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An Analysis of Cognitive Factors in School-Aged Children with Emotional Disturbance and ADHD Using the WISC-IV

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AN ANALYSIS OF COGNITIVE FACTORS IN SCHOOL-AGED CHILDREN WITH EMOTIONAL DISTURBANCE AND ADHD USING THE WISC-IV

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Dissertation Approval

This is to certify that the thesis presented to us by MARÍA FRAGNITO MADDALO on the 11 day of December, 2014, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

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Abstract

Children with Emotional Disturbance and ADHD demonstrate social, emotional, and behavioral symptoms that present many challenges for School Psychologists because of differences between each student's individual needs. A high level of comorbidity exists for these children with internalizing and externalizing symptoms. Little is known about neurocognitive factors as they relate to ED versus ADHD.

The current study examined the cognitive profiles of a total of 58 children with ED versus ADHD, using the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). Index scores that were examined included Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed. The groups were compared in order to determine overall group mean differences. Further analysis identified proportions of differences between the groups at the 10, 15, 20, and 25 point levels for the following Index level comparisons: VCI-WMI, PRI-WMI, PRI-PSI, VCI-PSI, VCI-PRI, WMI-PSI.

Results of the study found overall group mean differences between the groups for VCI. Further analysis of Index level comparisons indicated that children with ED demonstrated significance with VCI>WMI and VCI>PSI and PRI>WMI. Children with ADHD demonstrated significance with WMI>VCI, which is the opposite of prior research findings. Limitations of the current study and implications for future research are also discussed.

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Chapter 1: Introduction

Introduction

The accurate conceptualization and identification of what it is that constitutes Emotional Disturbance (ED) under the purview of IDEA regulations has been the subject of frequent debates within the literature. The debates have persisted over definitional issues concerning what ED is and what it is not. Although the definition of ED varies among fields of practice including education, law, and psychology, it is most nebulous in the field of special education. The characteristics and criteria identified within the special education law for the eligibility category of ED are not operationally defined. This imprecise nature of defining ED eligibility has serious implications for School Psychologists, who are often considered the gatekeepers, with the task of evaluating and classifying children as eligible or not eligible for special education services. In considering students for ED, School Psychologists must navigate through the vague and ambiguous criteria for emotional and behavioral disorders to make these determinations. This problem of definition also has implications for students because they may not have access to educational programs that they truly need, may have limited access, or may have too much access, depending upon the interpretations of the law in relation to specific situations. The special education law allows students with ADHD to be classified under a different category, according to Other Health Impairment (OHI). However, due to comorbidity of emotional and behavioral diagnoses and the presence of internalizing and externalizing behavioral symptoms, students with ADHD may sometimes also be classified as having ED.

Statement of the Problem

The current ED criteria within the law allow for a high level of subjective interpretation among practitioners when making special education determinations. The development and use of indirect and subjective measures such as the Behavior Assessment System for Children in order to identify subtypes of students with emotional and behavioral needs relies solely on the rater's perception of social, emotional, and behavioral factors. By measuring symptoms alone, rating scales do not consider the potential impact that specific neurocognitive processes may have on students' behavior and overall social-emotional functioning.

Emerging neuropsychological research is relying on scientific information regarding the impact of specific brain processes on the cognition, emotions, and social behavior of students with ED and ADHD. Evidence exists in support of the impact of the right hemisphere of the brain, along with processes of the prefrontal cortex, and a framework for understanding the complexities of emotional processing.

Purpose of the Study

The purpose of the current study is to determine whether or not significant differences exist between WISC-IV Index scores for students with ED and students with ADHD. In addition, this study will investigate the performance of students with ED and ADHD on measures of working memory and processing speed on the WISC-IV, relative to other measures of cognitive ability, including verbal comprehension and perceptual reasoning. Accurate understanding of the cognitive profiles associated with ED and ADHD will assist School Psychologists and other professional school staff with increasing the accuracy and comprehensiveness of services provided to students.

Research Questions

1. Do WISC-IV Index scores differ significantly, based on ADHD diagnosis and ED classification?

2. Do students diagnosed with ADHD show a different pattern of score differences than ??students classified as ED when scores on specific WISC-IV Indexes are compared with scores on other WISC-IV Indexes?
   a. How do students with ADHD and students classified as ED perform on Index level cognitive measures of verbal and perceptual reasoning, relative to their performance on an Index level measure of working memory? (That is, comparing and contrasting the difference between VCI scores and WMI scores and comparing and contrasting the difference between PRI scores and WMI scores for the ADHD and ED groups.)
   b. How do students with ADHD and students classified as ED perform on Index level cognitive measures of verbal and perceptual reasoning, relative to their performance on measures of processing speed? (That is, comparing and contrasting the difference between PRI scores and PSI scores and comparing and contrasting the difference between VCI scores and PSI scores for the ADHD and ED groups.)
   c. How do students with ADHD and students classified as ED perform on Index level cognitive measures of verbal reasoning, relative to their performance on measures of perceptual reasoning? (That is, comparing and contrasting the differences between VCI scores and PRI scores for the ADHD and ED groups.)
   d. How do students with ADHD and students classified as ED perform on Index level cognitive measures of working memory relative to their performance on measures of processing speed? (That is, comparing and contrasting the differences between WMI scores and PSI scores for the ADHD and ED groups.)

Chapter 2: Review of the Literature

Introduction

The concept of Emotional Disturbance (ED) began with the work of Eli Bower in 1958, when he was appointed to study how emotionally disturbed children would be best educated. In his work with colleagues, school districts, teachers, and other professionals, Bower's studies found that as children became older, they exhibited more emotional and behavioral problems, and it became more difficult to educate them (Bower, 1981).

Bower's work was integrated into the Education for all Handicapped Children Act (EHA) in 1975, with the creation of PL 94-142. This act stated that all children must have access to a free and appropriate public education, regardless of their handicapping condition; it also identified the term "seriously emotionally disturbed." Since that time the criteria has remained the same, but the term "serious" was removed from the definition with the creation of the Individuals with Disabilities Education Act (IDEA) in 1997. The U.S. Department of Education (1997) reported that this determination had no effect on the Emotional Disturbance category; its intention was solely to remove the negative connotation of the word "serious". With the reauthorization of IDEA in 2004, the definition again remained unchanged. Thus, Emotional Disturbance is currently considered to be a special education category that is used within school settings to describe children and adolescents with social, emotional, and behavioral difficulties whose inability to learn is determined not to be the result of other confounding factors (U.S. Department of Education, 2004). According to the Individuals with Disabilities Education Act (IDEA 2004), Section 300.8, entitled *Child with a disability*, Emotional Disturbance is defined as follows:

(i) Emotional disturbance means a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a child's educational performance:

(A) An inability to learn that cannot be explained by intellectual, sensory, or health factors.

