3-2010

Cognitive Differences Among Individuals with Attention-Deficit/ Hyperactivity Disorder on the Stanford-Binet Intelligence Scales, Fifth Edition

Meridee L. Runge

Cognitive Differences Among Individuals with Attention-Deficit/Hyperactivity Disorder on the Stanford-Binet Intelligence Scales, Fifth Edition

by

Meridee L. Runge

Presented to the Faculty of the

Graduate Department of Clinical Psychology

George Fox University

in partial fulfillment

of the requirements for the degree of

Doctor of Psychology

in Clinical Psychology

Newberg, Oregon

March 2010

Cognitive differences among Attention-Deficit/Hyperactivity Disorder diagnostic subtypes on the Stanford-Binet Intelligence Scales, Fifth Edition.

A dissertation submitted to the faculty of the

Graduate Department of Clinical Psychology

George Fox University

Newberg, Oregon

by

Meridee L. Runge

in partial fulfillment of the requirements

for the degree of

Doctor of Psychology

1 March 2010

APPROVED: _____
Rodger K. Bufford, Ph.D.

_____
Gale H. Roid, Ph.D.

_____
Elizabeth Hamilton, Ph.D.

Cognitive Differences Among Individuals with Attention-Deficit/Hyperactivity Disorder on the Stanford-Binet Intelligence Scales, Fifth Edition

Meridee L. Runge

Graduate Department of Clinical Psychology

George Fox University

Newberg, Oregon

Abstract

Attention-deficit/hyperactivity disorder (ADHD) is a common psychiatric diagnosis in childhood based on high levels of inattention or hyperactivity beyond those expected by the child's developmental level. Past research shows cognitive discrepancies in ADHD populations with verbal deficiencies observed primarily in tasks that require a combined auditory and verbal component. Working memory has been a long acknowledged deficit in persons with ADHD.

This research examined cognitive differences among children with ADHD on working memory and other components of the Stanford-Binet Intelligence Scales, 5th edition (SB-5). Verbal and nonverbal working memory, as measured by the SB-5, were hypothesized to be different for the ADHD sample compared to controls and between ADHD subtypes. Participants were gathered from the SB-5 standardization sample that were diagnosed with ADHD and matched with a group of normal controls.

Data was analyzed using ANOVA followed by a cluster analysis of discrepancies found at subtest and testlet levels. Due to matching and statistical control, results showed no differences in Full-Scale IQ, Verbal IQ, or Nonverbal IQ between normals and those with ADHD. Those with ADHD took an average of 20 minutes longer to complete the SB-5, consistently showed greater response variability, and exhibited significant differential item functioning for Vocabulary and Object Series/Matrices, which are the routing scales, in addition to more difficult Block Span items. Deficits in working memory appear to account for these differences.

These results suggest that compared to normal children with the same level of general intelligence, those with ADHD will take longer to complete many academic tasks, will perform significantly more poorly on tasks requiring working memory, and yet may also do better on academic tasks that do not tax working memory. Thus compared to normal children, those with ADHD are likely to seem inconsistent in their performance. While these findings are specific to the SB-5, based on observations of children with ADHD we suspect that these differences between normal children and those with ADHD will generalize widely.

Acknowledgments

The author would like to extend special gratitude to her dissertation committee, Drs. Rodger Bufford, Gale Roid, and Elizabeth Hamilton. More than you know, I appreciate your time, effort, edits, reassurance, and direction throughout this process. In addition, exceptional thanks goes to readers, friends and editors. To the George Fox University professors and my outstanding cohort, I cannot thank you enough for your support and guidance these many years! To my family and friends, words cannot express my gratitude for your support and encouragement. You have all been there for me through this whole experience, holding me up when I needed it, rooting me on when it was called for, and making me laugh in between. Thank you so very much.

Table of Contents

Table of Tables

Table of Figures

Chapter 1

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common disorders diagnosed in childhood, with American Psychiatric Association (APA) reported prevalence rates between 3-7% in school-aged children, with boys being diagnosed with ADHD three to four times more than girls (APA, 2000). Individuals must demonstrate a developmentally inappropriate level of inattention or hyperactivity in order to be diagnosed with the disorder. Inattention is defined by the most recent *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR) as: failing to give attention to details, careless mistakes, difficulty sustaining attention on tasks, not following through on instructions, not seeming to listen when spoken to, avoidance of tasks that require sustained attention, losing things, distracted by extraneous stimuli, and being forgetful in daily activities (APA, 2000). The hyperactive symptoms are described by: frequent fidgeting, often leaving seat in classroom, restlessness, trouble engaging in quiet activities, excessive talking, and being constantly "on the go." Impulsive symptoms are also listed under the hyperactive domain and include behaviors such as blurting out answers to soon, difficulty waiting turns, and interrupting others.

Currently, there are three primary subtypes that serve to categorize the broad range of ADHD symptoms. The *Diagnostic and Statistical Manual of Mental Disorders-IV-TR* (DSM-IV-TR; APA, 1994) identifies the three subtypes as primarily hyperactive, primarily inattentive,

and combined types. Furthermore, diagnosis of ADHD requires symptom presentation before the age of seven and in more than one setting, for example at school and home. Lastly, if inattentive or hyperactive symptoms are better accounted for by a pervasive developmental disorder that disorder takes precedent over ADHD (APA, 2000).

Conceptualization of ADHD

The DSM diagnostic history and differentiation of ADHD into the subtypes of hyperactive, inattentive, and combined has changed throughout *Diagnostic and Statistical Manual of mental Disorders* (DSM) editions and revisions. ADHD was first officially identified in 1980 by the American Psychiatric Association. DSM-III initially introduced the term *Attention Deficit Disorder* and included two distinctions that divided the disorder into ADD with or without hyperactivity (APA, 1980). The subsequent DSM-III revision subsumed all diagnostic subtypes under one attention deficit label (APA, 1987). The DSM-IV (APA, 1994) reintroduced the inattentive and hyperactive subtypes. Inattentive, Hyperactive, and Combined subtypes are the present diagnostic distinctions that were carried over from the last edition into the most recent text revision.

