A CHC THEORETICAL APPROACH TO EXAMINING COGNITIVE AND ACADEMIC DEFICITS AMONG STUDENTS WITH ADHD USING A THREE-BATTERY CONFIGURATION

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Abstract

Current research into ADHD and Cattell-Horn-Carroll (CHC) factor scores has been examined (Rowland, 2013; Sjöwall, Roth, Lindqvist, & Thorell, 2013), but few studies have evaluated the discrepancies in CHC factor scores of students diagnosed with ADHD compared to healthy controls using the updated Woodcock-Johnson ® IV (WJ IV™) three-battery configuration. With little research on the WJ-IV three-battery configuration, this study expands on the limited research into the discrepancies among students with ADHD compared to healthy controls using CHC factor scores.

Subjects for this study were obtained from 12 schools in a large urban district in northwestern Arizona and standardization data that was obtained from the Woodcock-Johnson® IV (WJ IV™). The district has twelve school sites with a total of 7,223 students. Class sizes average 22 students with 380 certified teachers, four full time school psychologists, and two full time school psychology interns. The ADHD group data came from students referred for a re-evaluation with an educational eligibility of Other Health Impairment and a diagnosis of ADHD to determine re-eligibility of special education services as required by Individuals with Disability Education Act (IDEA) and the control data came from the Woodcock-Johnson® IV standardized data. Subjects for the ADHD group included 31 students diagnosed with ADHD. The healthy control included 31 students with no clinical diagnosis derived from the standardized data supplied by the 'Woodcock Institute for the Advancement of Neurocognitive Research and Applied Practice', used by permission of the publisher, Riverside Assessments, LLC. The primary basis used to form the control group for the study is age. Additional criteria used included gender, ethnicity, and general intellectual ability (GIA) scores.

Results indicated there were significant differences in performance among groups for two of the ten CHC factors. Compared to the healthy control group, the ADHD group displayed relative weaknesses in auditory processing and long-term retrieval which could ultimately impact student success within the general education setting. These findings indicate that students with ADHD have difficulty with hearing information presented orally and storing, consolidating, and retrieving prior information learned.

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Chapter 1: Introduction

In the United States, it is estimated that over six percent of students are diagnosed with Attention-Deficit Hyperactivity Disorder (ADHD) with a global prevalence rate of five percent. Students with ADHD often exhibit symptoms of various neuropsychological, behavioral, cognitive, academic, and social interaction problems, which are usually first identified by a parent or teacher and referred to a school psychologist for further review (Barkley & Murphy, 2005; DuPaul, & Stoner, 2014; Nijmeijer et al., 2008). Common co-occurring disorders reported among students diagnosed with ADHD include "learning disorders, oppositional defiant disorder, conduct disorder, depressive disorder, and anxiety disorder" which often impact academic functioning, behavioral, and social interactions (Muskin, 2014; Sattler, 2008). Due to the challenge of distinguishing normal behaviors and developmental delays of students from clinically significant impairment, a psychoeducational evaluation is frequently initiated to establish whether the behaviors constitute deficits that significantly limit daily life activities and academic achievement.

Attention-Deficit Hyperactivity Disorder within a School Setting

Within the discipline of school psychology, it is a best practice that a school psychologist shall follow a multi-modality approach to psychoeducational evaluations. A multi-modality approach simply states that the observed behavior, distress, awareness, reasoning, interpersonal relationships and medication use" of an individual must be taken into consideration whereby all these factors facilitate the problem assessment process (Brown-Chidsey & Steege, 2011; Merrell, 2003; Messick, 1984; Rowland, 2013). The multi-modality approach is outcome focused and based on the current student discrepancies within academic, behavioral, and social performance and evaluates the development of interventions to reduce those discrepancies (DuPaul, & Stoner,

2014; Gresham, 2004). A comprehensive psychoeducational evaluation follows a multi-modality approach and consist of a review of the student's background history, behavioral rating scale across settings, direct observations, and cognitive/academic assessment measures.

Examining Cognitive and Academic Deficits Among Students with ADHD

Earlier research indicates that students with ADHD often tend to score lower on cognitive tests, specifically within the areas of processing speed and long-term memory by a difference of as much as nine points compared to same age peers (Devena, & Watkins, 2012; Ek, Westerlund, & Fernell, 2013; Frazier, Demaree, & Youngstrom, 2004; Oerlemans et al., 2015). Moreover, 30 to 45 percent of students with ADHD exhibit academic deficits that warrant a learning disability classification (DuPaul, & Stoner, 2014). Research referencing the serious inattentive and hyperactive symptoms like that of the modern-day diagnosis of ADHD can be found within medical journals dated as far back as 1890 (James). Developments over the last 25 years have resulted in a surge of neuroimaging and genetic research. Recent diagnostic criteria within the DSM 5 for ADHD further extends research developments by expanding the requirement of evidence of symptoms across settings. In the last century, research on cognitive and academic deficits associated with students diagnosed with ADHD has resulted in one consensus; no specific cognitive dysfunction characterizes all children with ADHD. Medication and intervention regimes are tailored specifically to each student based on his or her specific cognitive and academic weaknesses and presenting symptomology. Although an ADHD diagnosis is not solely based on a cognitive or academic assessment, but rather on a systematic review of behaviors, a full comprehensive evaluation should be completed. Research has shown that if a student's cognitive profile is not reviewed, a student may score well on behavioral ratings due to psychostimulant medication, yet still fail to perform well academically and

socially due to cognitive impairments (Nigg, 2011; Toplak, Connors, Shuster, Knezevic, & Parks, 2008; Wigal et al., 2011).

Student's diagnosed with ADHD typically experience more academic related problems than their peers, including lower grade point averages, lower standardized test scores, greater likelihood of special education services, higher absenteeism, greater likelihood of retainment in grade, higher probability of dropping out of school, and lower likelihood of pursuit of postsecondary education (Bussing et al., 2016). Moreover, untreated ADHD can have lifelong effects on those diagnosed (Fredriksen et al., 2014; Harpin, 2005). In a study that explored the executive functioning of students diagnosed with ADHD compared to healthy controls, those with ADHD had fewer years of education, were less likely to attend college, had lower grade point averages, and had lower personal incomes (Stavro, Ettenhofer, & Nigg, 2007). The diagnosis of ADHD cases has nearly doubled over the last two decades within the United States (Mayes, Bagwell, & Erkulwater, 2008). With the increase in ADHD cases, many scholars have strived to increase the accuracy of psychological test measures with theoretical frameworks such as the Cattel-Horn-Carroll (CHC) theory that identifies comparative cognitive constructs within a psychometric model.

Expanding Current Knowledge of Diverse Populations through CHC Factor Scores

As one of the most prominent theories of intelligence, CHC delivers a hierarchical psychometric framework to guide and interpret the individual constructs measured by intelligence batteries. With the use of CHC factor scores, commonly referred to as composite scores, an individual's performance can be interpreted across all broad (Stratum II) abilities. CHC factor scores represent broad abilities that expand out to create narrow abilities to comprise an overall composite score. The composite can then be interpreted across multiple batteries (e.g.,

cognitive, academic, neurological) that incorporate the CHC psychometric properties of data analysis. Due to its extensive support in research literature, scholars frequently use it as a primary source for categorizing and translating "tests of intelligence and cognitive abilities" (Flanagan, 2013). Over the last several years, many have utilized it for categorizing cognitive tests to simplify analysis of cognitive abilities and present a basis for establishing assessments for individuals with suspected disabilities. Furthermore, given the well-documented structural validity of CHC theory and the external validity support derived from various research methodologies, the CHC theory is the ideal theoretical framework for interpreting the Woodcock-Johnson® IV (WJ IV™) three-battery configuration for the current study (McGill, & Buses, 2015; McGrew, & Woodcock, 2001). In addition, CHC factor scores can link assessment to invention for students with ADHD within the framework of a problem-solving approach (Fiorello, Hale, & Snyder, 2006; Hale et al., 2008; Kaufman, Kaufman, & Lichtenberger, 2011).

One such study that evaluated the generality of CHC theory across batteries was a study conducted by Julie Rowland (Rowland, 2013). Rowland (2013), "examined the cognitive abilities of [students] diagnosed with ADHD compared to [healthy controls]" (Rowland, 2013, p.4). Results of the study found cognitive discrepancies between students with ADHD compared to healthy controls in the areas of "long-term storage and retrieval and processing speed" (p. 48). In addition, the students with ADHD presented with deficits in processing speed that resulted in difficultly in various tasks such as copying or expressing themselves quickly and efficiently (Rowland, 2013).

The current study expands on the current knowledge of research into the assessment of cognitive and academic deficits of students diagnosed with ADHD (Pinto, Rijsdijk, Ronald, Asherson, & Kuntsi, 2016; Sorge, Toplak, & Bialystok, 2016; Tamm et al., 2016). Current

research into ADHD and CHC factor scores have been examined (Rowland, 2013; Sjöwall, Roth, Lindqvist, & Thorell, 2013), but few studies have evaluated the discrepancies in CHC factor scores of students diagnosed with ADHD in comparison to healthy controls using the updated WJ-IV three battery configuration. With little research on the WJ-IV three battery configuration, this study expands on the limited research into the discrepancies among students with ADHD in comparison to healthy controls using CHC factor scores.

The basis of the present study is to establish whether:

1. differences between cognitive and academic CHC factor scores exist between students with ADHD in comparison to students without ADHD and
2. to inform and implement classroom interventions for students with ADHD, based on cognitive and academic discrepancies.

Chapter 2: Literature Review

Chapter two provides an analysis of the literature related to ADHD. The first area reviewed includes the defining characteristics associated with ADHD. Secondly, a review of the potential risk components that have been reported in earlier studies is evaluated to ascertain the risks associated with an ADHD diagnosis. Next, cognitive and academic concerns typically associated with ADHD are explored to access the impact these deficits have on overall individual performance. Finally, the research on CHC abilities among students with ADHD across multiple measures is evaluated to explain common deficits found among this group and the school-based interventions that are normally provided to students with an ADHD diagnosis.

Defining ADHD

ADHD is a neurological disorder that frequently presents before grade school and is marked by developmental inappropriateness of inattention and/or impulsivity and hyperactivity that often significantly impairs personal, social, academic or occupational functioning across multiple settings (Sattler, & Hoge, 2006). Many students are referred and diagnosed with ADHD within their first five years of grade school (Biederman, Newcorn, & Sprich, 1991; Goldman, Genel, Bezman, & Slanetz, 1998; Riley, 2004). Moreover, research findings found that the typical age of an ADHD diagnosis for male and females is seven years of age and of those diagnosed, over six percent take daily medication to control their symptoms.

Common Features and Comorbidity

Common features of ADHD include a history of hyperactivity, impulsivity, and/or inattention that interferes with the daily life functioning of the student. Hyperactivity refers to symptoms that emerge when the student exhibits excessive motor movement. Behaviors often observed include: fidgeting or squirming in seat, leaves seat when anticipated to continue to be

seated, runs about when inappropriate to do so, is unable to work independently quietly, often seems to be on overly stimulated in daily activities, talks to much, blurts out answers prematurely, cannot wait, and interrupts or intrudes on others' activities (American Psychiatric Association, 2013; DuPaul, Power, McGoey, Ikeda, & Anastopoulos, 1998; Murphy & Barkley, 1996). Inattention refers to symptoms that emerge when a student is seen as off task. Behaviors often observed include, lack of attention to details, careless mistakes in daily tasks, cannot sustain attention to tasks or activities, doesn't seem to listen well, cannot organize activities well, avoids or seems reluctant to engage in activities that require considerable effort, misplaces items necessary to complete assignments, or is easily sidetracked and forgets things (American Psychiatric Association, 2013). Impulsivity refers to symptoms that emerge when a student is seen as having difficulty with controlling impulsive behaviors.

Research demonstrates that the frequency of comorbid disorders among ADHD populations includes oppositional defiant disorder (ODD; 30-60%), conduct disorder (CD; 20-50%), learning disorders (20-40%), anxiety disorders (15-30%), and depression (15-30%). Pliszka (2014), found that over "67-80% of clinic-referred students with ADHD will have at least one other coexisting psychiatric disorder" (p. 140). Of those diagnosed, over half will meet diagnostic requirements for oppositional defiant disorder (ODD) or conduct disorder (CD). Studies examining these occurrences indicate that students diagnosed with ADHD and ODD or CD in comparison to an ADHD diagnosis alone were highly susceptible to academic difficulties (McGee, Williams, & Silva, 1984; Moffitt & Silva, 1988). Estimated learning deficits among students with ADHD generally include math, reading, written expression, and spelling disorders. Research conducted within the last decade suggests that "deficits in working memory and set shifting" are of concern for students with ADHD and academic deficits.