(B) An inability to build or maintain satisfactory interpersonal relationships with peers and teachers.

(C) Inappropriate types of behavior or feelings under normal circumstances.

(D) A general pervasive mood of unhappiness or depression.

(E) A tendency to develop physical symptoms or fears associated with personal or school problems.

(ii) Emotional disturbance includes schizophrenia. The term does not apply to children who are socially maladjusted, unless it is determined that they have an emotional disturbance under paragraph (34 CFR 300.8 (c)(4)(i)) of this section. (IDEA, 2004)

Examination of IDEA Emotional Disturbance Criteria

IDEA section I: Limiting factors and characteristics.

Limiting factors. According to the current IDEA (2004) definition, ED includes three limiting factors; these include the period of time, the degree of difficulty, and the effect on educational performance. An examination of these limiting factors is necessary in order to attempt to understand the inclusions and exclusions of this statement.

Over a long period of time. The statement regarding the need for a long period of time appears to exist for the purpose of ruling out temporary reactions to situational factors or to particular stressors that may be considered as being related to typical adjustment (Tibbetts, 2013). Further, establishing that the issue is occurring over a long period of time allows for appropriate behavioral assessment and time for interventions to be initiated and implemented. The effectiveness or lack of effectiveness of such behavioral interventions may assist with the distinction between difficulties related simply to situational behavioral factors and more severe difficulties related to an actual condition of ED. In operationally defining a long period of time, practitioners should consider a minimum of 6 months (Tibbetts, 2013). This is aligned with current criteria for many emotional diagnoses as listed currently in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*, that may provide additional support in the appropriate identification of ED (DSM-IV-TR), (APA, 2000).

To a marked degree. According to Tibbetts (2013), to understand the portion of the statement regarding marked degree, one should consider both pervasiveness and intensity of symptoms.

The National Association of School Psychologists (NASP) defines pervasiveness as it relates to children with emotional and behavioral disorders as, "The number of settings in which difficulties occur in the school, family, or community" (Thomas & Grimes, 2002, p. 1708). The distinguishing factor between students with ED and students exhibiting behavioral problems is the continuity of the behaviors over time with a high frequency, across settings, and across individuals. Conversely, students displaying problematic behaviors without having ED are usually confined to certain environments or to particular individuals (Tibbetts, 2013).

According to NASP, intensity means, "The level of severity of the difficulties as they affect academic achievement, acquisition and execution of social skills, and/or interpersonal relationships within the school setting (Thomas & Grimes, 2002, p. 1708)." The behaviors present must be related to the ED condition, and adversely affect the student and/or others within the student's environment (Tibbetts, 2013).

Adversely affecting a child's educational performance. In considering the determination that a student's condition is adversely affecting his or her educational performance, the concerns must be present within the school setting and must be impairing the student so severely that he or she is not progressing within the current educational placement. Educational performance refers both to academic and to nonacademic areas of functioning, including behavioral and social factors as well (Tibbetts, 2013).

Characteristics of emotional disturbance. According to special education law, the existing emotional condition must also cause at least one of the following characteristics: an inability to learn, an inability to build and maintain relationships, inappropriate type of behavior under normal circumstances, pervasive unhappiness, or fears and physical symptoms related to the emotional condition (U.S. Department of Education, 2004). If a student possesses one of the characteristics without an actual emotional condition, this alone does not indicate the presence of ED (Slenkovich, 1983).

Inability to learn. The initial characteristic or manifestation of ED is stated as follows: "An inability to learn that cannot be explained by intellectual, sensory, or health factors (IDEA, 2004, Section 300.8, (c)(4)(i)(A)." According to Slenkovich (1983), the key term within this characteristic is *inability*, because the student's condition must be so severe that he or she cannot learn. Tibbetts (2013) indicates that the purpose of this characteristic is to allow for a comprehensive evaluation to determine the reason for such an inability to learn. A student may meet eligibility for one of the other special education categories, such as Intellectual Disability, Specific Learning Disability, Autism, or Other Health Impairment. Disabilities that fall under these categories may also cause a student to have difficulty with learning or have an inability to learn at the same rate as same-aged peers. The inability to learn cannot be determined through observations of the student not completing schoolwork, obtaining failing grades, or daydreaming within the classroom (Slenkovich, 1983). Only through comprehensive assessment of cognitive, academic, social, emotional, and behavioral factors is the school psychologist most accurately able to determine the reason for the student's learning difficulties and determine if an ED is the mitigating factor (Tibbetts, 2013).

Inability to build/maintain relationships. The IDEA definition includes: "an inability to build or maintain satisfactory interpersonal relationships with peers and teachers (IDEA, 2004, Section 300.8, (c)(4)(i)(B)" as a second characteristic of ED. In order to meet this characteristic of eligibility, a student must display difficulty establishing and maintaining relationships both with teachers and with peers within the school setting. Difficulty with peer social interaction alone is not indicative of meeting this ED characteristic (Tibbetts, 2013). Bower (1981) states that interpersonal relationships include the ability to display empathy, the ability to be independent, the ability to develop and to maintain close friendships, the ability to display assertiveness, and the ability to work with others as well as to work alone. According to Slenkovich (1983), this characteristic does not include a student who simply does not have friends, who has a poor relationship with his or her teacher, who makes poor choices in friends, or who is ostracized by his or her peers. Last, according to Tibbetts (2013), in evaluating students, internalizing behaviors such as withdrawal, externalizing behaviors such as aggression, and delays in social development should be exclusionary factors. A student's inability needs to be distinguished from a student's lack of motivation to develop interpersonal relationships, or an inherent lack of social perception or social awareness.