The diagnostic changes observed throughout the DSM reflect the variety of historical conceptualizations of ADHD. Research reflects these changes by examining differences between subtypes in addition to comparison of ADHD and non-ADHD control groups. Questions about the distinctiveness of ADHD subtypes have been based on conflicting research findings on cognitive ability when comparing hyperactive, inattentive, and combined categories (Frazier, Demaree, &Youngstrom, 2004; Riccio, Homack, Jarratt, & Wolfe, 2006). In addition, differential diagnosis and identification of comorbid disorders is important to understand

functional deficits based on cognitive and executive functions. The ways that ADHD subtypes are identified in the research are not standardized; researchers often use different combinations of behavioral observations, parent reports, and teacher reports. The vast range of methods has led to conflicting research when trying to confirm or deny the distinctiveness of ADHD subtypes. Work groups on ADHD are currently established to reevaluate the conceptualization and diagnostic criteria for the upcoming Diagnostic and Statistical Manual of Mental Disorders, fifth edition, now scheduled for release in 2013.

Comorbidity

Adding to the already complex nature of ADHD, rarely is the disorder diagnosed in isolation. The most common comorbid disorders with ADHD include learning disorders, conduct disorder, anxiety, and depression (Seidman et al., 2006). Aman, Armstrong, Buican, and Sillick (2002) found higher rates of anxiety, tic, and elimination disorders among children with low cognitive ability compared to ADHD children with average IQ. Additionally, cognitive impairment such as mental retardation is associated with higher rates and types of comorbidity compared to children with normal cognitive functioning (Aman et al., 2002).

Comorbid conditions are common in ADHD. This presentation adds complexity and contributes to further deficits in functioning. Cognitive limitations are frequently observed among children with multiple comorbid disorders (Bridgett & Walker, 2006). More specifically, academic and language skills show substantial deficit, as well as behavioral deficits in motor coordination, in children with ADHD and comorbid disorders (Crawford, Kaplan, & Dewey, 2006). Cognitive functioning continues to decrease when more than one disorder is diagnosed, particularly in memory ability and visual-perceptual skills (Crawford et al., 2006). Comorbid

disorders strongly affect a child with ADHD's level of impairment and functioning as shown by previous research.

The important implications of comorbidity for accurate diagnosis and treatment of childhood disorders are well recognized; however, successful prognosis often relies on early diagnosis and intervention for many disorders. Thus, a clear distinction between disorders and subtypes is beneficial to inform early intervention and treatment considerations for ADHD. Comorbidity is more often the rule than the exception. ADHD co-occurs often with a variety of childhood disorders including learning disabilities, oppositional defiant disorder, conduct disorder, depression, and anxiety (Spencer, Biederman, & Mick, 2007). Recent research has also identified sleep disturbances that present along with ADHD in children. Children with ADHD have more resistance to bedtime, trouble falling asleep, awake more during the night, and have a harder time with morning awakening than control children (Cortese, Faraone, Konofal, &Lecendreux, 2009).

Emerging cognitive and neuropsychological research domains evidence the increasing interest in understanding the factors that contribute to etiology, assessment and treatment of ADHD in children. Clinicians, teachers, and parents readily identify problem areas for attention deficit children. Comprehensive understanding of ADHD presentation is complicated by the fact that children with ADHD are often diagnosed with another disorder as well. Comorbidity is more often the rule than the exception. ADHD co-occurs with a variety of childhood disorders including learning disabilities, oppositional defiant disorder, conduct disorder, depression, and anxiety (Spencer et al., 2007). Aman et al. (2002) also found moderate rates of comorbidity among children with ADHD; they found 28% met criteria for an anxiety disorder, 28% were

diagnosed with Oppositional Defiant Disorder or Conduct Disorder, and 33% had motor or vocal tics.

The current system of categorizing ADHD is more a description of behavioral symptoms than a complete understanding of the etiology of the disorder. Further understanding of ADHD can lead to improved intervention and greatly benefit those children diagnosed with the disorder.

Theory of Behavioral Inhibition

Barkley (1997b) proposed a theory of ADHD that provided a preliminary attempt at launching a theory-driven approach to ADHD research. His theory marked a pivotal point in ADHD conceptualization that produced what has become the most referenced ADHD theory. There are two main concepts that Barkley identified as important to concentration, planning, attention, and other complex cognitive tasks. *Behavioral inhibition* and *executive functioning* are the key functions in his theory. Barkley's theory proposes an interaction between behavioral inhibition and executive functioning that contributes to the observed hyperactivity, impulsivity, and inattention characteristics of ADHD. Foundational to Barkley's theory is the role of behavioral inhibition, which requires the ability to inhibit prepotent responses. Prepotent responses are a series of complex cognitive tasks that require the individual to simultaneously stop a response in progress, and to maintain selective attention to important parts of a situation or problem (Barkley, 1997b). Barkley differentiates behavioral inhibition from executive functioning. He describes behavioral inhibition as separate from executive functions, yet hierarchically related. Theoretically, people may have appropriate behavioral inhibition without possessing well-developed executive functioning. However, effective executive functioning requires behavioral inhibition. Executive functions as defined by Lezak are "those capacities

that enable a person to engage successfully in independent, purposive, self-serving behavior" (Lezak, 1995, p. 42).

Behavioral inhibition, according to Barkley (1997b), is necessary for four particular executive functions: working memory, self-regulation of arousal, internalization of speech, and reconstitution (see Figure 1). Theoretically, the four executive functioning tasks require attending to internal processes and inhibiting behaviors in response to external stimuli. The ADHD child's behavioral *disinhibition* allows an environment full of distractions to interfere with the child's ability to execute planning and goal-directed behavior. The prefrontal cortex is implicated in many deficits shown among individuals with ADHD. Brain injured patients, particularly with damage to the prefrontal cortex and subcortical regions, demonstrate symptoms similar to ADHD, suggesting potential brain dysfunction in ADHD individuals (Barkley, 1997b).

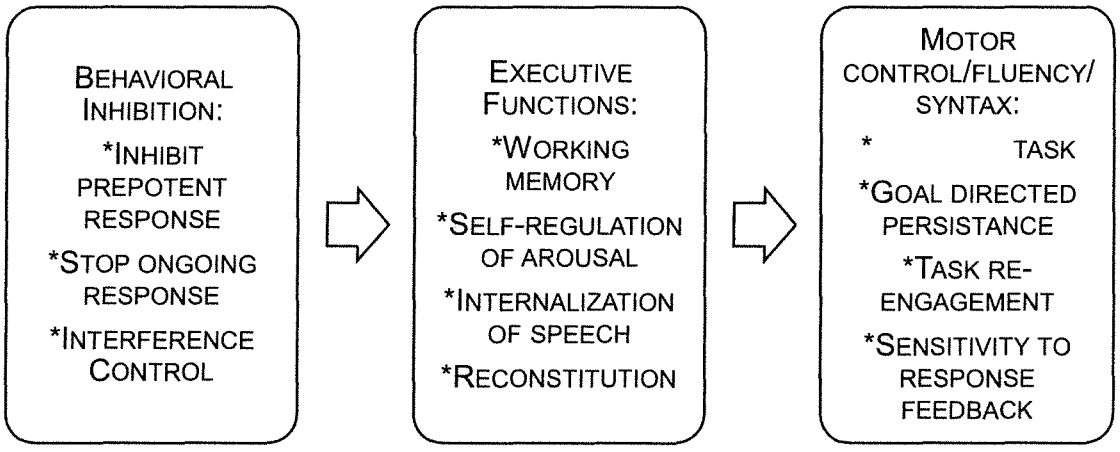

Figure 1. *The relationship of behavioral inhibition necessary for executive functioning in order to exhibit motor control as described in R.A. Barkley's (1997b) theory of behavioral inhibition.*