Studies identify anxiety as a comorbid disorder often associated with ADHD. Recent research on students with ADHD indicated that anxiety improved the participant's performance on measures of attention (Vloet, Konrad, Herpertz-Dahlmann, Polier, & Gunther, 2010). However, other scholars' debate this finding suggesting that anxiety aggravates attention performance (Sorensen, Plssen, Nicholas, & Lundervold, 2011). The relationship between ADHD and depressive disorders explores several topics. Compared to many of the other comorbid diagnoses associated with ADHD, depressive disorders tend to have a higher impact on social functioning, an earlier onset in females, and greater risk of suicide (Barkley, 2014). Studies into the etiology of ADHD and depressive disorders have suggested that the disorders may be genetic in nature. Finally, the newest addition to the DSM-5 is disruptive mood dysregulation disorder (DMDD), which requires that a student with ADHD "also exhibit chronic irritability between aggressive episodes" (Pliszka, 2014, p. 148). A debatable topic in the literature is whether DMDD was added to the DSM-5 to counterbalance the ongoing controversy surrounding the diagnosis of bipolar disorder in children (Biederman, 1998; Carlson, 2007; Klein, Pine, & Klein, 1998). However, many clinicians within the field find the new addition to be warranted (Copeland, Angold, Costello, & Egger, 2013).

Etiology

Substantial research over the last decade has shown that neurodevelopmental and heritable factors play a major part in the origin of ADHD. Neuropsychological studies suggest that low performance in continued attention and cognitive functioning are evidenced within the prefrontal cortex, indicating that it may play a role in ADHD (Halperin, Marks, & Schulz, 2016). Neuroimaging researchers'' have confirmed reduced brain volume in individuals with ADHD in comparison to controls. Additionally, students with ADHD tend to be delayed in their brain

development when compared to same age peers. Additional studies have indicated that students with a biological parent with ADHD have 30 percent likelihood of developing the disorder. In fact, the type and severity of the ADHD diagnosis between the parent and student are often correlated (Bornovovalova, Hicks, Iacono, & McGue, 2010; Macek, Gosar, & Tomori, 2012). Meanwhile, the risk to siblings of students with ADHD is 32 percent. Twin studies conducted in various countries have found several genetic links that account for over 50 percent of the traits contributing to ADHD (Posthuma, & Polderman, 2013; Thapar, Cooper, Eyre, & Langley, 2013).

Cognitive Deficits Associated with ADHD

Many early studies of ADHD alluded to the fact that students with ADHD were above average in intelligence or often seen as gifted (Hartnett, Nelson, & Rinn, 2004); however, recent scholarly research suggests otherwise. In a study conducted by McConaughy, Ivanova, Antshel & Eiraldi (2009), 177 students were assigned to four groups (ADHD-C; ADHD-PI; clinically referred without ADHD; and controls) then administered the Wechsler Intelligence Scale for Children®, Fourth Edition and Wechsler Individual Achievement Tests®, Second Edition. Results found that students with ADHD-C had considerably lower cognitive scores on the WISC-IV and "lower reading achievement than other clinically referred students without ADHD" (p. 66). Reading and learning disorders are typical among students with ADHD; in fact, 20 to 40 percent of students identified as displaying characteristics of ADHD are diagnosed with a learning disorder.

Fried et al. (2016), in a study that evaluated 276 students identified with ADHD compared to 241 students without, found deficits among students with ADHD when assessing working memory and educational outcomes. Working memory deficits were measured using

select subtests of the WISC-R Freedom from Distractibility (FFD) factor based on Digit Span, Arithmetic, and Coding (Fried et al, 2016). Educational deficits were measured using written interviews and rating scales (Fried et al, 2016). The findings indicated that students with ADHD have drastically higher rates (32%) of working memory deficits than students without ADHD (14%) (Fried et al., 2016). Furthermore, students with ADHD appeared to "have an increased risk of grade retention, placement in special classes, and lower academic achievement in both reading and math" (Fried et al., 2016, p. 492).

Deficits in processing speed among students with ADHD are another area of recent research. Jacobson et al. (2011) evaluated 62 students (41 ADHD, 21 controls) to determine whether working memory influenced the processing speed of reading fluency for students diagnosed with ADHD. Findings from analysis concluded that students with ADHD compared to controls showed reduced processing speed and deficits on WISC-IV Coding. In another study, Goth-Owens, Martinez-Torteya, Martel, & Nigg (2010) examined the processing speed deficits of 572 students using the Trail Making and Stroop Naming Tests. The three groups (72 ADHD-Predominately Inattentive, 66 ADHD-Combined, and 7 ADHD-Hyperactive/Impulsive) were compiled based on DSM-IV classifications which consisted of ADHD- PI, ADHD- C, and ADHD- HI. Data analysis showed that the ADHD-PI exhibited slower performance on processing speed measures compared to ADHD-C and ADHD-HI. Although many of these studies explain the cognitive deficits associated between students with ADHD in comparison to students without ADHD, they fail to examine the efficacy of CHC factor scores in examining cognitive abilities among students with ADHD using multiple measures of assessment. The next section will examine the use of the CHC theory in examining the cognitive abilities of students with ADHD using multiple assessments.

Academic Deficits Associated with ADHD

Students with ADHD may begin to face academic struggles as early as preschool. Concerns are often developmental in nature and related to executive functioning in the areas of inhibitory processes and working memory. Research indicates that these delays in executive functioning have increased the likelihood that the parents of students with ADHD are delaying school entry for these students as a means to potentially increase academic readiness. Parental rationale into delayed school entry has been that they are giving their student an opportunity to develop cognitively and socially, which in turn would result in an academic edge. However, a recent study found a negative relationship between ADHD and delayed school entry, indicating that additional time may not be the solution for students with ADHD and academic concerns (Barnard-Brak, Stevens, & Albright, 2017).

Academic deficits among students with ADHD become highly evident during their first few years of school. Typically, intensive academic and behavioral interventions are implemented and for some students, medication, regulation, and counseling. Students with ADHD often display difficulty in reading and written tasks when compared to their same age peers. Research suggests that students with ADHD-HI performed lower than healthy controls in writing, however, students with ADHD-PI displayed difficulties in all academic areas when compared to healthy controls (Oner, Vatanartiran, & Karadeniz, 2018).

Students with ADHD who wish to further their education and attend college often continue to struggle academically. According to a study by Gromley, DuPaul, Weyandt, & Anastopoulos (2016), subjects with ADHD averaged lower GPA scores compared to healthy controls. In addition, research has indicated that school-age students with ADHD display difficulty in study skills and foreign languages (Weyandt & DuPaul, 2006).

ADHD and CHC Factors

Many studies have examined the deficits presented by students with ADHD (Floyd, McGrew, Barry, Rafael, & Rogers, 2009; Penny, Washchbusch, Carrey, & Drabman, 2005); however, few studies have examined the extent that these deficits have on individual cognitive and academic abilities among students with ADHD using a three-battery approach. The three-battery approach assesses individual cognitive, academic, and oral language abilities using one test measure (WJ IV™).

Short-Term Working Memory (Gwm). Previous studies have reported that deficits in short-term memory (Gwm) are typically in students with ADHD (Brown, Reichel, & Quinlan, 2009; Fassbender et. al., 2011). Brown, Reichel, and Quinlan (2009), conducted a study that investigated the executive functioning of student's with ADHD that presented with high IQs. For the study, the researchers' used the Brown ADD Rating scale, specific subtests from the Wechsler Memory Scale®, and the full Wechsler Adult Intelligence Scale® to evaluate potential cognitive deficits. Findings of the study found that students with ADHD displayed greater weaknesses in short-term memory. In another study, Rapport et al., (2008), evaluated students with ADHD compared to healthy controls on working memory to investigate whether meaningful differences existed between the two groups. A working memory model was utilized for the study and included subtests in working memory, thought, and action. Results indicated significant deficits among individuals with ADHD in all three areas assessed (memory, thought, and action).

Visual Processing (Gv). Research involving visual processing (Gv) among students with ADHD has shown that students with ADHD typically perform at the same level as healthy controls. Laasonen et. al., (2012), evaluated three groups (ADHD, dyslexia, and healthy controls)

to establish whether meaningful differences among the groups existed in visual processing. Based on the results, the researchers' found no significant deficits in visual processing for subjects with ADHD but did indicate that subjects with dyslexia displayed concerns in visual attention. Alibadi, Borhani, Alizadeh, & Amiri, (2011), examined the visual-spatial attention of students with ADHD in comparison to healthy controls. Measures used included the WISC-IV, the Edinburgh Handedness Inventory, and the Star Cancellation Test. Results of the study found no meaningful differences among the two groups.

Long-Term Retrieval (Glr). Skodzick, Holling, and Pedersen (2017), led a meta-analysis to appraise the performance of long-term retrieval deficits in adults with ADHD. The researchers' reviewed 19 studies that investigated the characteristics associated with long-term retrieval deficits in ADHD adults. The meta-analysis included studies that compared the cognitive abilities of adult ADHD subjects to healthy controls in long-term retrieval. The meta-analysis results indicated that deficits typically found in ADHD adults were closely related to learning disorders present in the encoding phase of learning (Skodzik, Holling, & Pedersen, 2017). Wells (2005) examined the cognitive strengths found among students with ADHD within a private school setting. For the study, Wells (2005) recruited 72 students with an ADHD diagnosis with subjects "ranging in age from 14 to 19 years of age." The full cognitive and academic batteries of the Woodcock-Johnson-Revised were administered to subjects to evaluate cognitive strengths and weaknesses within the group. According to the results, 35% of the subjects displayed relative weaknesses in long-term retrieval (Wells, 2005).

Cognitive Processing Speed (Gs). In a recent study, Kibby, Vadnais, and Rickels (2019) investigated the deficits in processing speed between ADHD subtypes and healthy controls. The study included subjects that presented with ADHD-Predominately Inattentive Type, a diagnosis

of ADHD-C, and control subjects. The WISC-III was given to subjects to assess processing speed performance within the groups. The researcher found that subjects with both ADHD subtypes performed significantly lower than the healthy controls (Kibby, Vadnais & Rickels, 2019). Another study utilizing the WISC-III found similar results when assessing processing speed performance in ADHD subtypes (Moura, Costa, & Simoes, 2019). For the study, the researchers' recruited 179 students. Significant differences in processing speed were reported between the groups, however no meaningful differences were found when analysis evaluated performance between ADHD subtypes and healthy controls (Moura, Costa, & Simoes, 2019).

Auditory Processing (Ga). Gomez and Condon (1999) examined the auditory processing performance of subjects with ADHD with and without a diagnosed learning disability. Subjects for the study consisted of three groups: ADHD with a learning disability (ADHD-LD), ADHD no history of a learning disability (ADHD), and healthy controls (HC). Results indicated that subjects with ADHD-LD performed considerably lower in auditory processing related to ADHD and HC.

Comprehension-Knowledge (Gc). Ek et al., (2013), explored the cognitive performance among subjects with ADHD using the WISC-III. Subjects for the study included 42 students with a diagnosis of ADHD and 102 healthy controls. Results from independent t-tests found that subjects with ADHD performed at the same level of typical age healthy controls in verbal comprehension (Ek. et al., 2007).

Fluid Reasoning (Gf). In 2005, Wells examined the cognitive strengths and weaknesses of subjects with ADHD using the Woodcock-Johnson-Revised Cognitive Battery. Subjects for the study included 72 adolescent students that met the diagnostic criteria of ADHD. Results of

the study found that fluid reasoning and short-term memory were potential strengths in the subjects (Wells, 2005).

Broad Reading Cluster (Grw-R). Samuelsson, Lundberg, and Herkner (2004), investigated the potential correlation between ADHD and reading disabilities. According to the researchers', 120 subjects were recruited, of the 120 subjects recruited, 24 had an ADHD diagnosis. Subjects were given assessments in phonological awareness, word decoding, spelling, and reading comprehension (Samuelsson, Lundberg, & Herkner, 2004). The researchers' found no differences between the students with ADHD when compare to students with no ADHD diagnosis (Samelsson, Lundberg, & Herkner, 2004).

Broad Mathematical Cluster (Gq). Antonini et al., (2016), evaluated the math performance of students with ADHD in comparison to students without ADHD. The study consisted of 147 subjects between the age of 7 to 11 years of age. Subjects were given several mathematical measures to ascertain mathematical performance among the two groups. Results indicated that subjects with ADHD did not display significant differences in comparison to the control group. Specifically, no meaningful differences between the two groups were found in math productivity or accuracy (Antonini et al., 2016).

Broad Written Language Cluster (Grw-W). Eckrich, Rapport, Calub, and Friedman (2019), investigated the written abilities of subjects with ADHD. The study consisted of 60 subjects with 27 healthy controls and 33 subjects with an ADHD-Combined Presentation diagnosis. Subjects were given the WISC-IV full battery and specific subtests of the KABC-2 that measure written expression. Analysis of the measures found that subjects with ADHD displayed significant differences in written expression compared to healthy controls. According to the authors, discrepancies in cognitive functioning and phonological short-term memory

accounted for the differences in written expression between the two groups (Eckrich, Rapport, Calub, & Friedman, 2019).