The presence of an ED must prevent the student from entering into relationships with others (Slenkovich, 1983). In making this determination, one should consider whether or not the difficulty results from an acquisition deficit or from a performance deficit. In considering an acquisition deficit, the school psychologist would find that a student is not acquiring skills at the same rate as grade level peers. Thus, the student does not use the skill because he or she does not possess the skill. Conversely, with a performance deficit, the student may actually possess the skill, but does not put it into practice and does not apply it appropriately in social situations (Tibbetts, 2013). Analysis of deficits has important implications for intervention, because students with acquisition deficits versus performance deficits will require vastly different interventions that focus on learning the skills versus initiation and execution of the skills.

Inappropriate types of behavior under normal circumstances. The third characteristic that a child may manifest involves "Inappropriate types of behavior or feelings under normal circumstances (IDEA, 2004, Section 300.8, (c)(4)(i)(C)." The difficulty with understanding this statement lies with the conceptualization and definition both of *inappropriate behavior* and of *normal circumstances*. Slenkovich (1983) indicates that this statement does not include hyperactivity, anxiety, anger, shyness, concerns regarding self-image, or violation of social norms. According to Tibbetts (2013), behavior disorders are excluded from this category. Bower (1981) indicated that a key consideration in making the distinction between children with emotional difficulties and children with abnormal social behavior involves assessing the extent to which a child has behavioral freedom. Behavioral freedom indicates that a child has control over his or her own behavior, and is not affected by internal states of necessity. Further, in considering the meaning of a normal circumstance, a child with a lack of control over his or her own behavior is not functioning within a normal circumstance and will react in what appears to be a disproportionate manner to a simple request (Bower, 1981).

Pervasive unhappiness or depressed mood. Fourth, IDEA states, “A general pervasive mood of unhappiness or depression (IDEA, 2004, Section 300.8, (c)(4)(i)(D)” may be another characteristic of ED. With this criterion, School Psychologists must consider the differences between educational classification and clinical diagnosis, using the DSM-IV-TR. A child must display outward symptoms of depression that differ from sadness as a reaction to situational factors. If it is found that the student does display symptoms due to situational sadness, then he or she should not be considered a student with ED (Tibbetts, 2013). According to Slenkovich (1983), a student’s development of depressive symptoms that are related to family, school, or friendships does not qualify him or her for ED. Likewise, Kelly (1992) indicates that practitioners must refrain from viewing situational unhappiness as being equal to pervasive unhappiness or depression that warrants clinical diagnosis. A student’s unhappiness may result from being unable to obtain successfully what he or she wants, or to self-destructive behaviors that occur for the purpose of obtaining attention. Slenkovich (1983) and Tibbetts (2013) caution against the use of projective assessments or the use rating scales to make this distinction. These types of assessments typically cannot accurately distinguish the difference between symptoms as a typical response to situational factors versus a clinical disorder (Tibbetts, 2013).

Development of physical symptoms or fears. The final characteristic of ED involves, “A tendency to develop physical symptoms or fears associated with personal or school problems (IDEA, 2004, Section 300.8, (c)(4)(i)(E).” There are two considerations within this statement.

The first consideration involves the development of physical symptoms. Under this qualification, the physical symptoms must stem directly from the student’s condition of ED, and not in relation to a primary medical condition. A student may develop symptoms such as headaches, ulcers, or stomachaches that appear to be directly related to stressors in the educational environment (Tibbetts, 2013). Physical problems or fears that exist alone and without an emotional condition do not qualify a student under this characteristic (Slenkovich, 1983). Further, the student's symptoms must appear to be out of his or her control. If the symptoms are suspected to be within the student's control, this may imply a behavioral concern rather than one that qualifies as a manifestation of ED (Tibbetts, 2013).

The second consideration under this statement involves the development of fears related to personal or school factors. In this case, fears include a focus on something unknown that results in an unusual physiological reaction. Fears that are inclusive of ED involve anxiety, social phobia, and panic (Slenkovich, 1983; Tibbetts, 2013). The specific behavioral and physiological reactions exhibited must appear inappropriate or exaggerated to the point of avoidance of the situation, activity, person, or item that seems to be the direct cause (Tibbetts, 2013).

IDEA section II: Inclusions and exclusions.

Schizophrenia. According to IDEA (2004), ED includes Schizophrenia. The diagnosis of Schizophrenia, as outlined in the DSM-IV-TR (APA, 2000), meets the criterion for the presence of symptoms over a long period of time (at least 6 months), and involves delusions, hallucinations, disorganized speech, grossly disorganized or catatonic behavior, and negative symptoms such as flat affect, alogia, or avolition (APA, 2000). This statement appears to be the most operationally defined section of the IDEA criteria for ED because it involves an actual diagnosis that is recognized by medical and clinical professionals.

Social maladjustment. According to IDEA (2004), the presence of Social Maladjustment excludes a student from ED. Thus, an important consideration is whether or not the student's condition is related to ED, or to Social Maladjustment, which is not a special education category. According to Bower (1981), the idea of Social Maladjustment as being an exclusionary factor for ED is not logical because the two conditions typically coexist. Further, Bower (1981) states that if a child has ED due to an inability to learn, an inability to build relationships, inappropriate behavior, pervasive unhappiness, and/or the development of adverse physical symptoms or fears, then one could argue that such a child is also Socially Maladjusted. It is contradictory to operationally define ED according to specific social maladjustments and then to go on to declare those qualifiers as causing the student to be ineligible for services (Bower, 1981).

Skiba and Grizzle (1991) purported that it is important to determine how School Psychologists might rule out Social Maladjustment in determining eligibility for ED. Because there is no operationally defined statement of Social Maladjustment in the federal definition of ED, this becomes quite difficult.

A suggested method for discrimination between ED and Social Maladjustment has been through use of the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association, due to its diagnostic classification system of various types of social, emotional, and behavioral disorders (Slenkovich, 1983). Skiba and Grizzle (1991) indicate that this categorical system could be used to identify children with emotional difficulties as existing separately from children with behavioral difficulties. According to Slenkovich (1983), the law specifically includes an exemption for children who are considered to have a behavior disorder, a conduct disorder, or antisocial behavior. ED results solely from an emotional condition such as severe anxiety (Slenkovich, 1983).