Barkley's model of ADHD created a needed theoretical base for subsequent ADHD research and provided a compelling proposition that continues to prompt discussion among clinicians and researchers in the field. Barkley's theory informs research particularly in the cognitive and neuropsychological fields of ADHD (e.g., Fuggetta, 2006; Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2005).

Cognitive Functioning in ADHD

Cognitive differences are a primary domain that researchers examine in many disorders, including ADHD. Research has examined cognitive discrepancies between ADHD and non-ADHD individuals (Bridgett & Walker, 2006) with further research on differences between ADHD subtypes of hyperactive, inattentive, and combined (Frazier et al., 2004). In a meta-analytic review of the literature, Frazier et al. (2004) observed significant effects on overall cognitive ability (i.e., Full-Scale IQ [FSIQ]) for individuals with ADHD and ADHD with a co-occurring learning disability compared to controls. The results of Frazier's meta-analysis found lower FSIQ for ADHD participants compared to controls, and showed no difference in FSIQ between ADHD subtypes. This may indicate a more general cognitive dysfunction or a variety of specific cognitive deficits that are not noticed when only examining the FSIQ. Specific cognitive strengths and weaknesses are lost when examining a global dimension such as FSIQ. Deficits could exist that are unique to the individual or particular subtypes of ADHD. These deficits would be neglected when only looking at a full-scale score. However, when examining cognitive differences general observations begin to emerge.

Cognitive discrepancies in ADHD populations have shown verbal deficiencies observed primarily in tasks that require a combined auditory and verbal component (Andreou, Agapitou,

&Karapetsas, 2005). The working memory and freedom from distractibility constructs are now frequently used to determine deficits in concentration, attention, and short-term memory. The freedom from distractibility construct has been conceptualized to better understand the traditional tasks of Wechsler Arithmetic, Digit Span, and Letter-Number Sequencing subtests (Groth-Marnat, 2003). These tasks on traditional cognitive assessment measures require the child being assessed to listen to information presented (i.e., a list of numbers), remember this information, cognitively manipulate it, and then respond verbally. Although the freedom from distractibility concept has been associated with Wechsler assessments, similar tasks are conducted on the Stanford-Binet measure, which allow the same abilities to be assessed regardless of which test is being used.

In addition to general working memory deficits, it has been found that ADHD groups had lower verbal comprehension and lower scores on the freedom from distractibility index (Andreou et al., 2005). As a result, individuals with ADHD were more inattentive and struggled with verbal tasks as the task became more complex. In addition, ADHD groups showed increased difficulty encoding visuospatial information to be readily retrieved (Barnett, Maruff, & Vance, 2005). While comparing ADHD subtypes, inattentive and combined types demonstrate more deficiencies in cognitive functioning compared to hyperactive ADHD (Chhabildas, Pennington, &Willcutt, 2001). This may suggest more generalized cognitive deficits for inattentive and combined ADHD while hyperactive ADHD may produce more specific deficiencies.

Early research on ADHD started with looking at global cognitive ability, such as general measures of FSIQ. As research progressed, specific domains of functioning were examined. Research on ADHD often examines specific processes; attention and memory are two of the

most researched. Barkley's (1997b) theory of behavioral inhibition and executive functioning produced a launching point for investigating numerous aspects of cognitive and neuropsychological research. Studies frequently observe specific neuropsychological deficits in children with ADHD compared to controls. Fuggetta (2006) identified deficits in processing speed, task switching, and attentional processes. Congruent with Barkley's theory, the deficits that emerged in Fuggetta's research support the assumption that environmental distractions affect children with ADHD more than other children. Futhermore, individuals with ADHD demonstrate greater difficulties with response inhibition and cognitive flexibility (Geurts et al., 2005), also strongly implicated in Barkley's theory.

Neuropsychological research demonstrates growing evidence of performance deficits in tasks requiring attention, memory, behavioral inhibition, and cognitive processing among ADHD children. While researching subtype differences, it was found that inattention was the best predictor of assessment performance, even for hyperactive children when inattention was accounted for (Chhabildas et al., 2001). Barkley (1997a) postulates that different aspects of attention may be implicated in the different subtypes of ADHD. He further proposed that inattentive subtypes of ADHD may have specific deficits because of impaired focused and selective attention, whereas hyperactive subtypes' impairments may be related to difficulties with behavioral inhibition and sustained attention.

Overall, research demonstrates impairments in executive functioning in children with ADHD. Studies that have examined the subtypes of ADHD in hopes of validating the current DSM's diagnostic subtyping are limited but growing. As APA work groups examine the current

conceptualization of Attention-Deficit/Hyperactivity Disorder, new diagnostic criteria may be forthcoming.

The Current Study

Subtypes of Attention-Deficit/Hyperactivity Disorder have been a source of constant change in terms of DSM diagnosis as seen by changes in diagnostic categories throughout DSM revisions. While research has examined Full-Scale IQ differences between subtypes and differences between ADHD and non-ADHD groups, growing research has explored the specific characteristics that may distinguish primarily hyperactive, inattentive, and combined subtypes of the disorder.

The purpose of the research reported here was to examine the cognitive performance differences seen in ADHD on the Stanford-Binet Intelligence Scales, Fifth Edition. The SB-5's structure is unique because each factor index (e.g., Fluid Reasoning, Quantitative Reasoning, Working Memory, Knowledge, and Visual-Spatial Processing) is assessed through both verbal and nonverbal subtests. Given the impairments in specific cognitive functions for individuals with ADHD, the combined components of verbal and nonverbal assessment of same-functions is an area of research not often examined.