Associations Between CHC Abilities and ADHD Across Multiple Measures

The widespread use of the CHC theory to interpret broad cognitive abilities gained prominence "in the 1980s with the publication of the Woodcock-Johnson Tests of Cognitive Ability" (Woodcock & Johnson, 1989). It was not until a decade later that cross-battery approaches were introduced which allowed psychologists to interpret cognitive abilities across all three stratums (e.g., broad, general intelligence, and narrow) of cognitive abilities. With this psychometrically reliable system of measurement, school psychologists would now have the ability to make "theory-based interpretations of any battery to augment that battery with cognitive, achievement, and neuropsychological subtests from other batteries to gain a more complete understanding of an individual's pattern of strengths and weaknesses" (Flanagan, Ortiz, & Alfonso, p. 1, 2013).

Due to the CHC theoretical background and the psychometric reliability of the cross-battery option, many practitioners began to utilize the multiple assessment approach to assess diverse populations across various settings. Harrier and DeOrnellas (2005) used a multiple assessment approach to examine the cognitive abilities of subjects with ADHD on two separate measures. The authors hypothesized that subjects with ADHD would display lower scores on tasks that measured reconstitution. For the study, subjects were enrolled using the snowball technique. The study included 93 subjects with ADHD and 85 subjects without ADHD. Tests administered included the WISC-III, the WJ-III COG, and the WISC-III-PI (Harrier & DeOrnellas, 2005). Preliminary analysis found that age and gender did not contribute to differences among the tests administered (Harrier & DeOrnellas, 2005). Therefore, the ADHD

group was divided into subtypes (ADHD-Hyperactive/Impulsive, ADHD-Predominately Inattentive, and ADHD-Combined). The results indicated that students diagnosed with ADHD Predominately Inattentive and ADHD-Combined did not perform as well as the control group or the ADHD-HI on measures that involved visual-spatial planning and reconstitution, specifically students with ADHD-Predominately Inattentive and ADHD-Combined performed considerably lower on the WISC-III timed tests, and Analysis Synthesis and Concept Formation (Harrier & DeOrnellas, 2005). No significant delays were reported for the ADHD-HI subtype. The researchers' concluded that different subtypes of ADHD may perform differently on tasks of planning and reconstitution (Harrier & DeOrnellas, 2005).

In a study that takes a psychoeducational perspective, Penny, Waschbusch, Carrey, and Drabman (2005) examined whether behavior during test administration could be a factor in cognitive deficits found among students with ADHD. Subjects included 36 males and 16 females varying in age (Penny, Waschbusch, Carrey, & Drabman, 2005). Students were recruited from a research program that worked with students with disruptive behavior disorder. Parents of the subjects were asked to withhold their student's stimulant medication during testing days. Materials administered included the Disruptive Behavior Disorder Rating Scale, the Guide to the Assessment of Test Session Behavior®, the WJ-III COG, and the Wide Range Achievement Test® (Penny et al., 2005). Using a CHC theoretical approach to analyze the variance among measures, the researchers' found that significantly lower scores in processing speed were associated with inattentive behaviors, but not hyperactive behaviors and the behavior was not arbitrated by testing (Penny et al., 2005). Overall, it was concluded that the results of the study confirmed earlier findings that "inattention in students with ADHD is associated with slower processing speed" (Penny et al., p. 215, 2005).

Another study investigated executive functioning deficits in students with ADHD and autism using the CHC theoretical framework to assess short-working memory and visual motor abilities. Englund, Decker, Allen, & Roberts (2014) hypothesized that students with ADHD and autism would display lower overall performance in short-working memory and visual motor integration compared to normal controls. Students attending public schools participated in the study. Students for the study included three groups (control, ADHD, and autism) with a total of 172 subjects in all. The ADHD group include 25 students with ADHD-Combined, 14 with ADHD-Predominately Inattentive, and 10 ADHD-Hyperactive/Impulsive subtypes. Subjects with ADHD were required to forgo taking their stimulant medication during testing sessions (Englund, Decker, Allen, & Roberts, 2014). Tests administered included the Stanford-Binet Intelligence Scales®, Fifth Edition™ and the Bender-Visual Motor Gestalt Test®, Second Edition. The results indicated that students diagnosed with ADHD and autism did not perform as well as the control group on tasks that involved visual-motor integration (Englund et al., 2014). When the three groups were compared in relationship to working memory, results indicated that ADHD and autism subjects performed significantly worse than control groups which was consistent with previous research (Englund et al., 2014). The authors concluded that "the weaknesses may be related to impairments in functional connectivity and abnormalities in the frontal areas of the brain, which have been demonstrated in both populations" (Englund et al., p. 103, 2014).

Another study examined the executive functioning abilities of Taiwanese students with ADHD using the WISC-IV®-Chinese and the CHC theoretical framework. According to Yang et al. (2013) the basis of the study was to identify CHC factors of the WISC-IV-Chinese measure to determine if similar results would be found if using the WISC-IV within the United States.

Subjects included 334 students from elementary and middle schools (Yang et al., 2013). Subjects were obtained from a local medical hospital. Materials administered included the WISC-IV core subtests and five additional subtests (Yang et al., 2013). The researchers' found that students with ADHD had lower scores in processing speed in comparison to controls (Yang et al., 2013). Moreover, it was concluded that the study confirmed earlier findings that students with ADHD-C and students with ADHD-PI vary in their processing speed with inattentive subtypes displaying lower performance (Yang et al., 2013).

As demonstrated within the last several studies, the CHC theoretical framework has been used to access students with ADHD using multiple measures of assessment across diverse populations. It is for this reason that the CHC theory was utilized for the current study.

Cattell-Horn-Carroll Theory (CHC) of Cognitive Abilities

The Cattell-Horn-Carroll Theory is a comprehensive model that interprets the individual differences of performance on cognitive and achievement tests. The origin of the CHC theory started with Raymond Cattell and his presentation of the Gf-Gc theory at the 1941 American Psychological Convention. According to Cattell's theory, "Fluid Intelligence (Gf) encompasses inductive and deductive reasoning abilities that are influenced by biological and neurological factors and learning through interaction with the environment" (Flanagan, p. 1, 2013). He further held that Crystalized Intelligence (Gc) was "primarily acquired knowledge that reflected the influences of individual cultural change" (Flanagan, 2013). In the 1960s, John Horn broaden the Gf-Cc theory and added additional factors to the Gf-GC model, which included "visual perception (Gv), short-term memory (Gsm), long-term storage and retrieval (Glr), and speed of processing (Gs)" (Flanagan, 2013). Then in 1990, Horn added yet again an additional three

factors “decision speed and reaction time (Gt), quantitative (Gq), and broad reading- writing (Grw)” (Ding, & Alfonso, 2016; Flanagan, 2013).

John Carroll, a contributor to CHC theory, introduced the hierarchy of intellectual abilities (General, Broad, Narrow), the psychometric theory differentiates factors based on relative ability. According to Carroll the three strata identify different breadths of an individual’s cognitive ability. The first tier of the model, Stratum I is subsumed abilities of stratum II and III and measures “higher-order cognitive processes” (Gustaffason & Undheim, 1996). Stratum II measures broad abilities that “represent greater specializations of abilities in quite specific ways that reflect the effects of experience and learning, or the adoption of particular strategies of performance” (Carroll, 1993). The factors included within stratum II include “fluid intelligence (Gf), crystalized intelligence (Gc), general memory and learning (Gy), broad visual perception (Gv), broad auditory perception (Gv), broad retrieval ability (Gr), broad cognitive speediness (Gs), and decision/reaction time/speed (Gs)” (Flanagan, 2013). Stratum III, the general level, measures “basic constitutional and long-standing characteristics of individuals that can govern or influence a great variety of behaviors in a given domain” (Carroll, 1993).

After research and agreement, the two theories (Cattell-Horn Gf-Gc theory and Carroll’s Three-Stratum Theory) were combined to become the CHC theory known to researchers’ today (McGrew, 2005). Since the first introduction to cross-battery assessment in 1990, numerous studies have evaluated the generality of the CHC theory across battery-configurations with regard to gender and culture and the results have been tremendously supportive in the use of the theory to differentiate strengths and weaknesses among groups. The current study will further CHC psychometric literature regarding the generality of CHC factor (Gc, Gf, Gwm, Gv, Glr, Gs, and Ga) and Broad Cluster scores (Reading, Mathematics, and Written Language) cross-battery

assessments across diverse populations. In the next section, the elements of CHC theory will be listed in order to detail the specific subtests that are administered on the WJ-IV to obtain CHC factor scores and Broad Cluster scores. In addition, a description of the of the subtests and the abilities they measure are provided.

Short-Term Working Memory (Gwm). Within the CHC theory, short-term memory measures an individual's "ability to encode information, maintain it in memory, and immediately recall the information in the same sequence it was given" (Flanagan, & Harrison, 2012; McGrew, LaForte, & Schrank, 2014). On the WJ IV COG Test 3: Verbal Attention and Test 10: Numbers Reversed can be administered to derive an individual's short-term working memory ability or Gwm (Ding & Alfonso, 2016). In addition, Test 5: Sentence Repetition from the WJ IV OL should be administered with the WJ IV COG subtests "to make an interpretative cluster for Auditory Working Memory" (Ding & Alfonso, 2016; Flanagan & Alfonso, 2016, p. 61).

Visual Processing (Gv). Visual processing measures an individual's "ability to mentally manipulate imagery to solve problems" (Flanagan, & Harrison, 2012). On the WJ IV COG Test 7: Visualization can be administered with Test 14: Picture Recognition to derive an individual's visual processing ability or Gv (Ding & Alfonso, 2016; Flanagan & Alfonso, 2016, p. 61).

Long-term Retrieval (Glr). Long-term retrieval "measures an individual's ability to store, consolidate, and retrieve information over time" (Flanagan, & Harrison, 2012; McGrew, LaForte, & Schrank, 2014). On the WJ IV COG Test 6: Story Recall can be administered with Test 13: Visual-Auditory Learning to derive an individual's long-term retrieval ability or Glr. (Ding & Alfonso, 2016; Flanagan & Alfonso, 2016, p. 13).

Cognitive Processing Speed (Gs). Processing speed "measures an individual's ability to perform simple cognitive tasks quickly and efficiently" (Flanagan, & Harrison, 2012). On the WJ

IV COG Letter-Pattern Matching and Pair Cancellation can be given to derive an individual's cognitive processing speed ability or Gs (Ding & Alfonso, 2016).

Auditory Processing (Ga). Auditory processing measures an individual's "ability to identify and process nonverbal information to sound" (Flanagan, & Harrison, 2012). On the WJ IV COG Phonological Processing and Nonword Repetition can be administered to derive an individual's auditory processing ability or Ga (Ding & Alfonso, 2016).

Comprehension-Knowledge (Gc). Comprehension-Knowledge measures an individual's accumulated knowledge beginning in infancy. On the WJ IV COG Oral Vocabulary and General Information can be administered to derive an individual's comprehension-knowledge ability or Gc. In addition, Test 1: "Picture Vocabulary from the WJ IV OL can be administered" (Ding & Alfonso, 2016; Flanagan & Alfonso, 2016, p. 61).

Fluid Reasoning (Gf). Fluid Reasoning measures an individual's ability "to solve unfamiliar problems that cannot be solved automatically." On the WJ IV COG Fluid Reasoning Number Series and Concept Formation can be administered to derive an individual's fluid reasoning ability or Gf (Ding & Alfonso, 2016; Flanagan, 2016).

Broad Reading Cluster (Grw-R). Broad Reading Cluster measures an individual's reading achievement and reading decoding (Flanagan, & Harrison, 2012). On the WJ-IV ACH Letter-Word Identification, Passage Comprehension, and Sentence Reading Fluency can all be administered to derive an individual's Broad Reading cluster (Ding & Alfonso, 2016).

Broad Mathematical Cluster (Gq). Broad Mathematical Cluster measures an individual's overall math achievement, problem solving, and reasoning abilities (Flanagan, & Harrison, 2012). On the WJ IV ACH Applied Problems, Calculation, and Math Facts Fluency

can be administered to derive an individual's Broad Mathematics cluster (Flanagan & Alfonso, 2016, p. 16).

Broad Written Language Cluster (Grw-W). Broad Written Language Cluster measures an individual's overall written achievement (Flanagan, & Harrison, 2012). On the WJ IV ACH Spelling, Writing Samples, and Sentence Writing Fluency can be administered to derive an individual's Broad Written Language cluster (Flanagan & Alfonso, 2016, p. 17).

The WJ IV three-battery configuration provides researchers' an in depth look at the cognitive, academic, and oral abilities of each individual assessed across measures. If deficits are found within a specific factor, it is common practice to provide interventions that are specific to the area of deficiency reported. Within the school setting, interventions are tailored to increase academic, cognitive, and behavioral success in students within the school setting. Next, a few interventions provided within the school setting will be addressed.

School Based Effective Interventions

Although interventions within the school setting are usually similar to recommendations provided within the clinical setting, the breadth and depth of the deficits often plays a role in how interventions are implemented within the school setting. For example, cognitive and academic deficits are frequently addressed using individual and group interventions, whereas behavioral concerns may require additional outside resources.