However, the National Dissemination Center for Students with Disabilities (2010), suggests that ED comprises many different disabilities, conditions, and illnesses, including anxiety disorders, mood disorders, conduct disorders, eating disorders, obsessive-compulsive disorder, and other psychotic disorders (NICHY, 2010). Further, Forness and Kavale (2000) state that if students with conduct disorders are denied access to special education services, underlying emotional difficulties such as depression or anxiety may be missed in those students (Forness & Kavale, 2000).

The Emergence of ADHD as a Neurodevelopmental Disorder

With the initial publication of the first Diagnostic and Statistical Manual of Mental Disorders in 1952, before the name "Attention Deficit Disorder" was coined, there were disorders associated with impairment in brain tissue function. These disorders, under which ADHD would likely have fit, involved "emotional conflicts" (APA, 1952, p. 14). However, beginning in the 1960s with the development of the second edition of the Diagnostic and Statistical Manual for Mental Disorders, symptoms related to emotional impulsivity and to difficulties with self-regulation were not included in the diagnostic criteria (Barkley, 2010; APA, 1968). The DSM-II described a disorder called "Hyperkinetic Reaction of Childhood (or Adolescence)" as being characterized by overactivity, distractibility, short attention span, and restlessness (APA, 1968, p. 50). With additional revisions and publication of the DSM-III in 1980, the title "Attention Deficit Disorder" was introduced and could be classified "with Hyperactivity" and "without Hyperactivity" (APA, 1980, p. 41-44). Diagnostic criteria included symptoms related to inattention, impulsivity, and hyperactivity. Associated features were thought to include negativism, increased mood lability, low frustration tolerance, stubbornness, and temper outbursts (APA, 1980). However, these emotional responses were not included as part of the diagnostic criteria. In 1987, with the development of the third edition revised (DSM-III-R), Attention Deficit Disorder was changed to Attention Deficit Hyperactivity Disorder, and a relationship was determined between the symptoms of ADHD and Oppositional Defiant Disorder, a behavioral disorder characterized by a pattern of negative, hostile, and defiant behavior (APA, 2000). The question of differential diagnosis between ADHD and Mood Disorder because of the overlap of symptoms such as psychomotor agitation, inability to concentrate, hyperactivity, and attentional difficulties was posed (APA, 1987). With the fourth edition of the manual in 1994, Attention Deficit Hyperactivity Disorder was classified as having three subtypes, including Predominantly Inattentive, Predominantly Hyperactive-Impulsive, and Combined. Associated features continued to identify low frustration tolerance, temper outbursts, stubbornness, and mood lability. Dysphoria and depressive symptoms were added as associated features. The relationship between Oppositional Defiant Disorder, Mood Disorders, as well as Anxiety Disorders in conjunction with ADHD was further established (APA, 1994).

In the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Revised (DSM-IV-TR), ADHD was categorized as being a disruptive behavioral disorder of childhood manifesting by age seven. Key signs included inattention, disorganization, hyperactivity, and/or impulsivity. The three subtypes of the disorder and potential co-morbidity with Oppositional Defiant Disorder did not change from the DSM-IV publication (American Psychiatric Association, 2000). With the publication of the fifth edition of the DSM in 2013 (DSM-5), ADHD was classified as a neurodevelopmental disorder, and several diagnostic changes were implemented. With the occurrence of ADHD in approximately 5% of children and 2.5% of adults, there is a need to establish symptoms over a continuum. Therefore, the APA (2013) has raised the age of onset of symptoms from age seven to age twelve. This allows a period of time for developmental symptoms to emerge in childhood. Although the subtypes of ADHD remained unchanged, the addition of Other Specified ADHD and Unspecified ADHD was added for those children who demonstrate symptoms but do not meet full criteria for the neurodevelopmental disorder (APA, 2013).

Finally, although it does not affect the diagnostic criteria, the APA (2013) goes into further detail about differential diagnoses and comorbidity. A number of emotional and behavioral disorders are considered for differential diagnosis; these include Oppositional Defiant Disorder (ODD), Intermittent Explosive Disorder, Reactive Attachment Disorder, Anxiety Disorders, Depressive Disorders, Bipolar Disorder, and Disruptive Mood Dysregulation Disorder. It is further noted that comorbidity occurs between ADHD and ODD in about 50% of children with the combined type of ADHD, and approximately 25% of children with the inattentive type of ADHD. Conduct disorder is apparent in about 25% of those children diagnosed with ADHD Combined type. There is also evidence of comorbidity with ADHD symptomatology and disruptive mood regulation disorder, although the prevalence and exact type of ADHD is unknown. Internalizing disorders such as anxiety and major depressive disorder occur less frequently. Intermittent explosive disorders occur occasionally within the adult population (APA, 2013).

Neuropsychology of Emotional/Behavioral Disorders and ADHD

Previous research on students with ED did not consider neuropsychology in making determinations regarding students' social, emotional, and behavioral functioning. In his early research, Bower (1981) stated that evaluators should not reduce a child solely to his or her autonomic nervous system. However, current neuropsychological research has shown a connection between brain-behavior relationships, with evidence in support of cognitive, social, emotional, and behavioral factors as playing a role in the needs of students with ED. NASP (2005) indicates that biological and neurological concerns may be contributing factors in the presenting difficulties of students with ED. Research on the functions of subcortical structures, the differences in the left versus right hemispheres, and on emotional processing is assisting with the understanding of abstract concepts such as cognition, emotions, and behavior, and their collective impact on a student's overall functioning.

Right versus left hemisphere functions. The right and left hemispheres of the brain have been studied in an attempt to determine more accurately the roles that they play in the regulation of various functions of daily life. Although processes of the left hemisphere appear to facilitate language functions and the processing of information using symbols such as letters and words, processes of the right hemisphere appear to be primarily nonverbal, and to be involved in perceptual and problem-solving tasks (Hale & Fiorello, 2004). The right hemisphere seems to have large effects on social, emotional, and behavioral functioning. Understanding of social cues may also involve the use of the right hemisphere, because children with dysfunction in this area often misunderstand or fail to interpret social information accurately (Hale & Fiorello, 2004). Manoach, Sandson, and Weintraub (1995) evaluated patients with previously documented right hemisphere dysfunction. These patients were also found to have social-emotional processing disorders, and significant neuropsychological deficits related to their functional performances.