Research Question

This study will further explore comparisons between ADHD and non-ADHD groups on factor indexes of the SB-5. Individuals with ADHD are hypothesized to have greater deficits in verbal tasks. Andreou et al. (2005) found that individuals with Attention-Deficit/Hyperactivity Disorder exhibited more deficiencies on tasks that had combined auditory and verbal components. Based on the research of Andreou et al., and in light of research that shows

Chapter 2

Method

Participants

There was one set of participants in this study; participants were children and adolescents, male and female, between the ages of 2 years, 0 months and 17 years, 11 months. Participants were gathered from the normative data of the Stanford-Binet Intelligence Scales, Fifth Edition (SB-5) standardization sample (Roid, 2003). Demographic characteristics of the participants were gathered at the time of original data collection. Demographics matched US census data based on the stratification used in the original sample by age, gender, and socioeconomic status based on parental education.

Inclusionary criteria for participants in the current research included a diagnosis of Attention-Deficit/Hyperactivity Disorder (ADHD) and age between 2 years 0 months and 17 years, 11 months. Confirmation of ADHD diagnoses was based on measures taken by researchers during the original sample collection, which included documentation of the diagnosis by a qualified professional. Since this research is based on ADHD symptoms and cognitive performance, participants who met the criteria for inclusion, but who also had a confirmed Traumatic Brain Injury (TBI) or a pervasive developmental disorder were excluded from analysis.

The initial goal was to have four groups: ADHD-Inattentive, ADHD-Hyperactive, ADHD-Combined, and Controls. Each ADHD subtype groups was not represented fully with

the participants in the sample so the final analysis included two group, ADHD and non-ADHD. Initial participant groups derived from the SB-5 normative sample initially resulted in a group of 239 participants. The sample for this study has 34 ADHD participants who are diagnosed with Inattentive, Hyperactive, or Combined subtypes of ADHD. On two of the subtest analyses there were 33 ADHD group participants because the format of the SB-5 "routes" individuals to the most appropriate starting point based on their ability. As a result, not all participants are administered every item. Furthermore, a group of 203-205 normal controls without a diagnosis of ADHD were selected to match demographic characteristics of age, gender, and socioeconomic status based on parental education.

Instrument

The primary instrument used in the current study was the Stanford-Binet Intelligence Scales, Fifth Edition. The standardization sample for the SB-5 was based on the scores of 4,800 participants aged 2 to 85+ years. Stratification was based on a national sample and included variables of gender, geographic region, ethnicity, and parental education (Roid, 2003).

The Stanford-Binet Intelligence Scales, Fifth Edition (Roid, 2003) is a well-known measure of intelligence in the fields of psychology and education. The SB-5 was developed to assess general intelligence from ages 2 to 85+ years through a series of 10 comprehensive subtests. In addition to the full scale IQ, nonverbal IQ, and verbal IQ, five primary factors comprise the SB-5; the primary factors of the SB-5 are, Fluid Reasoning, Knowledge, Quantitative Reasoning, Visual-Spatial Reasoning, and Working Memory. The unique quality of the SB-5 compared to previous editions and to other intellectual assessments is the replication of the five primary factors in both verbal and nonverbal domains. The verbal and nonverbal

domains each include five subtests, for a total of 10 profile scores. The nonverbal subtest instructions and responses involve pointing and moving of pieces along with a minimal need for receptive language. Verbal domain tasks, conversely, require greater ability to read and understand words and printed material.

The SB-5 takes two to three hours to administer and must be administered by trained examiners. Beneficial to the design of the SB-5 is the administration of routing subtests at the beginning, which allows for the examiner to identify the examinee's functional level and begin subtest administration at a tailored start point for each individual. This alleviates examinee frustration and accelerates the administration time. The standard order of test administration involves two routing subtests followed by completion of nonverbal and verbal levels for each factor index. Each factor is comprised of subtests, which in turn are composed of testlets. There are 6 testlets for each subtest (see Figure 2). Examinees may not be administered each testlet, given that examinees are administered the two routing subtests and may be placed mid-way through the testlets of a particular subtest.

The SB-5 has remarkable reliability and validity research. Internal consistency reliability of the subtests ranged from .84 to .89, averaged across age levels. Extensive validity studies including correlations in the .80 to .90 ranges for Full Scale IQ with other prominent IQ batteries, including SB-4, Wechsler Intelligence Scale for Children, Third edition and Wechsler Adult Intelligence Scale, Third edition, were reported in Roid (2003).

Procedure

All data used in the current study was archival. Permission was granted by the assessment's author, Dr. Roid, to access the normative data for the SB-5. After permission was

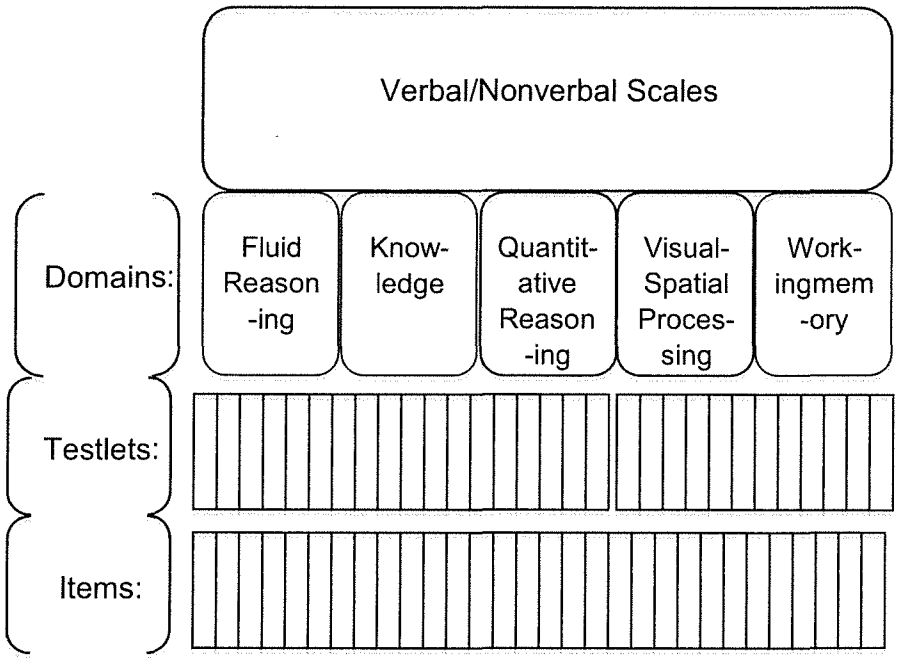

Figure 2. *Stanford-Binet Intelligence Scales, 5th Edition Organizational Structure.*

granted, all subjects matching the inclusion and exclusion criteria were selected out of the total sample. All subjects with ADHD diagnoses between the ages of 2 years, 0 months and 17 years, 11 months and without TBI or ASD were sorted out for further analysis. It was the intention of the current research to further divide all subjects diagnosed with ADHD into diagnostic subtypes of Inattentive, Hyperactive, and Combined. However, there was not adequate representation of each subtype to allow for appropriate data analyses for subtypes.

