could be argued that while the participants met clinical criteria for ADHD their level of symptom severity was minimal and therefore the results were muted due to the lack of severe clinical symptomology within the participant pool. It may also be argued that the participants, according to the CPT-II, did not meet DSM-IV diagnostic criteria for ADHD.

Swanson (1993) conducted a comprehensive examination of 341 reviews of the effects of stimulant medication on children with ADHD. His review found that psychostimulant medication was ineffective for 25 to 40 percent of children with ADHD in terms of behavioral improvements. Additionally, there was no evidence of significant improvement in reading, athletic or game skills, proactive social skills, learning and achievement other than improved attending. If the reviewed research indicated no changes in behavioral symptoms for up to 40% of participants, then it is likely that a much higher percentage of participants experienced no effects, or even negative effects, on cognitive components. "Inconsistent MPH-achievement findings may be in part due to differences in cognitive and behavioral dose-response relationships. When differential MPH dose-response relationships have been reported, lower doses typically improve academic behavior, with little or no additional benefit found for higher doses" (Hale et al., 2011).

Barkley et al., (2000) stated that it is extremely difficult to evaluate drug response in an outpatient setting. "[An outpatient setting] will compromise the clinician's abilities to systematically evaluate actual drug responding, thereby undermining clinical judgments of drug and dose effectiveness." Similar to the results described above, at the group level Barkley et al.,

(2000) found no response to medication per attention and inhibition in varied dosages in an outpatient research setting.

Stimulants have been the mainstay of psychopharmacologic treatment of ADHD for over fifty years. Methylphenidate is the most frequently prescribed stimulant (Goldman et al., 1998). While research continues to support the notion that psychostimulant medication improves behavioral characteristics (Barkley, 2004), the research is still unclear how effective psychostimulant medication is for aspects of memory such as sustained attention, encoding, retention, or recognition. The present study would suggest that psychostimulant medication has no demonstrable effects on children's performance on short term and delayed memory tasks.

Limitations

The CPT-II was used as an additional diagnostic measure to Appendixes A & E. However, it should be noted that the computer on which the CPT-II data was stored, crashed rendering the data inaccessible. This limited the amount of data that could be utilized from the CPT-II.

The data that were retrieved from the CPT-II suggested that the severity of the symptomology of the participants was within the average range. This appeared to limit the results as it is probable that participants with more severe clinical presentation may have gained more cognitive benefit from psychostimulant medication than participants with severity of symptoms in the average range.

The study also included all three diagnostic subtypes of ADHD, as well as several different medications and two different doses. Perhaps examining one specific diagnostic

subtype, one specific type of medication, or one specific dose of medication may have yielded different results.

Future Direction

It will be important for future research in this area to focus on each specific subtype of ADHD, to determine which, if any, may be more sensitive medication effects. The present study had a limited number of ADHD inattentive and hyperactive subtypes. Future studies examining medication effects on each of the three subtypes would be beneficial.

Research utilizing specific dosing standards, as well as specific medication types, would allow for medication effects on intellectual and memory processes to be examined more closely as there is ongoing debate in the research about which dosage of which medication yields more reliable results for both behavior and cognition (Hoeppner et al., 1997). Studies which investigate medication doses below recommended, at recommended, and higher than recommended doses for the three or four most commonly used medications would be greatly beneficial.

Memory retrieval and executive functioning are closely related. Future research integrating memory and executive functioning measures may created a more well rounded picture of medication effects on memory functioning and related executive functioning skills such as working memory, recall, and inhibition.