Neural circuitry. An examination of the systems of the prefrontal cortex and the effects that can be seen in individuals with damage to these areas also shows an established connection between brain function, cognition, emotions, and behavior (Koziol & Budding, 2010). Kolb and

Taylor (2000) indicate that behavioral functioning corresponds with brain functioning, and thus, changes in the brain will result in changes in behavior. In this case, emotion may exist as behavior, including changes in physiology, or overt behaviors such as laughter and physical aggression. Internal states of emotion may present as behavioral affect, and cognition may present as thoughts and perceptions (Kolb & Taylor, 2000).

There is evidence to suggest that emotional behaviors are controlled by neural circuitry of the prefrontal cortex (Kolb & Taylor, 2000; Koziol & Budding, 2010). The dorsolateral prefrontal circuit is highly involved in execution function capacities, such as focusing attention, inhibiting behavior, planning, organizing, and effectively using working memory. Typically, damage to this prefrontal circuit may cause emotional changes such as apathy and depression, or in behavioral changes such as difficulty with focusing attention, a lack of behavioral inhibition, inflexibility, perseveration, and an inability to plan/organize behavior (Koziol & Budding, 2010). Damage to the orbitofrontal circuit of the prefrontal cortex may cause changes in social behavior, and an individual may display emotional and behavioral changes such as irritability, disinhibition, impulsivity, and exaggerated emotionality. Motivation and attentional processes will also be affected by damage to this area (Koziol & Budding, 2010). Finally, damage to the medial frontal circuit in the anterior cingulate of the prefrontal cortex causes emotional changes such as apathy and behavioral changes such as mutism (Koziol & Budding, 2010).

Emotional processing. LeDoux (2000) advocates for a connection between emotion and cognition through a processing approach to the understanding of emotion. He discusses the amygdala as playing a key role in the processing of emotions such as fear; he also explores the idea that such processing can also influence the neuropsychological processes that are mediated by the prefrontal cortex, including attention, perception, and memory.

Social-emotional processing disorder causes difficulty with social relationships, social interactions, social perception, verbal and visuospatial abilities, attention, emotional regulation, and academic achievement (Manoach et al., 1995). Their study of patients aged 14 to 34 with social-emotional processing disorder and documented right hemisphere neuropsychological dysfunction found that these patients had poor emotional functioning, psychiatric difficulties, attention difficulties, and low academic achievement in mathematics. Patients were also suspected to have diagnoses such as Attention Deficit Hyperactivity Disorder, Social Phobia, and Asperger's Syndrome (Manoach et al., 1995).

Current research also supports the contention that some students with neuropsychological deficits that influence their cognitive, social, emotional, and behavioral functioning also have comorbid learning needs (Manoah et al., 1995). Due to basic deficiencies in memory storage, reasoning, and adaptive behavior skills, students may have difficulty with social perception, which subsequently plays a role in the presence of disabilities related to learning (Myklebust, 1975). Further, decreased levels of social competence and increased levels hyperactivity, aggression, depression, and social withdrawal were found in children with comorbid learning needs (McConaughy & Ritter, 1986).

Attentional and executive processes. Neuropsychological factors related to attention and executive processes play a role in an individual's ability to manage daily activities effectively. Zubin (1975) stated that attention is an important pre-requisite for learning and memory. Historical models of attention include multiple factors, with components such as focus/execute, sustain, encode, and shift (Mirsky, 1987; Mirksy, Anthony, Duncan, Ahearn, & Kellem, 1991). According to Mirsky et al. (1991), focus and execute are co-occurring components, with the focus component involving an individual's ability to identify target information for processing, and the execute component allowing the individual to follow through with providing a response. Executive processes, often referred to as executive functions, may assist with these attentional components by allowing multiple cognitive functions to act in conjunction with one another. They are responsible for the organization and processing necessary to engage in goal-directed behavior, thinking, perceiving, and feeling (McCloskey, Perkins, & Van Divner, 2009).

Current neuropsychological research identifies a frontal-subcortical model of attentional and executive processes. This is especially important research for understanding cognitive processes in children with ADHD. The frontal lobes are believed to be the source of one's ability to use attention and executive functions effectively. Three of the frontal-subcortical circuits that drive attention and executive functions are the dorsolateral prefrontal circuit, the orbitofrontal circuit, and the medial frontal circuit, also known as the anterior cingulate circuit (Koziol & Budding, 2010; Miller, 2013). These circuits have been implicated in playing a role in the cognitive processes of children with ED and ADHD.

Specifically, the dorsolateral prefrontal circuit (DLPFC) is implicated in disorders of attention, because lesions in this area typically produce attentional deficits. According to Koziol and Budding (2010), deficits in the DLPFC produce difficulties with selection and maintenance of attention, also known as the focus/execute/selective and sustain components of attention (Mirsky, 1987), Mirsky et al., 1991, & Miller, 2013). Difficulties with the functioning of the DLPFC may produce apathetic emotional response, a lack in initiation of behavior, and problems with shifting attention and with thinking from one item to another (Koziol & Budding, 2010). The DLPFC is also responsible for generation of cognitive activity, including response inhibition, functions of working memory, planning, organization, problem solving, and visuospatial skills (Koziol & Budding, 2010). With lesions or damage to the DLPFC, these neurocognitive functions may be impaired (Koziol & Budding, 2010; Miller, 2013). Neuropsychological evaluation using tasks that directly relate to functions of the DLPFC reveal specific deficits in these areas. Evaluation of patients with frontal difficulties who perform tasks requiring strategic thinking, organization, and planning reveals significantly greater use of random trial and error strategies and significantly more rule violations than those patients who are determined to have no cognitive difficulties (Koziol and Budding, 2010).