Additionally, a control sample of 205 individuals was randomly chosen from the normative sample and matched based on age, gender, and other demographic characteristics to the ADHD sample. This process led to two primary groups for analysis: ADHD and controls.

After participants were identified, diagnoses confirmed, appropriately divided, and matched with a control sample, data were analyzed looking at nonverbal and verbal subtest differences between ADHD and control groups. The independent variable for this research was the two groups of participants, ADHD and control. The dependent variables were the specific subtest and testlet scores. Data analysis involved comparing the two independent groups with multiple dependent variables using the ANOVA statistic with an alpha level of .01. Alpha level is chosen to aid in interpretation by decreasing the chance of obtaining false positive results. A cluster analysis was used to further explore significant differences identified between the groups.

Chapter 3

Results

The current study involved two main components. The first was designed to investigate working memory impairments in individuals with a confirmed diagnosis of Attention-Deficit/Hyperactivity Disorder compared to controls on the Stanford-Binet Intelligence Scales, Fifth Edition. The second component was to explore the hypothesis that individuals with ADHD struggle more with verbal tasks because the complexity of the task increases as verbal and auditory demands increase.

In the ADHD group there were 32-34 participants, ages 4 years, 3 months to 16 years, 5 months, with a mean age of 10 years, 9 months. Out of the total number of ADHD participants, 8 were female (23.5%) and 26 were male (76.5%). The control group of matched individuals without ADHD had a total of 203-205 members. The average age of control group participants was 9 years, 9 months with an age range of 4 years, 1 month to 17 years, 0 months. Gender of the control group was split as follows, 60 females (29.3%) and 145 males (70.7%). The total sample had a mean age of 9 years, 11 months.

An analysis of variance was conducted to examine global cognitive differences. The ANOVA revealed no mean differences between ADHD participants and normal participants on FSIQ, VIQ, NVIQ, or the Abbreviated IQ measures (see Table 1).However, ADHD participants took a significantly longer time to complete the SB-5 than the normal participants. Assessment

duration for the ADHD group was on average was 20 minutes longer than for controls (89.19 vs 109.18 minutes; $F(1, 235) = 12.165$, $p < .001$, Cohen's $d = .57$). It was also noted that the control group participants were routed to a higher start level and thus were administered fewer items than the ADHD participants.

Table 1

Tests for Mean Differences Between ADHD and Control Participants on Full-Scale, Verbal, Nonverbal, and Abbreviated IQ Scores

	Std. Deviation	df	Levene	Levene Sig.	Mean Square	F	F Sig.
Full Scale IQ	19.79 (total)		32.448	< .001			
Between Groups	31.34 (ADHD)	1			105.501	.268	.605
Within Groups	17.27 (Control)	223			393.248		
Verbal IQ	10.00 (total)		21.730	< .001		.647	.422
Between Groups	15.39 (ADHD)	1			64.802		
Within Groups	8.85 (Control)	232			100.193		
Nonverbal IQ	10.59 (total)		28.979	< .001		.000	.988
Between Groups	16.07 (ADHD)	1			.026		
Within Groups	9.43 (Control)	228			112.680		
Abbreviated IQ	4.90 (total)		11.984	.001		.101	.751
Between Groups	6.72 (ADHD)	1			2.445		
Within Groups	4.56 (Control)	234			24.134		

Note. $p = <.05$

A further observation was that even where no mean differences were detected, ADHD participants generally showed significantly greater variability in their responses to the SB-5 items. The variability among ADHD participants was higher on all these variables, and also

significantly higher for the Nonverbal Fluid Reasoning subtest. Thus ADHD individuals consistently produced more variable responses even though they had similar IQ scores for Full Scale, Verbal, Nonverbal, and Abbreviated measures (see Tables 2 & 3).

Table 2

Standard Deviations and Significance Comparing Variability of ADHD vs Controls on SB-5 Primary Factors

	ADHD sd	Control sd	df	Levene	Sig.
NVIQ	16.07	9.43	1,235	28.98	<.001
VIQ	15.39	8.85	1,228	21.77	<.001
FSIQ	31.34	17.27	1,232	32.45	<.001
ABIQ	6.72	4.56	1,234	11.98	.001
Duration	37.07	29.80	1,235	5.35	.022

Note. NVIQ = Nonverbal IQ; VIQ = Verbal IQ; FSIQ = Full-Scale IQ; ABIQ = Abbreviated IQ.

For Vocabulary and Object Series/Matrices, the verbal and non-verbal routing domains, significant effects related to ADHD were found by means of ANCOVA. When controlling for age and FSIQ, significant differences were observed in items on the verbal Knowledge subtest (Vocabulary, see Table 5) and nonverbal Fluid Reasoning subtest items (Object Series/Matrices [OSM]). Only significant results are reported; a total of 35 comparisons were made for OSM and 26 comparisons for Vocabulary.

Table 3

Standard Deviations and Significance Levels for Mean Differences comparing ADHD vs Controls on SB-5 domains

	ADHD sd	Controls sd	Df	F	Sig.
Nonverbal Fluid Reasoning	3.645	3.182	1,223	6.491	.012
Nonverbal Knowledge	4.086	2.500	1,223	.181	.671
Nonverbal Quantitative Reasoning	3.389	2.340	1,223	.004	.948
Nonverbal Visual Spatial Processing	3.599	2.394	1,223	1.817	.179
Nonverbal Working Memory	3.793	2.690	1,223	1.285	.258
Verbal Fluid Reasoning	3.763	2.792	1,223	.280	.597
Verbal Knowledge	3.758	2.371	1,223	1.186	.277
Verbal Quantitative Reasoning	3.609	2.231	1,223	1.350	.247
Verbal Visual Spatial Processing	3.442	2.468	1,223	.705	.402
Verbal Working Memory	3.070	2.327	1,223	.488	.485

The nonverbal Working Memory factor on the SB-5 is assessed largely by the Block Span task. Block Span is created to be a comparable task to the Wechsler Digit Span subtest, but nonverbal. Analysis of Block Span testlet levels found many areas of significance (See Tables 4 & 6). Particularly significant was that higher levels of Block Span items were most frequently observed to be harder for individuals with ADHD. Block Span requires examinees to recall both "forward" and "sorted" block tapping. As examinees progress to higher levels of Block Span on