Typically, interventions within a school setting will be broken down into three categories: accommodations, instructional strategies, and related services. Accommodation refers to the services needed to enable the student to progress toward attaining his or her annual goals. Instructional strategies are techniques that a teacher can incorporate into daily instruction to assist students in attaining their annual goals. Related services is additional supports above and

beyond typical classroom instruction and often refers to the use of an Occupational Therapist for deficits in fine or gross motor functioning, a Speech Pathologist for deficits in articulation, expressive and receptive language, and if behavioral concerns are excessive, additional behavioral supports provided by a School Counselor.

Students with short-term memory deficits will frequently receive all or some of the following accommodations: a seat in a location away from distractions, clear oral directions from the teacher, monitoring of student understanding by teacher, instructions provided globally so that the student understands the tasks, and, if tutoring is necessary, a seat next to a peer helper. Instructional strategies that can be beneficial include breaking instructions into parts when teaching, provide a written or pictorial model, repeat important information, and provide the individual extra time to copy information.

Students with visual processing deficits will often be read aloud schedules, descriptions of visual presentations, and text-to speech. Instructional strategies that are frequently implemented include, the oral reporting of written assignments, extended time on tests, and the use of simple diagrams or images to clarify written tasks.

Long-term retrieval accommodations frequently include, written directions, open book tests, and the use of a calculator. Instructional strategies typically consist of, review of rote information often, repetition of previously learned information, and peer tutor support.

Students with processing speed deficits will frequently receive all or some of the following accommodations: extra time to complete assignments, shorter tasks, a reduction in written assignments, and individualized test taking. Instructional strategies that can be beneficial include allowing the student additional time to formulate a response during class discussions.

Students with auditory processing deficits will frequently receive accommodations that

include, preferential seating and peer assistance. Instructional strategies that have been shown to be beneficial include, written study guides, phonemic awareness activities, and the use of symbols to represent phonemes.

Comprehension-Knowledge accommodations can consist of any of the following: preferential seating, the use of a glossary or word bank. Instructional strategies that can be implemented include, the pairing of oral instructions with demonstrations, the use of an advance organizer, and a thesaurus.

Students with fluid reasoning deficits will frequently receive accommodations that include, the monitoring of individual comprehension of a given task, practice tests to ensure comprehension, and peer support. Instructional strategies that have been shown to be beneficial include, breaking complex tasks into component parts, the use of real-life examples to explain text, and the use of a study guide.

The previous examples of school-based interventions provide a glimpse of effective accommodations and instructional strategies used within school settings for CHC deficits. This is not an exhaustive list and as research continues to expand on the efficacy of interventions, one would hope that further research would include studies that investigate the efficacy of interventions commonly used with students with ADHD based on specific CHC factor deficits.

Summary

This chapter provided a summary of the common features that accompany ADHD along with the comorbid disorders often diagnosed in conjunction with the disorder. In addition, the various causes of ADHD were explored from neurological and genetic factors to biological explanations. Furthermore, cognitive deficits common among ADHD populations in comparison to healthy controls was investigated.

While there were studies to validate the cognitive discrepancies found among students with ADHD and healthy controls, additional studies were described to clarify the association between CHC abilities and ADHD across multiple measures. A brief history of the CHC theoretical framework was provided along with descriptions of the individual factors to enable a clear understand of the origin of the original two theories and their authors contributions. Finally, school-based interventions for school settings were introduced for short-term memory, visual processing, long-term retrieval, auditory processing, comprehension-knowledge, fluid reasoning and processing speed.

The Current Study

Currently no studies have evaluated the cognitive and academic deficits found among students with ADHD using a three-battery configuration such as the WJ IV. This is a concern, especially when accommodations and interventions are typically designed to address specific individual needs. Therefore, the basis of the study was to evaluate the cognitive and academic deficits of students with ADHD using a three-battery approach.

Based on the literature review the author proposed the following hypotheses:

1. Subjects with ADHD will not have significantly lower factor scores on comprehension-knowledge (Gc) factor scores than students without ADHD.
2. Subjects with ADHD will not have significantly lower factor scores on fluid reasoning (Gf) factor scores than students without ADHD.
3. Subjects with ADHD will have significantly lower factor scores on short-term memory (Gwm) factor scores than students without ADHD.
4. Subjects with ADHD will not have significantly lower factor scores on visual processing (Gv) factor scores than students without ADHD.

5. Subjects with ADHD will have significantly lower factor scores on long-term retrieval (Glr) factor scores than students without ADHD.
6. Subjects with ADHD will have significantly lower factor scores on cognitive processing speed (Gs) factor scores than students without ADHD.
7. Subjects with ADHD will not have significantly lower factor scores on auditory processing (Ga) factor scores than students without ADHD.
8. Subjects with ADHD will not have significantly lower cluster scores on broad reading ability (Grw-R) than students without ADHD.
9. Subjects with ADHD will have significantly lower cluster scores on broad writing ability (Grw-W) than students without ADHD.
10. Subjects with ADHD will not have significantly lower cluster scores on broad mathematical ability (Gq) than students without ADHD.

Chapter 3: Methodology

The rationale of this chapter is to describe the methodology used to examine the cognitive abilities of students with ADHD compared to healthy controls. The prevalence of students diagnosed with ADHD has increased over the last two decades resulting in the need for thorough multi-modality approaches to evaluation and individual-based interventions (Polanczyk, Willcutt, Salum, Kieling, & Rohde, 2014). Even so most of the current research on ADHD relied primarily on cognitive assessments that failed to take Response to Intervention (RtI) factors into consideration during the assessment process. However, the new WJ IV three-battery configuration with its current updates incorporates the "response to intervention approach, which was not emphasized" in the third edition of the WJ-III COG (Ding, & Alfonso, 2016; Flanagan, & Alfonso, 2016; Kaufman & Kaufman, 2015; Kilpatrick, 2015). This new approach provides evidence-based interventions specific to the deficits found in the assessment. According to the author over 500 interventions are available to clinicians based on the specific needs identified. Cognitive, behavioral, and academic disparities among students with ADHD cannot be addressed if future research is not dedicated to the assessment, evaluation, and interventions of the population using the most up-to-date psychometric measures available (Gormley, DuPaul, Weyandt, & Anastopoulos, 2016). Therefore, a quantitative approach was considered to answer the following research questions:

1. Will the CHC factor scores be able to discriminate cognitive and academic performance between the two independent groups?
2. Will students with ADHD exhibit poorer Gc, Gf, Gwm, Gv, Glr, Gs, Ga, Grw-R (Broad Reading), Gq (Broad Mathematics), and (Grw-W) Broad Written Language performance than students without ADHD?

Research Design

According to Gay, Mills, and Airasian (2012), "casual comparative design involves selecting two groups that differ on some variable of interest and comparing them on some dependent variable." (p. 231). Within the current study, the casual comparative design was used to compare two organismic characteristics (e.g., ADHD diagnosis versus no ADHD diagnosis) on the dependent variables derived from the WJ IV three-battery configuration. As noted by Gay, et al., control concerns exist within any study pertaining to casual comparative research and involve lack of resources, manipulation, and randomization within the study (Gay, Mills, & Airasian, 2012). However, the use of matching, comparing homogeneous groups or subgroups, and analysis of covariance can assist in controlling for interval validity. Inclusion criterion was implemented within the study to assist in matching independent groups and comparing homogeneous groups.

Subjects

Data for this study was obtained from 12 schools in a large urban district in the northwestern corner of Arizona that had students with an ADHD diagnosis and standardization data from the WJ-IV. The district has twelve school sites with a total of 7,223 students. Class sizes average 22 students with 380 certified teachers, 4 full time school psychologists, and 2 full time school psychology interns. The ADHD group data came from students referred for a re-evaluation with an educational eligibility of Other Health Impairment and a diagnosis of ADHD to determine re-eligibility of special education services as required by IDEA. The control data came from the Woodcock-Johnson® IV standardized data. Subjects for the ADHD group included 31 students diagnosed with ADHD. Healthy control subjects included 31 students with no clinical diagnosis derived from the standardized data supplied by the 'Woodcock Institute for

the Advancement of Neurocognitive Research and Applied Practice', used by permission of the publisher, Riverside Assessments, LLC. The primary basis used to create the control group for the study was age. Additional criteria used included gender, ethnicity, and reported general intellectual ability (GIA) score. The sample size was selected based on prior research (Schrank, Mather, & McGrew, 2014b), in which approximately 31 subjects per group provided sufficient power to detect differences at the $p < .05$ levels of large effects, which is anticipated in this study. Descriptive information was requested for each group which included gender, ethnicity, age, parent's highest level of education, and general intellectual ability (GIA) score. Inclusion criteria for the ADHD group included: a diagnosis of ADHD, the subjects must be between the ages of 6 years, 0 months to 17 years, 11 months at the time of assessment, must have all of the seven CHC factor scores (Gc, Gf, Gwm, Gv, Glr, Gs, and Ga), must have cluster scores in the areas of (Grw-R) Broad Reading, (Grw-W)Broad Written Language, and (Gq) Broad Mathematics, and must have a prior reported GIA score of 70 or above. Inclusion criteria for the control group included: no medical or academic disability diagnosis, the subjects must be between 6 years, 0 months to 17 years, 11 months at the time of assessment, must have all of the seven CHC factor scores (Gc, Gf, Gwm, Gv, Glr, Gs, Ga), must have cluster scores in the areas of (Grw-R) Broad Reading, (Grw-W) Broad Written Language, and (Gq) Broad Mathematics, and must have at least a prior reported GIA score of 70 or above.

Once Institutional Review Board (IRB) approval was obtained by the University of Nevada and the school district, recruitment of potential ADHD subjects through the referral process began. Prior to participation in the study, a meeting of the Multidisciplinary Evaluation Team was held, and a review of existing data was conducted to determine whether further evaluation was needed. ADHD subjects for the study were acquired based on their need for a re-

evaluation to determine eligibility for special education services within the school setting. Subjects included 31 subjects who had already been identified as having Other Health Impairment with a diagnosis of ADHD based on DSM-5 criteria and who were due for a re-evaluation as required by IDEA.

A waiver of consent and assent was presented to the caregiver and the student during a multidisciplinary meeting prior to the researcher using any or all student information. At the multidisciplinary meeting the team reviewed parent consent, youth and/or child consent, student rights, and confidentially to ensure the youth and/or child and caregiver were aware of their rights. A copy of the informed consent and the assent are attached in Appendix A.

The determination of eligibility under Other Health Impairment according to the Individuals with Disabilities Education Act (2004) includes the following:

> Other health impairment means having limited strength, vitality, or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that— (i) Is due to chronic or acute health problems such as asthma, attention deficit disorder or attention deficit hyperactivity disorder, diabetes, epilepsy, a heart condition, hemophilia, lead poisoning, leukemia, nephritis, rheumatic fever, sickle cell anemia, and Tourette syndrome; and (ii) Adversely affects a child's educational performance (34 CFR Sec. 300.8 (c)(9)).

Measures

Diagnostic Interview. Licensed school psychologists collected diagnostic data during initial intake interviews. Requested information included age, grade, sex, ethnicity, family history, developmental and medical history of complaints, developmental milestones, and

symptomology associated with the student's referral. An IDEA ADHD diagnosis was made based on federal regulations pertaining to eligibility determination under the funding category of Other Health Impairment.

Woodcock-Johnson® IV Tests of Cognitive, Academic, and Oral Abilities. The WJ IV COG is an assessment used to measure the broad and narrow cognitive abilities of individuals from 2 to 90 years. The new design aligns with the latest CHC theory of human cognitive abilities allowing researchers' the opportunity to explore a client's relative strengths and weaknesses through cognitive deficits and then apply interventions based on response to intervention (RtI). The measure includes 18 cognitive tests that are published in two components.

The Cognitive Standard Battery is comprised of subtests 1 through 10 "(Oral Vocabulary, Number Series, Verbal Attention, Letter-Pattern Matching, Phonological Processing, Story Recall, Visualization, General Information, Concept Formation, and Numbers Reversed)", and the Extended Battery is subtests 11 through 18 "(Number-Pattern Matching, Nonword Repetition, Visual Auditory Learning, Picture Recognition, Analysis Synthesis, Object-Number Sequencing, Pair Cancellation, and Memory for Words)" with an Intra-Cognitive variation procedure (core tests) to measuring General Intellectual Ability (GIA) that requires only tests 1 through 7 (Ding, & Alfonso, 2016).

The WJ IV ACH is an assessment used to measure academic abilities of individuals from early childhood to adulthood. The new design aligns with the latest CHC theory of human cognitive abilities allowing researchers' the opportunity to explore individual relative strengths and weaknesses through cognitive deficits and then apply interventions based on response to intervention (RtI). The measure includes 20 academic tests that are published in two components. The Standard Battery is comprised of subtests 1 through 11 "(Letter-Word

Identification, Applied Problems, Spelling, Passage Comprehension, Calculation, Writing Samples, Word Attack, Oral Reading, Sentence Reading Fluency, Math Facts Fluency, and Sentence Writing Fluency)" and the Extended Battery is subtests 12 through 20 "(Reading Recall, Number Matrices, Editing, Word Reading Fluency, Spelling of Sounds, Reading Vocabulary, Science. Social Studies, and Humanities)" with an Intra-Achievement variation procedure (core tests) that requires only tests 1 through 6 (McGrew, LaForte, & Shrank., 2014).