The orbitofrontal circuit (OFC) is another of the key frontal-subcortical circuits that may play a significant role in the manifestation of behavioral symptoms and executive function difficulties present with ED and ADHD. The OFC has connections with the limbic system; damage the lateral OFC is known to produce changes in personality. Such changes may include disinhibition of behavior, impulsivity, irritability, emotional lability, inappropriate social behavior, and/or inappropriate emotional response or feelings under normal circumstances (Koziol & Budding, 2010; Miller, 2013). Significant deficits have been found in individuals with right hemisphere orbitofrontal damage in particular. Mychack, Kramer, Boone, and Miller (2001) studied the influence of right frontotemporal dysfunction on social behavior in patients with dementia. The results showed that individuals with right hemisphere dysfunction of this area demonstrated aggression and socially inappropriate behaviors such as poor impulse control and difficulty with modulation of emotional behavior. The researchers stress the impact of the frontal and temporal lobes in the control of mood and behavior, particularly in those with right hemispheric dysfunction (Mychack et al., 2001). There is a tendency to interpret symptoms related to social, emotional, and behavioral functioning strictly within a psychological framework that leads to assumptions regarding psychopathology. Instead, these symptoms may be related to deficits of the OFC (Koziol & Budding, 2010).

The anterior cingulate circuit or medial frontal circuit (MFC) is the final subcortical pre-frontal circuit implicated as having an impact on executive functions. Because this area typically regulates the presence of drive and motivation, lesions or damage to this area often result in apathy (Koziol & Budding, 2010; Miller, 2013). Other behaviors related to problems with the MFC include impulsivity, difficulty with concept generation, difficulty with directing attention, and obsessive-compulsive characteristics (Koziol & Budding, 2010; Miller, 2013). Koziol and Budding (2010) further discuss the difficulty of neuropsychological evaluation with individuals having damage to this area. Because they may perform well on cognitive measures, the difficulties that these individuals experience may be wrongly attributed to psychological or emotional problems. However, research on brain-behavior relationships demonstrates that there is not a distinct separation between cognition and emotion. Problems with motivation and intrinsic drive may be considered executive deficits that are actually related to difficulties within this area of the brain (Koziol and Budding, 2010).

Learning and memory processes. According to Zubin (1975), learning and memory are directly influenced by attention. Further, Koziol and Budding (2010) identify processing as a factor in declarative learning and memory. The basal ganglia play an important role in the learning of new patterns of sequential motor and cognitive behavior through connections with frontal cortical areas. This type of learning is synonymous with the brain's development of habitual behavior (Koziol & Budding, 2010). With the initial learning of a task, one is required to use conscious control and to sustain attention. This necessitates activation of the prefrontal cortical areas, and may depend on executive functions (Koziol & Budding, 2010). However, once the task has been overlearned, it relies on subcortical processing and activity within the prefrontal cortices decreases. Thus two different types of processing, both higher-order control and automatic processing, are necessary for the efficiency of learning and memory. fter automaticity has occurred, the medial temporal lobe memory system becomes involved to facilitate the consolidation of memory processes into long-term memory (Koziol & Budding, 2010; Miller, 2013). The hippocampus, amygdala, and thalamus play a key role in information storage and consolidation. This system allows for later retrieval of information and connection with the prefrontal cortex (Koziol & Budding, 2010).

Internalizing and Externalizing Disorders

Neurobiological correlates. Research has demonstrated that individual brain regions do not correlate with specific diagnoses. Because of the vertical organization of the brain, there are contributions of multiple cortical-subcortical systems (Koziol & Budding, 2010). However, there is emerging research on neuroanatomical differences in individuals with differing diagnoses. Neuroimaging studies of children with depression have found differences in particular brain regions such as the hippocampus, amygdala, and frontal lobes (Teeter et al., 2009). Right and left amygdala volumes were significantly decreased in depressed children as compared with typical children (Rosso et al., 2005).

Further, increased water density in the white matter of children with both internalizing and externalizing disorders, including depression, bipolar disorder, conduct disorder, and ADHD has been found. This is significant because the development of white matter hyperintensities (WMH), specifically within the frontal lobes, is believed to play a large role in the manifestation of cognitive difficulties and psychiatric disorders in children and adolescents (Lyoo, Lee, Jung, Noam, & Renshaw, 2002). Frontal lobe white matter allows for the occurrence of subcortical connections within the brain. In addition, the white matter of the frontal lobe connects to the parietal, occipital, and temporal lobes. Subsequently, WMH may cause difficulties with functions of attention, executive functions, visuospatial skills, and emotional functioning (Filley, 1998).

Neuropsychological profiles. An interesting argument is presented by Koziol and Budding (2010), challenging the validity of the diagnostic criteria used by the DSM-IV-TR. Based on behavioral observations alone, diagnostic labels are placed on individuals; these labels have no correlation to neuropsychological testing or patterns of results. It proves impossible to intermix the two methods of evaluation, and provides a practical problem in terms of accuracy of diagnosis (Koziol & Budding, 2010).

Most recently, differences in cognitive processes such as attention and memory are emerging in patients, depending upon the identified disorder (Semrud-Clikeman & Teeter Ellison, 2009). Kusche, Cook, and Greenberg (1993) divided a sample of children with a mean age of eight years into four groups, that had been identified through elevated scores on the Achenbach Child Behavior Checklist (CBCL); these groups included a control group, anxiety/somatization/withdrawal (internalizing) group, externalizing group, and comorbid group (internalizing and externalizing). The WISC-R Block Design and Vocabulary subtests were utilized to assess cognitive functioning; the WISC-R Coding subtest was used as a measure of nonverbal, visuoperception. Additional areas assessed, using other measures, included recognition of emotions, motor functioning, and executive functions. Classroom behavioral functioning was assessed through teacher rating scales. Results showed that the three clinical groups (internalizing, externalizing, and comorbid) demonstrated significantly lower overall IQ scores, lower scores on nonverbal/visuoperceptual tasks, lower scores on motor tasks, a decreased ability to identify emotions, and decreased use of executive functions as compared with the control group (Kusche et al., 1993).

Analysis of individual groups found that children in the internalizing group displayed deficits in short-term verbal memory, nonverbal concept formation, and overall intelligence. This group did not display problems with attention or speed of processing. Children in the externalizing group showed deficits with overall intelligence, emotional understanding, and general use of executive functions. These children showed little difficulty with verbal short-term memory, but increased difficulty with nonverbal/visuoperceptual tasks. Children in the comorbid group displayed difficulties in all areas of cognitive and neuropsychological functioning that were assessed (Kusche et al., 1993).