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Appendix A

ADHD Questionnaire

ADHD Questionnaire

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

_____ Fails to give attention to details or makes careless mistakes in schoolwork, chores or other activities

_____ Has difficulties sustaining attention in tasks or play activities

_____ Does not seem to listen when spoken to directly

_____ Does not follow through on instructions and fails to finish schoolwork, chores, or duties in the home (not due to oppositional behavior or failure to understand directions)

_____ Has difficulty organizing tasks and activities

_____ Avoids or strongly dislikes tasks that require sustained mental effort (such as schoolwork or homework)

_____ Loses things necessary for tasks or activities (such as school assignments, pencils, books, or toys)

_____ Easily distracted by extraneous stimuli

_____ Forgetful in daily activities

Hyperactivity-Impulsivity: Six (or more) of the following symptoms must have persisted for at least six months to a degree that is maladaptive and inconsistent with developmental level:

_____ Fidgets with hands or feet or squirms in seat

_____ Leaves seat in classroom or in other situations in which remaining in seat is expected (such as the dinner table)

_____ Runs about or climbs excessively in situations where it is inappropriate (in adolescents this may be limited to a subjective feeling of restlessness)

_____ Has difficulty playing or engaging in leisure or play activities quietly

_____ Is “on the go” or acts as if “driven by a motor”

_____ Talks excessively

_____ Blurts out answers to questions before the questions have been completed

_____ Has difficulty waiting in lines or awaiting turn in games or group situations

_____ Interrupts or intrudes on others (such as butting into conversations or other activities)

Additional Diagnostic Criteria

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

_____ Some impairment from the symptoms is present in two or more settings.

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

_____ The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder.

Appendix B

Participation Flyer

$20 GIFT CARD OPPORTUNITY!!

What: A study on memory and the effects that psychostimulant medication has on the memory of children with Attention Deficit/Hyperactivity Disorder (ADHD). *As a token "Thank you", each child will receive a $20 gift certificate to Blockbuster Video for his/her participation. The parent will also receive a $10 gas card for their time and effort transporting their children.*

Who: Participants will be children between the ages of 9-12 who have been diagnosed with ADHD and are taking medication to control these symptoms. Children will be asked to complete a brief IQ assessment and a memory assessment, both of which will be divided between the 2 sessions. They will also do a computerized assessment that is much like a computer game. Session 1 will be approximately an hour, and session 2 will only take about 40 minutes. Participation is completely voluntary and may stop at any time

Where: All tasks will be administered by a trained doctoral psychology student at the Tigard High School Health Center.

Why: The results may help children with this condition, and their families, to be better informed about the effects stimulant medication has on memory in children with ADHD.

When: Assessments will be conducted at your convenience!

I hope that you and your child will be able to help with this project. To schedule your sessions, please contact Ben Dunagan at (503)333-7072 or email at bdunagan05@georgefox.edu by May 15th. I look forward to working with you and your child.

Appendix C

Consent Form

Consent Form

I understand that my child is a willing participants in this doctoral research investigating the effects of psychostimulant medication on the memory of children with ADHD. As a part of this study, my child will be asked to complete a cognitive assessment and a memory assessment, supply information about my child's ADHD symptoms and diagnosis, and be willing to have my child assessed both on and off of his/her prescribed medication. These assessments will be completed over two sessions.

I understand that myself, and my child will have the opportunity to take part in a discussion with the person administering the assessments regarding the procedures involved. I understand that myself and my child will be able to receive a summary of the study's results.

I understand that my child may stop his/her involvement at any point, with no explanation necessary.

If I have any questions that the person administering these tests cannot answer or concerns about the testing process, I can contact Ben Dunagan, MA. Mr. Dunagan is being supervised by Dr. Wayne Adams of George Fox University. Mr. Dunagan is available at 503-333-7072 or by email at: bdunagan05@georgefox.edu.

_____ _____

Printed Participant's Name Participant's Signature

_____ _____

Printed Parent's Name Parent's Signature

_____

Ben Dunagan, MS Ed., MA

Date:_____/_____/_____ _____

Test Examiner's Signature

Appendix D

Background Information

Background Information

Participant ID # _____

Examiner: _____

Child's Name: _____
First Middle Last

Date of Birth: _____/_____/_____ Age: _____

Sex (circle one please): Male Female

Ethnicity (circle one please): Caucasian African American Asian Hispanic
Other: _____

Grade (last grade passed): _____

Parents' Names: _____

Contact Information
What is the best way to contact you? (circle one please): Phone Email

Phone Number: _____ Email: _____

Home Address: _____
*Note: Contact information is used *ONLY* for scheduling appointments and will *NOT* be used in the research.