The WJ IV OL is an assessment used to measure oral language, listening comprehension, oral expression, and auditory and memory span of individuals between early childhood and adulthood. The measure includes eight English language tests (Picture Vocabulary, Oral Comprehension, Segmentation, Rapid Picture Naming, Sentence Repetition, Understanding Directions, Sound Blending, and Retrieval Fluency) in nine clusters, two clusters with one WJ IV COG test and one WJ IV OL test each, and three Spanish language tests forming three clusters. Auditory tests are presented from a CD through headphones.

Test Administration and Scoring. Administration time is approximately 5 to 10 minutes per subtest or approximately one hour for the Standard Battery. General test materials needed to administer the Full Battery include two Test Books, a Test Record and Response Booklet, and at least two pencils. A timer or clock with a second hand is required for timed tests. Headphones and a CD player are required for audio presentations. The examiner calculates raw scores during administration; additional scoring can be accessed using the WJ Online Scoring and Reporting System (McGrew, LaForte, & Schrank, 2014; Schrank & Dailey, 2014).

Norming. The normative data was collected between December 2009 and January 2012. With a total of 7,416 individuals from the United States and the District of Columbia ranging in "age from 2 to 90+ years of age" (Flanagan & Alfonso, 2016). Subjects that were representative

of the kindergarten to 12th-grade sample accounted for over half of the sample indicating the need for more concentrated research on this developmental period of cognitive development.

Reliability and Validity. "Reliability coefficients for subtests range from .74 to .97 with a median reliability of .89" (Flanagan & Alfonso, 2016). "Reliability coefficients for cluster scores range from .86 to .97, with median reliability of .93" (Flanagan & Alfonso, 2016). "Median reliability coefficients across ages for the general intelligence composites range .94 to .97" (Flanagan & Alfonso, 2016). Convergent and discriminate validity support consisted of average score changes with growth curves that followed different development courses over the age span (Flanagan & Alfonso, 2016). The range of test and cluster intercorrelations over the age span was .30 to .60 supporting the notion that the tests and clusters measure cognitive abilities that are different from one another (Flanagan & Alfonso, 2016).

Procedure

Students were referred to the researcher by licensed school psychologists within the school district based on their need for re-evaluation to determine re-eligibility for special education services in the area of Other Health Impairment with an existing diagnosis of ADHD as required by IDEA. Once a referral was placed with the researcher, she arranged a Multidisciplinary Evaluation Team (MET) meeting with the caregivers, student, general education teacher, special education teacher, and a school district representative to discuss the study and re-evaluation assessment procedures. After the MET determined that a re-evaluation was warranted, parental consent and child/youth consent were obtained. Parental consent and assent were obtained from each family that participated. The researcher assessed students over two sessions, each session lasting approximately one and one-half hours. During the first session each student was assessed on the WJ-IV COG and WJ-IV OL. During the second session, each

student was assessed on the WJ-IV ACH. Educational assessments were conducted in an empty room located at the student's home school. After students were assessed the following procedures were conducted.

A data form with fields for student age, gender, all CHC factor scores (Gc, Gf, Gwm, Gv, Glr, Gs, Ga), the cluster scores for (Grw-R) Broad Breading, (Grw-W) Broad Written Language, and (Gq) Broad Mathematics, ethnicity, parent's highest level of education, and general intellectual ability score was created on an encrypted computer for each eligible subject. Inclusion criteria for the ADHD group included: a diagnosis of ADHD, the subjects were between the ages of 6 years, 0 months to 17 years, 11 months at the time of the assessment, each subject had all seven of the CHC factor scores (Gc, Gf, Gwm, Gv, Glr, Gs, Ga), the cluster scores for (Grw-R) Broad Reading, (Grw-W) Broad Written Language, and (Gq) Broad Mathematics, and each subject had a prior reported GIA score of 70 or above. Only areas of the educational record that contained information which needed to be extracted to determine re-eligibility were accessed. The purpose of creating the data forms was to allow for the information to be extracted in a deidentified format. In order to reduce rates of incorrectly entered data, the researcher incorporated a double entry system in record keeping. The researcher generated two data forms for each student's educational record. Once all data had been entered twice, the data was downloaded into two Excel spreadsheets for comparison. The two spreadsheets were compared for differences using the appropriate Excel formula ("IF"). If differences were found among the two spreadsheets, reference to the original data entry documentation was made and the necessary changes were made. Once this process was complete, the Excel spreadsheet that contained the educational record numbers was be destroyed. Once all data forms were created and double-checked, the researcher generated a database without any Protected Health

Information (including record numbers) for research purposes. All study data was kept secure and was only accessible to the researcher. All data was stored electronically on a portable device (such as a laptop) with encryption and password protection.

Control subjects for the study were acquired from a data set provided by Riverside Assessments, LLC. Upon UNLV IRB approval, the researcher contacted the representatives of Riverside Assessments, LLC to obtain the standardization data from the WJ-IV. Once the 'Woodcock Institute for the Advancement of Neurocognitive Research and Applied Practice' had received verification that the IRB had been approved, they put the researcher in contact with Riverside Assessments, LLC, the publisher, (Appendix B) who worked with the researcher to select the matched sample from their standardization database and de-identify it before it was released. Riverside Assessments, LLC requested the demographic information needed to match the sample and the plan for keeping the data secure once the researcher had the data. Subjects included approximately 31 students who had not been diagnosed with ADHD and had no medical or academic disability diagnosis. For the control group an identical data form was utilized.

Chapter 4: Results

The study aimed to answer the following questions: Do CHC factor scores differentiate cognitive and academic differences among the ADHD group and control group? Do students with ADHD display meaningful differences from students without ADHD on the ten CHC factors of Comprehension-Knowledge (Gc), Fluid Reasoning (Gf), Short-Term Working Memory (Gwm), Cognitive Processing Speed (Gs), Auditory Processing (Ga), Long-Term Retrieval (Glr), Visual Processing (Gv) and three Academic Broad Clusters consisting of Broad Reading (Grw-R), Broad Mathematics (Gq), and Broad Written Language (Grw-W)? The standard score scale used in the WJ-IV is based on a mean of 100 and a standard deviation of 15. Statistical analyses were performed using IBM® SPSS® Statistics 26, a software package for data analysis (IBM, n.d.).

Preliminary Analysis

All test data was evaluated to ensure assumption including normality, independence, and homoscedasticity were met. Data was evaluated using frequency distributions and scatterplots for skewness and kurtosis and all data points that were within 3.0 standard deviations of the mean were considered to be within the acceptable range. Scores that were 3.0 standard deviations above or below the mean were rescored to become one value above or below the closet value of the normal distribution as recommended by Tabachnick and Fidel (2007).

Demographic Analysis

Analysis were carried out to determine whether the ADHD and control groups were similar on demographic variables. Demographic statistics were calculated for the ADHD group (n = 31) and control group (n = 31) on age, GIA, gender, ethnicity. Independent t-test revealed the groups did not differ in age, $t(60) = .456$, $p = .691$ or GIA, $t(60) = .001$, $p = 1.0$. Subjects for

the study ranged in age from 6 to 17 years old, with a mean age of 12.26 years. In addition, chi square analysis revealed the ADHD and control groups did not differ in gender, $\chi^2(1, N = 62) = .001$, $p = 1.00$, race/ethnicity, $\chi^2 (2, N = 62) = .001$, $p = 1.00$, or parent education completed, $\chi^2 (2, N = 62) = 3.61$, $p = .164$. The 62 subjects consisted of 40 (64.5%) males and 22 (35.5%) females. Subject's ethnicity was divided among three groups: Caucasian (87.1%), African American (6.5%), and other (Hispanic or Native American) (6.5%). Parental education consisted of three groups: Less than High School (9.7%), High School Graduate (53.2%), and More than High School (37.1%). Demographic data are summarized in Table 1.

Table 1: *Descriptive Statistics of Groups*

	ADHD Group *N*=31 *M* (SD)	Control Group *N*=31 *M* (SD)	Total *N*=62 *M* (SD)	Significance
Age in years	12.26 (2.93)	12.26 (2.93)	12.26 (2.90)	$p = 1.00$
GIA	79.39 (12.14)	80.74 (11.15)	80.06 (11.58)	$p = .691$
Gender				
Males	19 (61.3%)	19 (61.3%)	40 (64.5)	$p = 1.00$
Females	12 (38.7%)	12 (38.7%)	22 (35.5)	
Ethnicity				
Caucasian	27 (87.1%)	27 (87.1%)	54 (87.1)	
African American	2 (6.5%)	2 (6.5%)	4 (6.5)	$p = 1.00$
Hispanic	2 (6.5%)	2 (6.5%)	4 (6.5)	
Social Economic Status (SES)				
Less than High School	3 (9.7)	3 (9.7)	6 (9.7)	
High School Graduate	20 (65.5)	13 (41.9)	33 (53.2)	$p = .164$
More than High School	8 (25.8)	15 (48.4)	23 (37.1)	

Note. GIA=General Intellectual Ability

Pearson Correlations

A series of Pearson correlations were performed on all dependent variables in order to ensure MANOVA assumptions were met. As seen in Table 2 and 3, a significant pattern of correlations was revealed among the dependent variables, indicating the appropriate use of a MANOVA.

Table 2: *Correlations of the CHC factors on cognition*

	Gc	Gf	Gwm	Gs	Ga	Glr	Gv
Gc	1	0.236	.351**	0.016	.404**	.263*	.320*
Gf		1	.499**	.265*	0.078	.319*	.378**
Gwm			1	0.218	.315*	0.187	.330**
Gs				1	.313*	.324*	.269*
Ga					1	0.211	.350**
Glr						1	.397**
Gv							1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 3: *Correlations of the Broad Cluster scores on academics*

	Grw-R	Gq	Grw-W
Grw-R	1	.519**	.832**
Gq		1	.514**
Grw-W			1

**. Correlation is significant at the 0.01 level (2-tailed).

MANOVA

A single multivariate analysis of variance (MANOVA) was conducted to determine whether CHC factor scores could distinguish differences in cognitive performance among the ADHD and control group. Seven dependent variables were used: Gc, Gf, Gwm, Gs, Ga, Glr, and Gv. The independent variable was group. Preliminary analysis testing was evaluated to assess for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity among the groups, with no serious violations noted. The was a statistically significant difference between the ADHD and control group on the combined dependent variables, F (7, 54) = 4.51, p =.001; Wilks' Lambda =.63; partial eta squared = .37. When the results for the dependent variables were considered separately, the only differences to reach statistical significance, using a Bonferroni adjusted value of .007, were Ga, F (1, 60) = 7.95, p = .007, partial eta squared = .18 and Glr, F (1, 60) =13.16, p = .001, partial eta squared =.18. A review of the mean scores determined that subjects in the control group had higher scores on Ga (M = 87.46, SD = 14.26) compared to subjects in the ADHD group (M = 78.39, SD = 10.84). In addition, subjects in the control group had higher scores on Glr (M = 91.80, SD = 14.53) compared to the ADHD group (M = 79.77, SD = 11.40). As seen in Table 4.

Table 4: *MANOVA Group Differences for CHC Factors*

CHC Factor	ADHD		Control		*p*
	Mean	SD	Mean	SD	
Gc-Comprehension-Knowledge	87.06	9.08	89.59	13.43	.389
Gf-Fluid Reasoning	81.74	12.60	81.29	13.14	.891
Gwm-Short-Term Working Memory	90.26	12.37	87.35	11.05	.334
Gs-Cognitive Processing Speed	81.65	13.80	85.68	9.88	.190
Ga-Auditory Processing	78.39	10.84	87.46	14.26	.007
Glr-Long-term Retrieval	79.77	11.40	91.80	14.53	.001
Gv-Visual Processing	91.19	9.28	91.69	14.41	.871

A second one-way multivariate analysis of variance (MANOVA) was conducted to determine if CHC factor scores could distinguish differences in academic performance among the ADHD and control group. Three dependent variables were used: Broad Reading, Broad Mathematics, and Broad Written Language. The independent variable was group. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, with no serious violations noted. There were no statistically significant differences between subjects in the ADHD and control group on the combined dependent variables, F (3, 58) = 1.50, p =.223; Wilks' Lambda =.93; partial eta squared = .07. As seen in Table 5.