Internalizing. Internalizing disorders that manifest in children may include mood disorders such as depression and bipolar disorder, and anxiety disorders, such as generalized anxiety disorder, overanxious disorder of childhood, and obsessive-compulsive disorder (Semrud-Clikeman & Teeter Ellison, 2009). Studies examining the results of neuropsychological testing demonstrate support for the presence of right hemisphere dysfunction in children with internalizing disorders such as depression, bipolar disorder, and anxiety. The right prefrontal cortex, anterior cingulate, parietal cortex, and amygdala are emphasized as playing a role these disorders (Davidson, Abercrombie, Nitschke, & Putnam, 1999).

Attention problems, slower response and reaction times, slower performance on processing speed tasks, problems with new learning, and short-term and long-term retrieval deficits are often seen in children with depression (Semrud-Clikeman & Teeter Ellison, 2009). Although there are minimal studies that have been conducted on the neuropsychological functioning of children with bipolar disorder, preliminary research conducted by Dickstein et al.,

(2004) found that children with this disorder exhibit the greatest difficulties with shifting attention and also with visuospatial memory. Davidson et al. (1999) found that patients with disorders of anxiety, including obsessive-compulsive disorder, phobias, and post-traumatic stress disorder demonstrated significantly higher levels of activation in the right prefrontal cortex than did typical controls. Dencina et al., (1983) found that children with bipolar disorder performed better on verbal than on performance tasks when assessed using the WISC-R. Kaslow, Rehm, and Siegel (1984) found that children with depression performed poorly on the Block Design, Coding, and Digit Span subtests. These findings are of particular importance because right hemisphere dysfunction has been implicated in the presence of difficulties with emotional processing (LeDoux, 2000; Manoach et al., 1995). Lenti, Giacobbe, and Pegna (2000) examined profiles of depressed children in relation to WISC-R verbal and performance scores and ability to identify emotional facial expressions. There were no significant differences on the subjects' verbal and performance scores. However, subjects displayed significant difficulty with identification of emotions using facial expressions of fear and anger. Thus Lenti et al. (2000) demonstrate that the presence of right hemisphere dysfunction may not be identifiable by cognitive assessment alone, and that additional assessment of social-emotional areas is critical with this population.

Externalizing. Externalizing behavior disorders in children often include the manifestation of observable behaviors such as hyperactivity, aggression, and conduct problems. Specific diagnoses related to externalizing disorders may include ADHD, Conduct Disorder, and Oppositional Defiant Disorder; these may be referred to as disruptive behavior disorders (Semrud-Clikeman & Teeter Ellison, 2009). Prefrontal regions play a significant role in the hyperactivity or motor disinhibition, and impulsivity or loss of cognitive control that is often seen in children with ADHD. These children perform poorly on tasks of processing speed, spatial tasks, and tasks related to executive functions or inhibitory control (Semrud-Clikeman, & Teeter Ellison, 2009). These children may perform more poorly than peers without ADHD on IQ testing. This may be related to difficulties with cognitive and executive processes such as working memory, self-monitoring through internalized speech, and verbal fluid reasoning skills. The presence of comorbid symptoms related to Oppositional Defiant Disorder and Conduct Disorder may also exist. Finally, deficits in social skills play a significant role in overall adaptive functioning (Barkley, Fischer, Smallish, & Fletcher, 2006).

Further examination of behavioral disorders such as Conduct Disorder reveals that in addition to behavioral problems, cognitive, nonverbal reasoning, executive function, and language deficits may also be displayed. Intact language abilities may be a prerequisite skill for the ability to monitor and to control one's behavior through use of executive functions. Language difficulties resulting from left-hemisphere dysfunction may also facilitate impulsive behavior in these children (Semrud-Clikeman & Teeter Ellison, 2009). Other research demonstrates that children who are considered to have severe emotional disturbances also have impairments in right frontal areas, as evidenced by weak nonverbal reasoning abilities (Teeter & Smith, 1993).

Assessment of Neurocognitive Factors Related to ED and ADHD

The current view of comprehensive neuropsychological assessment supports the use of neurocognitive domains of functioning in the evaluation of potential neurocognitive deficits. According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM 5), neurocognitive assessment domains such as attention, executive function, working memory, processing speed, expressive and receptive language, social cognition, and perceptual skills are important areas of measurement (APA, 2013). The fields of clinical psychology, school psychology, and neuropsychology are growing closer as the utilization of neuropsychological domains becomes the preferred method of assessment for understanding students' needs. Further exploration of cognitive functions in students with ED and ADHD and how they may affect learning is essential for accurately identifying and servicing these students within schools.

Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). The Wechsler Intelligence Scale for Children (WISC-IV) is an individually administered cognitive assessment battery for children between the ages of 6-16. The WISC-IV comprises 10 core subtests, which define the Working Memory, Processing Speed, Verbal Comprehension, and Perceptual Reasoning Indices, and yields an overall Full Scale IQ (Wechsler, 2003). A unique feature of the WISC-IV is that its composite scores may be separated to remove Working Memory and Processing Speed and still produce an overall General Ability Index (GAI). The GAI may be utilized to produce an overall picture of cognitive ability despite the presence of statistical discrepancies between verbal and nonverbal reasoning abilities versus working memory and processing speed abilities (Raiford et al., 2005). This distinction may prove to be especially useful in the assessment of cognitive abilities for children with ADHD because research demonstrates that children with ADHD display working memory and processing speed abilities that are below their verbal and nonverbal reasoning abilities (Wechsler, 2003). Evidence also exists for connections between differing cognitive factors. According to Fry and Hale (1996; 2000), presented the concept of a developmental cascade, whereby processing speed is mediated by age. As processing speed increases with developmental age, there may be a positive correlation with working memory. In addition, fluid intelligence may increases as these corresponding factors increase (Fry & Hale, 1996; 2000). Kyllonen and Christal (1990) found that working memory and reasoning ability correlate highly with one another (r = .80 to .90). Further, differentiating the factors demonstrated that reasoning also correlated highly with general knowledge, and working memory correlated highly with processing speed (Kyllonen & Christal, 1990).

Processing speed. Processing speed involves measuring one's ability to scan and track visual information with cognitive efficiency (McGrew, et al., 2007). Processing speed involves a timing component and requires the ability to sustain attention, to focus, and to use graphomotor skills effectively (Sattler & Dumont, 2004). Visual scanning, tracking, and processing speed abilities are mediated by the primary visual cortex of the brain, lying within the occipital lobe's striate cortex (Miller, 2013).