Child's Diagnosis: _____

Age of Diagnosis: _____ Profession that Diagnosed: _____

Medication(s): _____

Dosage(s): _____

Side Effect(s): _____

Allergic to milk? Yes No

Does your child have vision or hearing difficulties? Yes No

If yes, explain: _____

1st Appointment: _____
2nd Appointment: _____

Has it been 72 hours since your child ingested his/her psychostimulant medication?

Yes No

Parent Ratings

How is your child's behavior overall?

1 2 3 4 5 6 7 8 9 10

How is your child's distractibility?

1 2 3 4 5 6 7 8 9 10

How is your child's activity level?

1 2 3 4 5 6 7 8 9 10

How has the medication affected your child's behavior?

1 2 3 4 5 6 7 8 9 10

Appendix E

ADHD Symptom History

Attention Deficit/Hyperactivity Disorder (ADHD)

Participant History

At what age did you first notice inattentive or hyperactive symptoms?

_____

At what age was he/she diagnosed with ADHD?

_____

Where, and by whom, was he/she diagnosed?

_____

Has your child ever been diagnosed with an emotional or behavioral problem other than ADHD? Yes No

If yes, please describe: _____

_____

At what age was he/she diagnosed? _____

Where, and by whom, was he/she diagnosed?

_____

Is this a current diagnosis? Yes No

Appendix F

Curriculum Vita

CURRICULUM VITAE

Benjamin Dunagan, PsyD.

9177 E. 35th Ave., Denver, CO 80238
(303) 570-5190
bdunagan09@gmail.com

Education

May 2011 **Doctorate (PsyD.)**
George Fox University
Graduate Department of Clinical Psychology
Newberg, OR, APA Accredited

May 2007 **Master of Arts: Clinical Psychology**
George Fox University
Graduate Department of Clinical Psychology
Newberg, OR, APA Accredited

Dec. 2004 **Master of Science: Community Counseling**
University of Nebraska at Kearney
Kearney, NE, CACREP Accredited

May 2002 **Bachelor of Science: Psychology; Minor in Sociology**
Nebraska Wesleyan University
Lincoln, NE

Licensure

Oct. 2010 – Aug. 2011 **Licensed Professional Counselor – State of Colorado**

- License number - 5878

Clinical Experience

Jan. 2011 – Current **Kaiser Permanente**
Denver, CO
Emphasis: Health Psychology
Responsibilities:

- Provide personality and diagnostic psychological assessments.

- Provide in-takes and individual psychotherapy with heavy caseload.
- Interdisciplinary work environment.

July 2009 – June 2010 **Internship (APA Accredited)**
Jersey Shore University Medical Center
Neptune, NJ
Emphasis: Primary Care Psychology, Behavioral Pain Management, & Medical Issues
Rotations:
Consultation and Liaison
- Consultation and evaluations with a variety of medical and psychological diagnoses including substance abuse.
- Comprehensive psychological assessments on inpatient psychiatric unit with co-morbid medical issues.

Behavioral Medicine
- Primary care psychology including post partum depression evaluations.
- Provided pain management interventions in conjunction with physicians at musculoskeletal clinic. Discussed rationale for pain medication treatment and prescriptions.
- Interventions included progressive muscle relaxation, diaphragmatic breathing, sleep management, cue-controlled relaxation, stress management, & CBT for pain management.

Inpatient Treatment
- Provided group and individual therapy for patients with SMPI, eating disorders, and other chronic conditions.
- Provided outpatient referrals and recommendations.