Table 5: *MANOVA Group Differences for Broad Cluster Scores*

Broad Cluster	ADHD		Control		*p*
	Mean	SD	Mean	SD	
Broad Reading	77.97	16.61	84.64	15.18	.104
Broad Mathematics	77.10	18.10	82.52	11.99	.168
Broad Written Language	80.45	18.31	83.92	16.87	.441

Discriminant Function Analysis

A discriminant function analysis (DFA) was examined to determine if student performance properly aligned into the ADHD group or the control group in the areas of cognitive performance. The variables that made the function for the DFA were cognition which included the seven CHC factors of comprehension-knowledge (Gc), fluid reasoning (Gf), short-term working memory (Gwm), visual processing (Gv), long-term storage and retrieval (Glr), cognitive processing speed (Gs), and auditory processing (Ga). The results of the discriminant function indicated significate differences between the two groups, Wilks' $\lambda = .63$, $\chi^2 (7) = 26.05$, $p = .001$. Based on the discriminant loadings of the factors, retrieval of previously learned information (Glr) and auditory processing (Ga) have the greatest predictive ability in discriminating between the two groups. The mean discriminative scores indicate that the ADHD group (-0.75) has a lower average score on the for the factors than the control group (0.75). Subjects in the control group recalled more prior learned information and were able to process auditory information with greater automaticity than the ADHD group. The relationships of cognitive performance among the groups are presented in Table 6. Significant score differences were documented for the ADHD and control groups from cognitive performance. The canonical correlation of .61 indicated that cognitive performance accounted for 37% of the variance between the groups. The

discriminant function revealed a significant correlation between groups and two factors. The two factors that significantly contributed to the cognitive performance were long-term storage and retrieval (Glr) and auditory processing (Ga). Performance in long-term storage and retrieval (Glr) (.61) indicated greater ability in predicting group membership than auditory processing (Ga) (.48). Specificity of predicted group membership, for the control group was 80%. Sensitivity of predicted group membership for the ADHD group was 71%. Overall, the percent correctly classified was 76%. Classification results are presented in Table 7.

Table 6: *Cognitive Factors on the Discriminant Analysis*

CHC Factor	*F*	*p*	Structure Coefficient Correlations	Discriminant Function Coefficient
Gc-Comprehension-Knowledge	.752	.389	.146	-.036
Gf-Fluid Reasoning	.019	.891	-.023	.052
Gwm-Short-Term Working Memory	.950	.334	-.164	-.567
Gs-Cognitive Processing Speed	1.76	.190	.224	.001
Ga-Auditory Processing	7.95	.007	.476	.803
Glr-Long-term Retrieval	13.16	.001	.612	.890
Gv-Visual Processing	0.026	.871	.027	-.464

Table 7: *Classification Results*

		Predicted Group Membership			
		Classification	Control	ADHD	Total
Original	Count	Control	25	6	31
		ADHD	9	22	31
	Percentage	Control	80.6%	19.4%	100
		ADHD	29.0%	71.0%	100

75.8% of original grouped cases correctly classified.

Summary

Chapter four summarizes the descriptive statistics used to match the ADHD and control group for the current study. Results indicated no significant differences among the two groups on age, gender, GIA, or parental education level. Significant differences were found among the groups in auditory processing (Ga) and long-term retrieval (Glr), however no significant differences were found among the groups in academic performance (Broad Reading, Broad Mathematics, Broad Written Language). Chapter five presents the interpretations of the findings and the recommendations for future research.

Chapter 5: Discussion

Literature examining cognitive and academic deficits among students with ADHD is inconclusive. Studies that have examined deficits among ADHD students have found few differences in cognition and academic performance when compared to healthy controls (Ek et al., 2007; Kibby, Vadnais, & Rickels, 2019). Although, studies have been inconclusive in significant findings of performance, researchers agree, that no individual CHC factor contributes to an ADHD diagnosis or identifies potential deficits in cognition or academic success. The Woodcock-Johnson® IV has been used across many clinical populations, but the literature lacks support for a three-battery approach to examining deficits among students with ADHD. Therefore, the focus of the current study was to fill the gap in the current literature examining deficits among individuals with ADHD using a three-battery configuration. The study examined whether cognitive and academic deficits would be present among students with ADHD when compared to healthy controls using the WJ-IV three-battery configuration. The CHC theory was utilized to examine performance among the groups. One-way MANOVAs were explored to evaluate potential differences among the groups. Additionally, a DFA was explored to determine group membership of significant findings.

Research Questions

This study examined the cognitive and academic deficits of students with ADHD. To achieve this, the WJ-IV® three-battery configuration was utilized to assess cognitive, academic, and oral language abilities. One-way MANOVAs were used to examine significant differences among the ADHD and healthy controls. In addition to MANOVAs, a DFA was conducted to determine group membership of significant findings.

The research questions examined the significant difference between cognitive and academic performance among ADHD participants compared to healthy controls.

Findings

Based on the research questions, 10 hypotheses were examined in the current study and as reported below, four of the ten were rejected. The findings from this study are similar to those in current research that examined cognitive and academic deficits among students with ADHD.

The predicted pattern of results was achieved for four of the seven factors in cognition: subjects demonstrated no differences in performance as hypothesized on comprehension-knowledge (Gc), fluid reasoning (Gf), long-term retrieval (Glr), and visual processing (Gv). For short-term memory (Gwm), processing speed (Gs), and auditory processing (Ga) the predicted pattern was not observed.

The findings from the current study did not support the hypotheses in the CHC cognitive factors short-term memory and processing speed when examining differences among the ADHD and control group it was hypothesized that the two groups would perform significantly different. It was expected that the ADHD group would perform worse than the control group in these areas. The non-significant findings in short-term memory and processing speed could be related to the absence of ADHD subtypes. Numerous studies have found that when examining students with ADHD compared to healthy controls that the two groups perform similar in cognition (Ek et al., 2007; Kibby, Vadnais, & Rickels, 2019). However, when ADHD subtypes are examined and compared to healthy controls results are typically mixed (Wells, 2005). The discrepancy between the two groups is frequently due to symptoms related to the ADHD subtype presented in the student. Specifically, prior studies have found that students with ADHD-Inattentive perform worse on tasks that involve executive functioning and often present with learning disabilities

(Bench, Jacobs, & Furlonger, 2019). The CHC model utilized within the WJIV® examines executive functioning and academic tasks individually using broad and narrow ability CHC factors to identify potential deficits in individual performance. These findings may contribute to the non-significant findings among the two groups within the study. As indicated previously, data analysis was conducted examining students with an eligibility of Other Health Impairment with a diagnosis of ADHD. Specific subtypes of ADHD were not examined, and this may explain the non-significant findings among the groups in short-term memory (Gwm) and cognitive processing speed (Gs).

Contrary to the fifth hypothesis, auditory processing was found to be significantly different between the ADHD and control group. The significant finding could be related to the CHC model. The CHC model examines the broad factors short-term memory and auditory processing individually, thereby alleviating possible deficits commonly found in executive functioning within ADHD groups that could frequently contribute to a false auditory processing disorder diagnosis. Thus, enabling clinicians to distinguish between potential auditory processing disorders versus executive functioning deficits when assessing students with ADHD (Bench, Jacobs, & Furlonger, 2019).

The predicted pattern of results was achieved for two of the three Broad Clusters in academic achievement: subjects demonstrated no difference in performance on broad reading (Grw-R) and broad mathematical (Gq). For broad writing language (Grw-W) the predicted pattern was not observed.

As for Broad Written Language (Grw-W) studies have found that many students with ADHD have deficits in academic performance that can impact reading, writing, and mathematical performance. Conversely, no significant differences were reported among the

groups in the current study in academic performance. The findings may suggest that consistent with current research, students with ADHD-Hyperactive and combined presentation typically perform similar to same age peers, but present with deficits in behavior and social skills (Bench, Jacobs, & Furlonger, 2019). Another explanation for the insignificant results found between the groups could be due to the specific CHC factor examined. The Broad Written Language factor combines the scores of individuals in spelling, writing samples, and sentence writing fluency to produce an overall written language cluster, thereby omitting individual performance on each specific subtest.

The first MANOVA revealed a significant difference between the ADHD group and the control group on the cognitive factors of long-term storage and retrieval (Glr) and auditory processing (Gs). Subjects in the control group scored significantly higher than subjects in the ADHD group on the two cognitive factors. A DFA was conducted to determine if subjects would be identified as belonging to the ADHD group or the control group. The factors that significantly contributed to the function were long-term storage and retrieval (Glr) and auditory processing (Ga). Significant mean differences were observed for the ADHD and control groups on these two functions. The DFA revealed a significant association between the ADHD group and control group on two predictors (long-term storage and retrieval (Glr) and auditory processing (Ga), with long-term storage and retrieval displaying a higher relationship to group membership. The function identifies an individual's ability to store and recall prior learned information at a later time with automaticity.

The second MANOVA detected no significant differences among the two groups in the area of academic performance (Broad Reading, Broad Mathematics, and Broad Written Language). The findings expand current knowledge into the use of the two cognitive CHC

factors to implement a systematic and multimodal approach to IDEA eligibility criteria when determining an educational eligibility of Other Health Impairment.

Implications

The current study found that differences between students with ADHD compared to healthy controls may depend largely on the ADHD subtypes. Students with ADHD-Inattentive tend to display deficits in executive functioning and have higher incidences of learning disabilities. However, students with ADHD-Hyperactive and Combined Presentation display deficits in social and emotional behavior. Based on the findings of the current study, it could be assumed that many of the ADHD subjects within the study presented with Hyperactive and Combined Presentations of the disorder. These findings are useful when implementing interventions to support individual cognitive and academic success.

Secondly, the study found that differences between the ADHD and control group in auditory processing and long-term retrieval could expand the utilization of the CHC model when assessing students with ADHD for a comorbid diagnosis of auditory processing disorder. The three-battery configuration explored cognitive, academic, and oral skills among students which can be interpreted using the CHC model to define deficits specific to individual student needs. As found within the current study, the CHC model identified deficits among students with ADHD and alluded to potential uses of specific CHC factors to assist in identifying auditory processing concerns that may warrant further investigation.

Limitations

Although the current study yielded some interesting findings, it has limitations that future research should address. The ADHD subjects all came from one town in northwestern Arizona and were largely Caucasian, which can limit the generalizability of the results to the general

population. Future research should include a larger sample with a diverse population which expands the ADHD group into subtypes. A larger ADHD sample would enable the broadening of research into the differences among the ADHD group to include ADHD subtypes which would distinguish whether specific subtypes perform differently on cognitive and academic factors compared to healthy controls. Other limitations to the current study included the lack of stimulant naïve ADHD subjects and the use of Broad Cluster Scores to identify potential academic deficits.

Future Research

Results of this study indicate that the CHC model may be useful in differentiating auditory processing and long-term retrieval deficits from symptoms typical to an ADHD diagnosis. Further research should examine the performance of all ADHD subtypes in auditory processing and long-term retrieval using the CHC model with medication naïve participants. Although the current study found significant differences among the groups in auditory processing and long-term retrieval, it is unknown whether the ADHD subjects' performance among the subtests may have been skewed due to stimulant medication. Future research into the impact of medication on ADHD executive functioning and academic performance using the three-battery configuration could provide mixed results This approach could further expand the current research into the use of the CHC model when diagnosing auditory processing disorders in subjects with ADHD and provide insight into the specific deficits associated with cognitive and academic performance

Conclusions

The purpose of the study was to answer the following questions: Do CHC factor scores differentiate cognitive and academic differences among the ADHD group and control group? Do

students with ADHD significantly differ from students without ADHD on the seven CHC factors of Comprehension-Knowledge (Gc), Fluid Reasoning (Gf), Short-Term Working Memory (Gwm), Cognitive Processing Speed (Gs), Auditory Processing (Ga), Long-Term Retrieval (Glr), Visual Processing (Gv) and three Academic Broad Clusters consisting of Broad Reading (Grw-R), Broad Mathematics (Gq), and Broad Written Language (Grw-W)?

A multivariate analysis of variance (MANOVA) showed a significant difference between the ADHD group and the control group on the cognitive predictors long-term storage and retrieval (Glr) and auditory processing (Ga). The control group scored significantly higher than the ADHD group on those two variables. A Discriminant Function Analysis was conducted to determine whether subjects would be identified in the ADHD diagnostic group or the control group. The factors that made the predictor were long-term storage and retrieval (Glr) and auditory processing (Ga). The results of the current study illustrated significant weaknesses in long-term storage and retrieval (Glr) and auditory processing (Ga) in students with ADHD. Research-driven interventions to address deficits in long-term storage and retrieval are numerous, however interventions to address auditory processing are just being to emerge. Schrank and Wendling (2015) provide intervention suggestions in the Woodcock-Johnson IV Interpretation and Instructional Interventions Program that correlate with WJ IV COG, WJ IV ACH, and WJ IV OL results. Several interventions for deficits in Glr are suggested such as, elaborative rehearsal of information, the use of mnemonics and visual presentations to improving learning acquisition (Schrank & Wendling, 2015). Interventions targeting Ga deficits include, the use of games that target the sounds of words, rhyming, and modeling of pronunciation of unfamiliar words (Schrank & Wendling, 2015). In addition, current research that evaluated language deficits among students with ADHD found that frequency modulation systems could

prove to be beneficial in supporting students with ADHD with speech-understanding in noise (Blomberg, Danielsson, Rudner, Soderlund, & Ronnber, 2019).