Table 4

Object Series Matrices Items – Levene Test for Equality of Variance

	df	F	Sig.
osm11	1,223	6.502	.011
osm15	1,223	4.065	.045
osm16	1,223	4.460	.036
osm20	1,223	7.945	.005
osm30	1,223	6.822	.010
osm31	1,223	15.020	<.001
osm32	1,223	8.431	.004
osm33	1,223	3.835	.051
osm36	1,223	4.527	.034
Anova for Mean Differences			
osm19	1,221	4.626	.033
osm22	1,221	5.126	.025
osm24	1,221	13.621	<.001
osm26	1,221	9.979	.002
osm27	1,221	5.731	.018
osm31	1,221	4.094	.044
osm32	1,221	4.248	.040
osmRAW	1,221	6.002	.015

this factor they are required to tap increasingly long series of blocks and to "sort" taps between yellow and red rows of blocks. Sorted taps on this task are clear examples of working memory as the task requires the examinee to "rework" the order of memory elements. Again, only significant results are reported; a total of 37 items were examined (no child completed all items).

Table 5

Vocabulary Items – Leven Test for Equality of Variance

	df	F	Sig.
voc36	1,223	8.623	.004
voc38	1,223	7.463	.007
voc40	1,223	4.832	.029
voc42	1,223	30.669	<.001
voc47	1,223	21.516	<.001
Anova Test for Mean Differences			
voc38	1,221	4.076	.018
voc42	1,221	10.885	.001
voc47	1,221	5.498	.020

Table 6

Block Span Items – Levene Test for Equality of Variance

	df	F	Sig.
3bs3	1,35	6.06	.019
5bs1	1,124	4.32	.040
5bs8	1,124	3.90	.051
9bs1	1,123	10.37	.002
11bs1	1,30	7.853	.009
11bs7	1,30	18.72	<.001
Anova for Mean Differences			
7bs2	1,195	4.426	.037
7bs7	1,195	9.121	.003
7bsRAW	1,195	5.431	.021
9bs1	1,121	4.410	.038

Chapter 4

Discussion

This research examined cognitive performance differences of individuals with Attention-Deficit/Hyperactivity Disorder on the SB-5. Further hypotheses were studied including the proposal that individuals with ADHD will perform less well on tasks involving working memory and in verbal tasks compared to their peers without an ADHD diagnosis. Contrary to the initially-proposed design of examining ADHD subtypes, general analysis was conducted exploring hypotheses about ADHD compared to a control sample. The unequal rates of boys with ADHD compared to girls with ADHD in this sample is representative of the general ADHD population which has a much higher percentage of boys diagnosed with the disorder. This study did not control for comorbid conditions such as anxiety, depression, or learning disorders. Future research, with a larger sample, may also be able to control for comorbidity.

Preliminary data analysis looked at the general cognitive scales of full scale intelligence (FSIQ), verbal intelligence (VIQ), and nonverbal intelligence (NVIQ). Because previous research shows that Full-Scale IQ scores may be lower among ADHD than non-ADHD individuals (Frazier, 2004), participants were initially matched for age, gender, and SES in the present study. The matching was successful. Results showed no mean differences between ADHD and normal participants for VIQ, NVIQ, FSIQ, or ABIQ. However, variability was significantly greater for those with ADHD on all of these variables.

ADHD participants took longer to complete the SB-5, showed more variable response patterns, and performed significantly more poorly on a number of Vocabulary, Matrices, and Block Span items. Most of these differences appear to be a function of relative deficits in working memory for ADHD participants. Vocabulary, the verbal routing scale, showed differential function for ADHD participants. Object Series Matrices, the non-verbal routing scale for the SB-5 also showed significant differential item function for ADHD participants. These differences suggest that ADHD participants likely completed more routing items than their normal counterparts; this may account for some of the additional time required for ADHD participants. However, it seems likely that they also completed more items on other SB-5 subscales as well. Object Series Matrices is part of the nonverbal Fluid Reasoning factor. It is a task similar to the Wechsler task of Matrix Reasoning and requires extensive attention to detail and a problem solving approach that requires refined executive functioning such as planning, inhibiting responses, and evaluating potential responses before answering the question.

The significant findings on the Vocabulary section were with particular items with "unusual" characteristics. Vocabulary is part of the verbal Knowledge factor and can be conceptualized as a measure of crystallized intelligence. An individual's "fund of knowledge" or exposure to formal education would often result in higher scores in this area. The items on which individuals with ADHD had significant problems were definitions to words such as *poncho*, *repose*, and *incrustation*. These words are all somewhat odd or rare and likely missed by a child with attentional problems.

Exploration of the rest of the SB-5 items, testlets, and subscales for differential item function appears warranted. It appears that persons with ADHD are likely to show a unique

pattern of functional skills. Lower levels of working memory will impair their performance on tasks requiring a large working memory capacity. These data are generally supportive of the findings that implicate working memory as a significant deficit among those with ADHD. Differential item functioning at the item level may also contribute to the increased testing time for participants with ADHD. These results suggest that persons with ADHD will likely take longer to perform many tasks, specifically those that require a significant degree of executive function and working memory abilities. Block Span items were particularly difficult for children with ADHD compared to normal children in this study.

Results of the current study support Barkley's (1997b) conceptualization of working memory deficits in ADHD and the harder time children with ADHD have with complex tasks. Longer time to complete tasks is likely related to working memory deficits, which make problem solving less efficient. The related functional deficits likely will adversely affect their functioning in many settings, especially those where significant demands on working memory or rapid responding are essential work functions. Such settings include many academic settings, but also likely include vocational settings such as air-traffic control, magazine editor, or detailed quality assurance work.

Emerging cognitive and neuropsychological research indicates the increasing interest in understanding the factors that contribute to etiology, assessment and treatment of ADHD in children. Fuggetta (2006) demonstrated specific deficits in processing speed, task switching, and attentional processes. Additionally, past research has shown greater difficulties with response inhibition and cognitive flexibility for children with ADHD (Geurts et al., 2005). Further understanding of ADHD could lead to improved detection and intervention of the disorder.