Neuropsychological Assessment
- Neuropsychological assessment with acute medical patients on rehabilitation unit.
- Patient presentations included stroke, toxic/metabolic or anoxic encephalopathy, neurosurgical interventions for malignant neuroplastic disease or hydrocephalus shunt placement, traumatic brain injury, cardiac crisis, multiple sclerosis, dementia, spinal cord surgery and general debility due to multiple & coexisting medical conditions.

Outpatient Clinic
- Outpatient psychotherapy with adults and adolescents.
- Co-facilitated group: Coping with Chronic Medical Conditions.

Aug. 2008 – June 2009 **Pre-Internship**
Kaiser Permanente
Portland, OR
Population: Adult, Adolescent, & Children Outpatient

Emphasis: Neuropsychological Assessment & Primary Care Psychology
Responsibilities:

- Provided weekly outpatient neuropsychological assessments for patients with both chronic and acute medical issues.
- Provided personality and diagnostic psychological assessments.
- Provided in-takes and individual psychotherapy with heavy caseload.
- Interdisciplinary work environment.

Supervisor: Ron Sandoval, PhD.

Aug. 2007 – June 2008 **Practicum II**
Oregon State Hospital
Salem, OR
Population: Adult Inpatient
Emphasis: Neuropsychological & Cognitive Assessment with SPMI
Responsibilities:

- Provided weekly cognitive assessments.
- Provided bi-weekly neuropsychological assessments for patients dealing with chronic medical problems.
- Presented at the Neuropsychological Grand Rounds: "Neuropsychological Functioning of Patient with Multiple Myeloma and Renal Failure"
- Interdisciplinary work environment.

Supervisor: James Clay, PsyD.

Aug. 2006 – Aug. 2007 **Practicum I**
Lifeworks Northwest: Cedar Mill & Tigard sites
Portland & Tigard, OR
Population: Adult Outpatient
Emphasis: Individual Psychotherapy
Responsibilities:

- Provided individual psychotherapy to patients presenting with a variety of diagnoses. Heavy case load.
- Conducted in-take interviews, provided diagnosis, and treatment planning.
- Treated diverse clientele and diagnostic issues.
- Offered a paid position at the end of the practicum.

Supervisor: Ken Ihli, PhD.

Jan. 2006 – April 2006 **Pre-Practicum training: GFU Counseling Center**
George Fox University, Newberg, OR
Population: Adult Outpatient
Emphasis: Individual Psychotherapy
Responsibilities:

- Provided individual psychotherapy with university students.
- Conducted in-take interviews, treatment planning, mental status, and goal setting.
- Completed case presentations to supervision group.

Supervisor: Sally Hopkins, PsyD.

July 2004 – Dec. 2004 **Masters Level Internship: Richard Young Hospital**
Kearney, NE
Population: Inpatient adolescents
Emphasis: Individual, Group, & Family Psychotherapy
Responsibilities:

- Provided individual, group, and family psychotherapy.
- Responsible for treatment planning and case notes.
- Work closely with the child psychiatrist.
- Interdisciplinary work environment.

Supervisor: Kathleen Shundoff, PhD.

Jan. 2004 – May 2004 **Masters Practicum: University of Nebraska at Kearney Counseling Center**
Kearney, NE
Population: Adults, Adolescents, and Children
Emphasis: Individual Psychotherapy
Responsibilities:

- Provided individual psychotherapy.
- Responsible for treatment planning and case notes.
- Regular case presentations to supervision group.

Supervisor: David Hof, PhD. Ed.

May 2002 – Oct. 2003 **St. Francis Hospital Alcohol and Drug Treatment Center**
Grand Island, NE
Population: Adults and Adolescents
Emphasis: Substance Abuse
Responsibilities:

- Worked with clients with substance abuse issues.
- Supervised client's daily activities.
- Co-facilitated group therapy.