Appendix A

UNLV

PARENT PERMISSION FORM

Department of Educational Psychology & Higher Education

TITLE OF STUDY: A CHC Theoretical Approach to Examining Cognitive and Academic Deficits among Children with ADHD Using a Three-Battery Configuration

INVESTIGATOR(S): Scott Loe, Ph.D; Jacqueline Hart, M.S.

CONTACT PHONE NUMBER: 702-895-2949 (Dr. Scott Loe)

Purpose of the Study

You are invited to participate in a research study. The purpose of this study is to examine whether there are any differences in cognitive and academic achievement among children diagnosed with ADHD compared to children without an ADHD diagnosis using three new assessments. It is hoped that the results of this study may serve to inform others of potential missed weaknesses in specific cognitive, academic, and oral skill areas associated with ADHD and provide new data that may influence new interventions.

Participants

Your child is being asked to participate in the study because your child meets one of the following criteria: 1) Your child is between the age of 6 years, 0 months and 17 years, 11 months; 2) Your child has a medical diagnosis of ADHD.

Procedures

If you allow your child to volunteer to participate in this study, your child will be asked to complete up to 3 hours of testing. Your child will be asked to do the following: At the first session, he or she will be given the *Woodcock-Johnson IV Tests of Cognitive Abilities*, an assessment used to measure cognitive abilities and intellectual level. In additional, one subtest of the *Woodcock-Johnson IV Tests of Oral Language Abilities*, an assessment used to measure oral language, auditory, and memory span will be administered during the first session. During the second session, your child will be given the *Woodcock-Johnson IV Tests of Achievement*, an assessment used to measure academic achievement in areas such as reading, writing, and math. Most of the tests are quite easy while others may seem more difficult. Some have time limits while others do not. The child will be provided with rest breaks as needed.

You will receive individual feedback after the testing and will be given information on how to contact the researchers when the project is completed to receive the general results of the study.

Benefits of Participation

Your child's participation will add to the understanding of cognitive and academic differences found among children with ADHD. This could lead to improvement in the detection of unidentified cases and provide data that may influence new interventions.

Participant Initials _____

Risks of Participation
There are risks involved in all research studies. This study may include only minimal risks. There is a chance of your child may experience mental fatigue during the assessment. To decrease the chance of fatigue, the researcher will allow breaks as necessary for his or her comfort.

Cost /Compensation
There *will not* be financial cost to you to participate in this study. The study will take approximately 3 hours of your child's time to complete.

Contact Information
If you or your child have any questions or concerns about the study, you may contact Dr. Scott Loe at **the UNLV Educational Psychology & Higher Education Department at 895-4164.** For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794, or via email at IRB@unlv.edu.**

Voluntary Participation
Your child's participation in this study is voluntary. Your child may refuse to participate in this study or in any part of this study. Your child may withdraw at any time without prejudice to your relations with the university. You or your child is encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link your child to this study. All records will be stored in a locked facility at UNLV for 5 years after completion of the study. After the storage time the information gathered will be destroyed.

Participant Consent:
I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

Signature of Parent

Child's Name (Please print)

Parent Name (Please Print)

Date

Participant Initials _____

UNLV

CHILD ASSENT FORM (AGES 6-12)

Department of Educational Psychology & Higher Education

TITLE OF STUDY: A CHC Theoretical Approach to Examining Cognitive and Academic Deficits Among Children with ADHD Using a Three-Battery Configuration

INVESTIGATOR(S): Scott Loe, Ph.D & Jacqueline Hart, M.S.

For questions or concerns about the study, you can contact, **Dr. Scott Loe at 702-895-2949.**

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted, contact **the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794 or via email at IRB@ unlv.edu.**

---

1. My name is Jacqueline Hart.
2. We are asking you to take part in this research study because we are trying to understand if children with ADHD that have problems learning have different needs compared to children like you, who do have ADHD.
3. If you agree to be in this study, you will be asked to look at pictures and answer questions that you would normally see on a math, reading, or spelling test at school.
4. If you are in this study, you may feel like you feel when you are taking a test at school.
5. The study will take two sessions each lasting 1.5 hours each to complete.
6. Please talk this over with your parents before you decide whether or not to participate. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say "yes" you can still decide not to do this.
7. If you don't want to be in this study, you do not have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop.
8. You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can ask me next time.
9. Writing your name at the bottom means that you agree to be in this study. You and your parents will be given a copy of this form after you have signed it.

Print your name _____ Date _____

Sign your name _____

UNLV

UNIVERSITY OF NEVADA LAS VEGAS

YOUTH ASSENT FORM (Ages 13-17)

TITLE OF STUDY: A CHC Theoretical Approach to Examining Cognitive and Academic Deficits among Children with ADHD Using a Three-Battery Configuration

INVESTIGATOR(S): Scott Loe, Ph.D; Jacqueline Hart, M.S.

CONTACT PHONE NUMBER: 702-895-2949 (Dr. Scott Loe)

Purpose of the Study

You are invited to participate in a research study. The purpose of this study is to examine whether there are any differences in cognitive and academic achievement among children diagnosed with ADHD compared to children without an ADHD diagnosis using three new assessments. It is hoped that the results of this study may serve to inform others of potential missed weaknesses in specific cognitive, academic, and oral skill areas associated with ADHD and provide new data that may influence new interventions.

Participants

You are being asked to participate in the study because you meet one of the following criteria: 1) You are between the age of 6 years, 0 months and 17 years, 11 months; 2) You have a medical diagnosis of ADHD.

Procedures

If you agree to volunteer to participate in this study, you will be asked to complete up to 3 hours of testing. You will be asked to do the following: At the first session, you will be given the *Woodcock-Johnson IV Tests of Cognitive Abilities*, an assessment used to measure cognitive abilities and intellectual level. In additional, two subtest of the *Woodcock-Johnson IV Tests of Oral Language Abilities*, an assessment used to measure oral language, auditory, and memory span will be administered during the first session. During the second session, you will be given the *Woodcock-Johnson IV Tests of Achievement*, an assessment used to measure academic achievement in areas such as reading, writing, and math. Most of the tests are quite easy while others may seem more difficult. Some have time limits while others do not. You will be provided with rest breaks as needed.

You will receive individual feedback after the testing and will be given information on how to contact the researchers when the project is completed to receive the general results of the study.

Benefits of Participation
Your participation will add to the understanding of cognitive and academic differences found among children with ADHD. This could lead to improvement in the detection of unidentified cases and provide data that may influence new interventions.

Risks of Participation
There are risks involved in all research studies. This study may include only minimal risks. There is a chance that you may experience mental fatigue during the assessment. To decrease the chance of fatigue, the researcher will allow breaks as necessary for your comfort.

Cost /Compensation
There *will not* be financial cost to you to participate in this study. The study will take approximately 3 hours of your time to complete.

Contact Information
If you have any questions or concerns about the study, you may contact Dr. Scott Loe at **the UNLV Educational Psychology & Higher Education Department at 895-4164.** For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794, or via email at IRB@unlv.edu.**

Voluntary Participation
Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for 5 years after completion of the study. After the storage time the information gathered will be destroyed.

Participant Consent:
I have read the above information and agree to participate in this study. A copy of this form has been given to me.

_____ _____
Print your name Date

_____
Sign your name

Appendix B

Agreement Date: May 15. 2019 ID: 051519B

Requestor: Fee: Gratis
University of Nevada-Las Vegas
Educational Psychologu and Higher Education
4505 S. Maryland Parkway
Las Vegas, Nevada 89154
Jacqueline Hart, M.S., NCSP
hartj19@unlv.nevada.edu
617-353-2060

Product:	Woodcock-Johnson® IV (WJ IV®)
Requested Use:	Data Sets
Selection Description:	Data Provide for Woodcock Johnson IV Norming, Ages 6 to 17 years, 11 months, Woodcock-Johnson IV Tests of Achievement, Woodcock-Johnson IV Tests of Cognitive Abilities and Woodcock-Johnson IV Tests of Oral Language. Demographics: Gender, Grade, Race, Ethnicity and Parent Education Level.

AGREEMENT

Riverside Assessments, LLC (the legal name of Riverside Insights™), the former assessment portfolio of (Houghton Mifflin Harcourt) (herinafter referred to as "Riverside") hereby grants Jacqueline Hart of the University of Nevada-Las Vegas, 4505 S. Maryland Parkway, Las Vegas, Nevada 89154, (hereinafter referred to as "Riverside") the nonexclusive, nontransferable permission to use Data Sets for the research project entilited A CHC Theoretical Approach to Examing Cognitive and Academic Deficits Among Children with ADHD using a Three-Battery Configuration under the following conditions, Riverside is the owner of Standardization and Validity Study Data Sets for Woodcock-Johnson® *WJ IV®) (hereinafter referred to as the "Work").

All use of the Woodcock-Johnson® IV (WJ IV®) is subject to the terms and conditions as follows:

Assessment materials may be used by Licensee only and may only be used in the referenced study. Under no circustances shall a third Party be granted and access whatsoever to the data without prior written consent.

Licensee acknowledges the information and data disclosed in connection with the study is confidential and proprietary to Riverside and agrees not to disclose any confidential information which has been received or any of the data or other contributions used.

A credit acknowledgement to Riverside shall be visable and should read as follows:

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Yang, P., Cheng, C. P., Chang, C. L., Liu, T. L., Hsu, H. Y., & Yen, C. F. (2013). Wechsler Intelligence Scale for Children 4th edition-Chinese version index scores in Taiwanese children with attention-deficit/hyperactivity disorder. *Psychiatry and clinical neurosciences*, *67*(2), 83-91.

Curriculum Vitae

Jacqueline Scott Hart

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EDUCATION

Doctoral Candidate in NASP-Accredited School Psychology Program Fall 2014-August 2020
University of Nevada, Las Vegas (UNLV) Advisor: Scott Loe, Ph.D.
Las Vegas, Nevada

Dissertation title: "A CHC theoretical approach to examining cognitive and academic deficits among students with ADHD using a three-battery configuration."

M.S. in Educational Psychology Conferred: August 2013
University of Nevada, Las Vegas (UNLV)
Las Vegas, Nevada

B.A. in Psychology Conferred: December 2011
Minor in Family Studies
University of Nevada, Las Vegas (UNLV)
Las Vegas, Nevada

PROFESSIONAL EXPERIENCE

Licensed School Psychologist
Kingman Unified School District
July 2018–Present
Kingman, Arizona

Coordinating and performing multidisciplinary psychoeducational assessments (screenings, initial evaluations, and reevaluations) in a preschool, elementary, and middle school setting. Collaboration with teachers, staff, families, and the community. Creating and implementing recommendations for academic and behavioral interventions. Performing general duties to fulfill the needs of the position.

LICENSES

Arizona Licensed School Psychologist	August 2018
Nevada Licensed Substitute Teacher	July 2017
Nevada Licensed School Psychologist	June 2018

CERTIFICATIONS/PROFESSIONAL DEVELOPMENT

Administration & Supervision of Special Education: Legal Aspects & Compliance (NAU)-
December 2019
Bounce Back Provider Training Course-
June 2019
CBITS Provider Training Course, Part 2-
June 2019
CBITS Provider Basic Training Course, Part 1-
June 2019
Nonviolent Crisis Intervention (CPI)-
January 2019
Nationally Certified School Psychologist-
May 2018
California Basic Educational Skills Test-
June 2017
The Graduate College Research Certificate Program-
Conferred: May 2013
Health Insurance Privacy and Portability Act (HIPPA) Certification -
Fall 2013-Present
The Collaborative IRB Training Initiative (CITI) Program-
Fall 2010- Present

INTERNSHIP TRAINING

Clark County School District
August 2017–May 2018
University of Nevada, Las Vegas Supervisor: Katherine Lee, Ph.D.

Coordinating and performing multidisciplinary psychoeducational assessments (initial evaluations and reevaluations) while under the supervision of a NASP licensed psychologist. Collaboration with teachers, staff, families, and the community. Creating and implementing recommendations for academic and behavioral interventions. Performing general duties to fulfill the needs of the position.

PRACTICUM TRAINING

School Psychology Advanced Practicum Student
Clark County School District Child Find Project
May 2015–August 2015
University of Nevada, Las Vegas
Supervisor: Tara Raines, Ph.D.

School Psychology Advanced Practicum Student
UNLV Student-Athlete Academic Services
August 2014–December 2014

University of Nevada, Las Vegas
Supervisor: Tara Raines, Ph.D.

Conducted psychoeducational evaluations for UNLV student athletes based on referrals placed by academic advisors. Evaluations included complete cognitive, academic, and behavioral assessment write-ups, which included specific interventions and recommendations for school and home, based on specific findings. I wrote one psychoeducational report per week for clients. Supervision was conducted on an individual basis and included direct training in effective report writing and case conceptualization.