The major limitation of the current study was the relatively small sample size of the ADHD group. Although there were significant differences observed between ADHD and control groups, the limited number of individuals with ADHD may have prevented discovery of significant differences in additional subtests ("misses" may have occurred), especially since variances were unequal. Ethnicity may be a contributing factor working memory and cognitive assessment, but was not explored in the current study. Particular analyses examining verbal working memory could not be run because of the small sample size. Future research is necessary to validate significant differences found within this research. Also, limitations in the sample prevented exploring for differences among ADHD subtypes, an original goal. Future research with a larger sample of ADHD participants could address this question as well.

Study Conclusions and Future Research

The findings in this research suggest that compared to children with the same level of intelligence, those with ADHD will take longer to complete many cognitive tasks. These functional deficits will likely greatly affect their performance in academic and vocational settings. Current results additionally suggest children with ADHD perform more poorly on tasks requiring large amounts of working memory. Finally, compared to children without ADHD, those with ADHD are likely to seem inconsistent in their performance. Working memory, variability of performance, and additional time required to complete tasks are representative of the struggles that individuals with ADHD have in their day-to-day lives. The impact of these deficits on academic and vocational satisfaction and achievement is a direction for future research and as a way of informing intervention.

Stefanatos and Baron (2007) provide an insightful review of ADHD research, literature, and current DSM classification and diagnostic problems. As DSM-V diagnosis-specific work groups assess classification concerns, there is a growing consensus that ADHD needs to address more neuropsychological, gender, age, and developmental aspects in the new DSM.

References

Aman, M., Armstrong, S., Buican, B., & Sillick, T. (2002). Four-year follow-up with children with low intelligence and ADHD: A replication. *Research in Developmental Disabilities, 23*, 119-134.

American Psychiatric Association (1980).*Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: Author.

American Psychiatric Association (1987).*Diagnostic and statistical manual of mental disorders* (3rd ed., revised). Washington, DC: Author.

American Psychiatric Association (1994).*Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

American Psychiatric Association (2000).*Diagnostic and statistical manual of mental disorders* (4th ed., text revision). Washington, DC: Author.

Andreou, G., Agapitou, P., &Karapetsas, A. (2005). Verbal skills in children with ADHD. *European Journal of Special Needs Education,20*, 231-238.

Barkley, R. (1997a). ADHD and the nature of self-control.New York: Guilford Press.

Barkley, R. (1997b). Behavioral inhibition, sustained attention, and executive functions: Constructing a unified theory of ADHD. *Psychological Bulletin, 121*, 65-94.

Barnett, R., Maruff, P., & Vance, A. (2005). An investigation of visuospatial memory impairment in children with attention deficit hyperactivity disorder (ADHD), combined type. *Psychological Medicine, 35*, 1-11.

Bridgett, D., & Walker, M. (2006). Intellectual functioning in adults with ADHD: A meta-analytic examination of full scale IQ differences between adults with and without ADHD. *Psychological Assessment, 18*,1-14.

Chhabildas, N., Pennington, B., &Willcutt, E. (2001). A comparison of the neuropsychological profiles of the DSM-IV subtypes of ADHD. *Journal of Abnormal Child Psychology,29*, 529-540.

Cortese, S., Faraone, S., Konofal, E., &Lecendreux, M.(2009). Sleep in children with attention-deficit/hyperactivity disorder: Meta-analysis of subjective and objective studies. *Journal of the American Academy of Child & Adolescent Psychiatry, 48*, 894-908.

Crawford, S. G., Kaplan, B. J., & Dewey, D. (2006). Effects of coexisting disorders on cognition and behavior in children with ADHD. *Journal of Attention Disorders*, *10*, 192-199.

Frazier, T., Demaree, H., &Youngstrom, E.(2004). Meta-analysis of intellectual and neuropsychological test performance in attention-deficit/hyperactivity disorder. *Neuropsychology*, *18*, 543-555.

Fuggetta, G. (2006). Impairment of executive functions in boys with attention deficit/ hyperactivity disorder. *Child Neuropsychology*, *12*, 1-21.

Geurts, H., Verte, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. (2005). ADHD subtypes: Do they differ in their executive functioning profile? *Archives of Clinical Neuropsychology*, *20*, 457-477.

Groth-Marnat, G.(2003). *Handbook of Psychological Assessment.*(4th ed.) New York: Wiley.

Lezak, M. D.(1995). *Neuropsychological Assessment*.New York: Oxford University Press.

Riccio, C. A., Homack, S., Jarratt, K. P., & Wolfe, M. E. (2006). Differences in academic and executive function domains among children with ADHD predominantly inattentive and combined types. *Archives of Clinical Neuropsychology, 21,* 657-667.

Roid, G. H.(2003). *Stanford-Binet Intelligence Scales - Fifth Edition*.Itasca, IL: Riverside.

Seidman, L., Biederman, J., Valera, E., Monuteaux, M., Doyle, A., & Faraone, S. (2006). Neuropsychological functioning in girls with attention-deficit/hyperactivity disorder with and without learning disabilities. *Neuropsychology*, *20*, 166-177.

Spencer, T.J., Biederman, J., &Mick, E. (2007). Attention-deficit/hyperactivity disorder: Diagnosis, lifespan, comorbidities, and neurobiology.*Journal of Pediatric Psychology, 32*, 631-642.

Stefanatos, G. A.,& Baron, I. S. (2007). Attention-deficit/hyperactivity disorder: A neuropsychological perspective towards DSM-V. *Neuropsychology Review*, *17*, 5-38.

Appendix A

Curriculum Vita

Meridee Runge, M.A.

EDUCATION

Doctor of Clinical Psychology *Anticipated August 2010*

Graduate School of Clinical Psychology, APA Accredited

George Fox University; Newberg, Oregon

- Dissertation: "Cognitive differences among individuals with Attention-Deficit/Hyperactivity Disorder on the Stanford-Binet Intelligence Scales, Fifth Edition."

Master of Arts in Clinical Psychology May 2007

Graduate School of Clinical Psychology, APA Accredited

George Fox University; Newberg, Oregon

Bachelor of Arts in Psychology May 2004

North Central University; Minneapolis, Minnesota

Summa Cum Laude

CLINICAL EXPERIENCE

Pre-Doctoral Intern August 2009- present

Warm Springs Counseling Center & Training Institute

Boise, ID; APA Accredited

- Responsibilities include: providing individual, group, clinical family therapy, and family therapy, conducting psychological assessments, performing clinical intake and psychosocial rehabilitation assessments, and multidisciplinary consultation with professional and lay populations.
- Comprehensive psychological assessments include internal and external referrals to address a variety of diagnostic clarification questions including cognitive and personality functioning.
- Facilitated adult women's process group for women with trauma and abuse histories.
- Provided clinical supervision for psychosocial rehabilitation workers and training for agency personnel as well as community groups.
- Populations served include a diverse array of children, adolescents, adults, and families.