Jan. 2001 – May 2002 **Undergraduate Practicum: Center Point Treatment Center**
Lincoln, NE
Population: Adolescents
Emphasis: Substance Abuse
Responsibilities:

- Worked with adolescents who were inpatient substance abuse treatment center.
- Co-facilitated substance abuse and eating disorders group therapy.
- Observed individual and group therapy.

Supervisor: Bill McNeil, PhD.

Jan. 2000 – May 2001 **Undergraduate Practicum: Northwest Family Center**
Lincoln, NE
Population: Adolescents
Emphasis: Adolescent Social Skills
Responsibilities:
- Worked with adolescents who had sexual abuse history.
- Facilitated involvement in social activities.
- Monitored progress concerning school work.

Supervisor: Bill McNeil, PhD.

Research Experience

2010 **New Jersey Psychological Association Foundation**
- Research into Causes and/or Treatment of Social Problems Award: *The Effects of Medication on Memory for Children Diagnosed with ADHD*.

2008 **Richter Grant for Travel**
- Awarded $1200.00 Richter Grant to fund travel to APA convention to present research on autism.

2007 **Richter Grant for Research**
- Awarded $750.00 Richter Grant for research concerning autism.

2007 **Richter Grant for Research**
- Awarded $4865.00 Richter Grant to fund dissertation concerning ADHD.

2007-2011 **Doctoral Dissertation:**
- **Title:** "The Effects of Medication on Memory in Children Diagnosed with ADHD".
- Investigates the impact of psycho-stimulant medication on memory.
- Dissertation Chair: Wayne Adams, PhD., ABPP

2007 **Research Assistant:** George Fox University
- **Title:** "Assessment of Long-term Memory"
- Paid position collecting data for dissertation measuring long term memory.

2006 **Research Assistant:** George Fox University
- **Title:** "Shame Recognition in Grade School Students"
- Responsible for data collection.

2006 **Research Assistant:** George Fox University
- **Title:** "Everyday Memory Scale".
- Paid position collecting norms for memory assessment.

2005 **Research Vertical Team Member**
- Meet twice a month to discuss, evaluate process, methodology, and design of group and individual research projects.

Supervisor: Wayne Adams, PhD., ABPP

2002 **Senior Research Project:** Nebraska Wesleyan University
Title: "Assessing Personality Differences and Classroom Approval Ratings"
Chair: Bill McNeil PhD.

Professional Presentations/Publications

2011 **Presentation:** 2011 APA Conference: Washington, DC. Poster presentation. "The Effects of Medication on Memory in Children Diagnosed with ADHD".

2009 Lennen, D.T., **Dunagan, B.J.**, Lamb, G.D., & Hall, T.A. (2010). Verbal prowess equals higher IQ: Implications for evaluating autism. *Research in Autism Spectrum Disorders.*

2008 **Presentation:** 2008 APA Conference: Boston, MA. Oral presentation. "Verbal prowess equals higher IQ: Implications for evaluating autism".

2008 **Presentation:** OSH Neuropsychological Grand Rounds Case Presentation: "Neuropsychological Functioning of Patient with Multiple Myeloma and Renal Failure". Presented with James Clay, PsyD.

Academic Experience

2007 – 08 **Graduate Assistant**: Neuropsychological Assessment: George Fox University Responsibilities: Teach usage of various neuropsychological assessment instruments and assess competence of students on said instruments. Paid position.

2008 **Research and Design**: George Fox University – Associate Professor Master's program.
Responsibilities: Class lecture, grading, and supervision of research projects.

2008	**Research and Statistics**: George Fox University – Associate Professor Master's program. Responsibilities: Class lecture, grading, and supervision of research projects.
2008	**Lifespan and Development**: George Fox University – Guest Lecturer Topic: Middle Age and Gerontological Development, April 1st.

Professional Associations

2008 – Present	National Academy of Neuropsychology
2005 – Present	American Psychological Association
2005 – Present	American Psychological Association of Graduate Students
2002 – 2006	Nebraska Counseling Association