School Psychology Practicum Student
August 2013–May 2014
The Practice
Supervisor: Tara Raines, Ph.D.
University of Nevada, Las Vegas

Conducted psychoevaluation evaluations in an outpatient University affiliated mental health clinic. A systematic approach to the psychoevaluation was taken to evaluate each client. Administration of a cognitive, academic, and behavioral battery was standard procedure. Additional assessments were conducted based on the specific referral concern. Diagnoses included personality disorders, adjustment disorders, ADHD, and learning disabilities. Supervision consisted of group and individual meetings during which report writing and patient diagnosis were reviewed. Specific patients were discussed in terms of differential diagnosis and accommodations related to their psychoevaluation needs.

GRADUATE RESEARCH

Dean Doctoral Fellow
August 2015–Present
University of Nevada, Las Vegas
Supervisor: Dean Kim Metcalf, Ph.D.

Assist in educational research, policy, and advocacy work at the local, state, and national level. Meet and interview current faculty and alumni to discuss their experiences at the university and detail their stories on the College of Education website. In addition, I have collaborated with David Vallett, Ph.D. in the first phase of the Clark County School District Peer Assistance and Review Program Study (PAR) study as a research member.

Graduate Research Assistant
May 2014–May 2015
University of Nevada, Las Vegas
Supervisor: Gregory Schraw, Ph.D.

Schedule, administer, and assign credit for individually assigned IRB approved undergraduate and graduate educational research studies through the College of Education Experiment Management System. Review and assign credit to alternates to research participation, which consist of position papers on various educational topics. I also collected all the data on an IRB

#1412-5031M study that Dr. Schraw and I was working on titled, 'The Effects of Casual Diagrams on Reading Comprehension.' The purpose of the study was to assess the influence of casual diagrams on reading comprehension.

Universal Screening for Behavioral and Emotional Risk
Fall 2012–Fall 2013
University of Nevada, Las Vegas
Supervisor: Tara C. Raines, Ph.D.

Duties included maintaining and update of review of screening literature and disproportionality literature. Annually organized materials for a universal screening project spearheaded by Dr. Raines that consisted of several high schools in Los Angeles United School District for distribution. Supervised and supported data cleaning for large scale screening project within the Los Angeles United School District. Imported data into systems for analysis and contributed to the development of peer reviewed research presentations and publications.

Cyber Counseling and Neuropsychological Assessment Lab
Fall 2012–May 2013
University of Nevada, Las Vegas
Supervisor: W. Paul Jones, Ph.D.

Administered to students a battery that measures neuropsychological function using the, Automated Neuropsychological Assessment Metrics (ANAM). Adhered to all rules and regulations in proper research conduct according to CITI training.

PRE-GRADUATE RESEARCH

Neuropsychology Research Program
Spring 2010–May 2012
University of Nevada, Las Vegas
Supervisor: Daniel N. Allen, Ph.D.

Responsible for scoring and entering dissertation data examining social cognitive deficits in individuals with bipolar disorder, assisting in the training of new research assistants and administering several neuropsychological measures of attention, executive function, and memory. Also trained in using brain-tracing software to identify neuroanatomical abnormalities in individuals with schizophrenia. Duties also included managing flyers for recruitment purposes and designing/presenting poster presentations.

Achievement Center
Summer 2010–Fall 2010
University of Nevada, Las Vegas
Supervisor: Brad Donohue, Ph.D.

Assisted clinical doctoral students in conducting home evaluations of substance abusing mothers in a NIDA R01 funded grant. During home evaluations of substance abusing mothers,

administered urinalysis testing for participating participants. In addition, aided Dr. Donohue in the research and application process of a NIH R01 grant that studied the evaluation of family behavior therapy for substance abuse in collegiate athletes.

MENTORING EXPERIENCE

Graduate Research Mentor
October 2014–Present
University of Nevada, Las Vegas
Supervisor: Scott Loe, Ph.D.

Provide research guidance to graduate and undergraduate students in school psychology. Areas of emphasis include research methodology, poster presentations, IRB proposals, SPSS data input, and fundamentals of literature reviews.

Student Affiliate in School Psychology Mentor
August 2013–Present
University of Nevada, Las Vegas
Supervisor: Scott Loe, Ph.D.

Provide guidance to new graduates within the department of school psychology on the core concepts of graduate life and the first year of graduate school. Create social activities that instill community with the department and within the student body. Actively engage students in quarterly discussions to highlight areas of concern and reflect on suggests for future growth within the social structure of the graduate population.

GRADUATE TEACHING EXPERIENCE

Graduate Teaching Assistant
January 2014–December 2015
University of Nevada, Las Vegas
Supervisor: Scott Loe, Ph.D.

Instructed graduate level lab in the proper application of assessment approaches used for the evaluation of students in school settings. Assessment tools covered within the course are the Wechsler Intelligence Scale for Children, Fourth Edition, and the Woodcock-Johnson IV Cognitive Abilities Assessment.

The class included discussions, video recordings, and hands-on practice sessions designed to train students in the appropriate administration and scoring of each instrument covered. The purpose of this course is to facilitate students' development of proficiency in these assessment procedures within a school setting.

Graduate Teaching Assistant
August 2013–May 2016
University of Nevada, Las Vegas
Advisor: Scott Loe, Ph.D.

Instructed graduate level lab that provided an opportunity for students to gain competency in administering clinical assessments of academic achievement in children, adolescents, and adult's populations. The class included discussions, video recordings, and hands-on practice sessions designed to train students in the appropriate administration and scoring of each instrument covered. The purpose of this course is to facilitate students' development of proficiency in these assessment procedures within a school setting.

PRE-GRADUATE TEACHING EXPERIENCE

Marriage and Family Therapy
Spring 2011–Summer 2011
Undergraduate Teaching Assistant
Supervisor: Markie Blumer, Ph.D.
University of Nevada, Las Vegas

Duties included preparing online coursework by uploading materials, creating online discussion boards, online grading, managing, and conducting small group meetings, and scoring participation in small groups. In addition, I was responsible for preparing study/review-session materials for students in MFT 350 (Human Sexuality), leading study sessions for students in MFT 350 before exams, assisting Dr. Blumer in auto-grade of student exams, and scoring extra credit material.

AWARDS/HONORS

Dunn Doctoral Scholar, Inaugural Dunn Doctoral Scholarship: Spring, 2017 ($200). Prospectus: Hart, J. (October, 2016). A CHC theoretical approach to examining cognitive and academic deficits among children with ADHD using a three-battery configuration.

PEER-REVIEWED PUBLICATIONS

Thaler, N. S., Allen, D. N., **Hart, J.**, Boucher, J. R., McMurray, J. C., & Mayfield, J. (April 2012). Neurocognitive Correlates of the Trail Making Test for Older Children in Patients with Traumatic Brain Injury. *Archives of Clinical Neuropsychology, 27*(4), 446-452.

Kimble, B., **Hart, J.**, Dunn, L. (2012): The Rocky Horror Picture Show, *Journal of Feminist Family Therapy, 24*(4), 359-361

PUBLISHED ABSTRACTS

Russler, K., Sanchez, I., Jones, W., Loe, S., Raines, T., **Hart, J.**, (October, 2013) *Impact of User Interface for Online Assessment of Simultaneous Processing with Compressed Speech*. *Archives of Clinical Neuropsychology, 28*(6), 513. Poster presented at the 33rd National Academy of Neuropsychology Annual Conference, San Diego, CA.

Parke, E., **Hart, J.,** Baldock, D., Barchard, K., Etcoff, L., Allen, D. (October, 2013) *Intelligence and achievement predictors of Attention Deficit Hyperactivity Disorder and Learning Disorders. Archives of Clinical Neuropsychology, 28*(6), 513. Poster presented at the 33rd National Academy of Neuropsychology Annual Conference, San Diego, CA.

Stolberg, P., **Hart, J.**, Allen, D., Mayfield, J. (October, 2013) *Sensitivity of WJ-III Score to Severity of Traumatic Brain Injury*. *Archives of Clinical Neuropsychology, 28*(6), 513. Poster presented at the 33rd National Academy of Neuropsychology Annual Conference, San Diego, CA.

Stolberg, P., **Hart, J.**, Jones, W., Mayfield, J., & Allen, D. (November, 2012) Executive Function Predicts Academic Achievement in Children with Brain Injuries. *Archives of Clinical Neuropsychology, 27*(6). Poster presented at the 32nd National Academy of Neuropsychology Annual Conference, Nashville, TN.

Hart, J., Thaler, N., Vertinski, M., Ringdahl, E., & Allen, D. (November, 2012) Selective Impairments in Recognizing Emotions are Present in Bipolar Disorder with Psychotic Features. *Archives of Clinical Neuropsychology, 27*(6). Poster presented at the 32nd National Academy of Neuropsychology Annual Conference, Nashville, TN.

Safko, E., Thaler, N., Cox, J., **Hart, J.,** & Allen, D. N. (March, 2012). Pattern of Memory Factors Differs among Age Ranges in Healthy Children and Adolescents. *Applied Neuropsychology.* Poster presented at the Annual Meeting of the American College of Professional Neuropsychology, March 9-11, 2012, Las Vegas NV.

Stolberg, P., **Hart, J.,** Jones, W., Mayfield, J., & Allen, D. N. (November, 2011). Associations between Executive functions and Academic Achievement in Children with Traumatic Brain Injury (TBI). *Archives of Clinical Neuropsychology, 26*(6), 544. Poster presented at the 31st Annual Convention of the National Academy of Neuropsychology, Marco Island, FL.

Hart, J. S., Ringdahl, E. N., Thaler, N. S., Mayfield, J., & Allen, D. N. (March, 2011) Criterion validity of the Comprehensive Trail Making Test in traumatic brain injury. *Applied Neuropsychology, 18, 234.* Poster presented at the 3rd Annual Meeting of the American College of Professional Neuropsychology, March 11-13, 2011, Las Vegas NV.

PROFESSIONAL PRESENTATIONS

Hart, J., Zeigler, A., Guttman, J., Birden, H., Raines, T. (August, 2015) *Self-Report of Cultural Competence in Psychology Immersion Program Participants.* Presented at the 123rd Annual Convention of the American Psychological Association, August 6-9, 2015, Toronto, Ontario, Canada.

Hart, J. & Raines, T. (May 2015). *Perceived cultural competence in professionals participating in a cultural immersion program.* Symposium presented at the Association for Psychological Science Conference in New York, New York.

Raines, T., Jones, W.P., Loe, S., Crank, J. **Hart, J.** (February, 2014) *Infusing School-Based Mental Health Instruction into School Psychology Graduate Programs.* Poster to be presented at the 2014 Annual Meeting of the Trainers of School Psychologists, Washington, D.C.

Raines, T., Kamphaus, R., Dowdy, E., Eklund, K., Lui, J., **Hart, J.** (August, 2013) *Universal Screening for Behavioral and Emotional Risk: Theory, Research, and Practice.* Symposium presented at the 121st Annual Convention of the American Psychological Association, Honolulu, HI.

Hart, J. S., Cox, J. L., Woolery, H., Safko, E., Thaler, N. S., Etcoff, L. M., & Allen, D. N. (April, 2012) *WISC-IV profiles in children with learning disabilities.* Poster presented at the 92nd Annual Convention of the Western Psychological Association, San Francisco, CA.

Umuhoza, D., Baldock, D., **Hart, J. S.**, Cox, J. L., Thaler, N. S., & Etcoff, L. M. (April, 2012). *Parental differences in symptom rating scales in children with ADHD*. Poster presented at the 92nd Annual Convention of the Western Psychological Association, San Francisco, CA.

Hart, J. S., Locasci, T., Hadland, C., Umuhoza, D., Turner, A., Barney, S. J., Thaler, N. S., Mayfield, J., & Allen, D. N. (April, 2011). *Neuropsychological and behavioral measures in children with traumatic brain injury.* Poster presented at the 91st Annual Convention of the Western Psychological Association, Los Angeles, CA.

PROFESSIONAL MEMBERSHIPS

2013 – Present: Society for the Teaching of Psychology (APA Division 2)
2013 – Present: School Psychology (APA Division 16)
2012 – Present: National Association of School Psychologists
2011 – Present: Society for Clinical Neuropsychology, (APA Division 40)
2010 – Present: American Psychological Association (#2647-5291)
2008 – Present: Phi Theta Kappa

OTHER ACTIVITIES

Vice President- Student Affiliates of School Psychology (SASP) UNLV Chapter: 2016-2017

UNLV Student Conduct Hearing Board/Academic Integrity Appeal Board & Rebel Peer Advisor: 2015-Present

Graduate Professional Student Association Representative: 2014-2015

Vice President- Student Affiliates of School Psychology (SASP) UNLV Chapter: 2014-2015

President- Student Affiliates of School Psychology (SASP) UNLV Chapter: 2013-2014

Volunteer, Nevada Partnership for Homeless Youth

AFAN AIDS Walk Participant: April 2011

Las Vegas Breast Cancer Charity Walks: 2011

ACADEMIC REFERENCES

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4505 S. Maryland Pkwy
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