Supervisor: Yvette Ward, Psy.D.; Licensed Psychologist.

Psychology Practicum Student July 2008- July 2009

Kaiser Permanente

Salem, Oregon

- Responsibilities included providing individual psychotherapy for children, adolescents, and adults ages 5 to 60within a managed health care system.
- Participated in collaborative, multidisciplinary treatment meetings and consultation.
- Conducted treatment planning and psychotherapy utilizing evidence based treatments within strong medical model.
- Performed ongoing intake and diagnostic assessments for a full range of mental health diagnoses.
- Maintained large caseload of patients within a manage care system and participated in collaborative planning of service delivery options in the mental health team to meet demand for services.
- Completed comprehensive adult neuropsychological assessments based on referrals from neurology and psychiatry departments.

Supervisor: Catherine deCampos, Psy.D, CFNP; Licensed Psychologist

Psychology Practicum Student September 2007-June 2008

Yamhill-Carlton School District

Yamhill, Oregon

- Responsibilities included providing individual psychotherapy for children and adolescents ages 8 to 17.
- Developed and implemented psycho-educational and process therapy groups for middle school and high school students.
- Provided school-based consultation with teachers and counselors.
- Involvement in community-based, multidisciplinary team case liaison.
- Conducted assessment for learning disabilities and emotional disturbances.
- Participated in development of appropriate interventions and recommendations for Individual Education Plans, 504 plans, and classroom behavioral modification.
- Developed district educational material regarding childhood mental health concerns for parents and caregivers.

Supervisor: Elizabeth Hamilton, Ph.D.; Licensed Psychologist.

Psychology Practicum Student August 2006- July 2007

Multnomah County Corrections Health

Portland, Oregon

- Responsibilities included providing individual psychotherapy with a diverse population of incarcerated adult men and women.
- Developed a suicide risk assessment training for Multnomah County correctional medical personnel.
- Conducted diagnostic interviews and personality assessments.
- Assessed inmate suicide risk.
- Participated on treatment consultation teams with psychologists, psychiatric nurses, counselors, and

physicians.
- Provided group psycho-education to inmates about drug and alcohol abuse.

Supervisor: Stephen Huggins, Psy.D.; Licensed Psychologist.

Psychology Practicum Student January 2006 - April 2006

George Fox University, Health and Counseling Center

Newberg, Oregon

- Responsibilities included providing outpatient psychological services to undergraduate university students.
- Conducted clinical interviews, collaborative goal-setting, and treatment planning with clients.
- Clinical presentation of clients and therapeutic progress in supervision group involving videotape review with supervisors.

Supervisor: Clark Campbell, Ph.D, ABPP.

Clinical Fieldwork Student/Direct Support Professional May-August 2003

Lutheran Social Services; Minneapolis, Minnesota

- Duties included: supervision of adolescent girls within supportive housing while attending outpatient chemical dependency treatment. Facilitated living skills and psycho-educational groups. Collaborative treatment monitoring and goal setting with residents.

SUPERVISIONEXPERIENCE

Psychosocial Rehabilitation Supervision 2009-present

Warm Springs Counseling Center & Training Institute; Boise, Idaho.

- Provide group and individual supervision as a psychology Pre-Doctoral Intern to psychosocial rehabilitation workers. Address treatment considerations, interventions, and ethical problems encountered by workers and their clients.

Graduate Teaching Assistant 2008-2009

George Fox University; Newberg, Oregon.

PSYD530 & PSYD531: Clinical Foundations to Treatment I & II

- Provided year-long supervision to first year PsyD students involving weekly videotape review of client sessions and feedback regarding six graduate students' clinical skill development. Lectured and led oversight groups to introduce legal and ethical issues of practice, the administrative structure and function of clinical settings, and the practical issues of assessment, psychotherapy, and record keeping.

Peer Mentor 2006-2009

George Fox University; Newberg, Oregon.

- Provided weekly professional, clinical, and academic support for graduate students.

TEACHING AND RESEARCH EXPERIENCE

Graduate Teaching Assistant January-May 2008

George Fox University; Newberg, Oregon.

PSYD521: Personality Assessment

- Assisted in lecturing, grading, and organizational tasks for doctoral level Personality Assessment course. Provided lecture and lab instruction about administration, scoring, interpretation, and report writing of MMPI-2, MCMI, PAI, and 16PF measures. Facilitated weekly assessment lab time, individual supervision with students, and assessment case discussion.

Research Assistant 2006-2007

George Fox University; Newberg, Oregon.

- Scoring of projective assessment, Thurston-Cradock Test of Shame, for researchdata collection.
- Collected research data involving administration of select subtests of theWRAML-2, WRAT-3,andRivermead Behavioral Memory Test.

Early ChildhoodEducation Teacher 2003-2005

Children's World Learning Center; Minneapolis, Minnesota

- Duties included: biannual child developmental assessments, curriculum development, and implementation of individualized educational-development plans.

LEADERSHIP AND TRAINING EXPERIENCE

Fetal Alcohol Syndrome: Foster Children and Families January 2010

Boise, Idaho.

- Presented training regarding effects of fetal alcohol spectrum disorders to a community based group of foster parents and social workers. Additional training objectives included physical, cognitive, and behavioral effects of fetal alcohol exposure, treatment options, and related parenting techniques.

Graduate Department of Clinical Psychology Interview Committee 2008-2009

George Fox University; Newberg, Oregon.

- Interviewed prospective students for admission and contributed to discussion and decisions regarding admittance to the Graduate Department of Clinical Psychology.

Student Lobbyist 2007

Oregon Psychological Association; Salem, Oregon.

- Advocated for mental health parity and prescription privileges for psychologists.

PROFESSIONAL PUBLICATIONS AND PRESENTATIONS

Runge, M., Bufford, R., Roid, G., & Hamilton, E. (2009, August). *Cognitive differences among individuals with Attention-Deficit/Hyperactivity Disorder on the Stanford-Binet Intelligence Scales, Fifth Edition*. Poster session presented at the meeting of the American Psychological Association, Toronto, Canada.

Runge, M. (2004, April). *Relationship between parental attachment and faith development*. Poster session presented at the meeting of Minnesota Undergraduate Psychology Conference, Saint Paul, Minnesota.

PROFESSIONAL AFFILIATIONS AND CERTIFICATIONS

American Psychological Association

Psi Chi National Honor Society in Psychology

CAFAS Certified

Idaho Service Extender License