Benner, Allor, and Mooney (2008) studied the impact of processing speed on the social adjustment and academic performance of students with emotional and behavioral disorders. The results of the study demonstrated several important findings. First, deficits in processing speed were found in 57% of students that had previously been identified as having an emotional or behavioral disorder. Second, deficits in processing speed directly related to lower performance on tasks of academic fluency, IQ, language, and overall academic achievement. Third, deficits in processing speed and academic fluency skills were able to predict difficulties with social adjustment that were present in students with emotional and behavioral disorders. Benner et al. (2008) stress the importance of further research on the relationship between processing speed, IQ, language, academic fluency, and social adjustment in students identified as having emotional and behavioral disorders.

Perceptual speed or fluency is another aspect related to processing that is understood as an individual's ability to discriminate between visual patterns while simultaneously maintaining attention throughout a timed task (Miller, 2013; Horn & Blankson, 2012). Rate of test taking is measured by one's performance on tests of simple decision-making (Horn & Blankson, 2012). The efficiency with which one can cognitively process information is directly related to mental activity speed (McGrew et al., 2007). Because processing speed tasks are typically timed tasks designed to assess speed and accuracy rather than the learning of new skills, they do not require complex thinking skills (Miller, 2013). Consequently, efficient cognitive processing speed allows for automaticity of responding for simple tasks, item identification and discrimination, so that one's attention can focus on more complex cognitive tasks (Benner et al., 2008; Fry & Hale, 2000). Processing speed ability appears to impact additional cognitive processes significantly; these include perceptual discrimination, motor speed, attention, concentration, visual memory, and visual-motor coordination, as well as academic, social, emotional, and behavioral skills (Sattler & Dumont, 2004).

Benner, Nelson, Allor, Mooney, and Dai (2008) examined the effects of processing speed for academic information in reading, writing, and math on externalizing behaviors, language skills, and academic skills in students with emotional and behavioral disorders. The results of the study found a significant effect ($p<.05$) of externalizing behavior on academic processing speed. Further, they found that both processing speed and language skills had a significant effect on level of academic skills ($p<.05$). In addition, language skills directly affected processing speed ($p<.05$). Externalizing behavior alone did not significantly impact academic skills ($p>.05$). The work of Benner et al. (2008) suggests that students with emotional and behavioral disorders may have more neuropsychological difficulties than previously identified, and therefore highlights the need for comprehensive assessment of neurocognitive domains. The viewpoint that a student's level of skills directly relates to the presence or absence of externalizing behaviors alone ignores the recent neuropsychological research that suggests otherwise.

Working memory. Koziol and Budding (2010) define working memory as the brain's ability to maintain information for a temporary period of time, therefore allowing for some level of task completion. In order to understand the functions of working memory, it is both important and necessary to examine its neuropsychological correlates which originate with the basal ganglia. These basal ganglia, located in the basal forebrain, play a significant role in the workings of motor function, cognition, and behavior (Koziol & Budding, 2010). Composed of multiple structures as well as direct and indirect pathways, the basal ganglia form the foundation for the higher-order cognitive process of working memory. They are highly influential through use of a gating system, which functions to select or disinhibit, and also to inhibit behavior. This means that the basal ganglia have a level of control over directing particular cortical regions to become active or inactive at particular times (Koziol & Budding, 2010). This process begins with the direct pathway, which allows information to be held selectively "online" within the brain; the indirect pathway works simultaneously to inhibit all other information, consequently working to prevent intrusions and distractions. When it is time for its use, the basal ganglia works to disinhibit the information, allowing it to be released; it then updates the remaining information that continues to be held within working memory (Koziol & Budding, 2010). According to Koziol and Budding's (2010) presentation of a working memory model, the system works within itself to hold the information, to release it, and to update, as necessary, the remaining information held online.

However, a second model of working memory is discussed by Baddeley (2003). This model suggests that a central executive system exists to mediate and to direct the overall process of working memory. The central executive was previously believed to be a system that existed for the general processing of information and acted as the attentional control center. Newly presented research by Baddeley (2003) suggests that an episodic buffer exists as a component of the central executive, which allows for storage capacity and also for integration of episodic information. This episodic buffer is controlled by the attentional processes of the central executive, and allows individuals to have conscious access to information in working memory. According to Baddeley (2003), the central executive system and episodic buffer also act in conjunction with two additional subsystems, the phonological loop and the visuospatial sketchpad. The phonological loop is mediated by internal rehearsal of subvocal speech, a process that allows verbal information to be held temporarily in immediate memory. As the amount of verbal information requiring verbal rehearsal increases, the information that is successfully held within working memory decreases, suggesting a limited capacity for verbal information (Baddeley, 2003). The visuospatial sketchpad functions nonverbally to temporarily store the “what” (visual presence) and the “where” (spatial location) of information, including color, location, and shape (Baddeley, 2003).

Verbal comprehension. Verbal Comprehension may be referred to as reasoning that uses language-based abilities involving knowledge and comprehension (Sattler & Dumont, 2004). According to Koziol and Budding (2010), language assists with the organization and acquisition of new information, and allows individuals to think and to use information effectively. The authors present the idea that language and social cognition are complex processes involving both subcortical functions in addition to those requiring higher-order cognitive control. Subcortical structures such as the basal ganglia may assist with the organization of behavioral speech patterns, and the cerebellum serves to temporally organize sound and assists with syllable sequencing. Further, the cerebellum assists with internal mediation of speech. Ullman (2001) describes a declarative/procedural model of language, which relies on the functions of declarative and procedural memory. The declarative memory system assists with learning new semantic and episodic information; the procedural memory system assists with learning new skills related to motor and cognition. This means that the declarative system facilitates storage of information related to facts, events, and knowledge. It also allows for the creation of associations between sounds and words. On the other hand, the procedural memory system assists with rules related to grammar and correct syntax and phonology. The two systems appear to work in conjunction with one another to facilitate the automaticity of language and associated verbal knowledge and comprehension abilities (Ullman, 2001).

Nelson et al. (2006) studied the relationships between externalizing behavior, language skills, academic fluency, and academic achievement in students with ED using the WISC-III Verbal Scale, which included the General Information, General Comprehension, Arithmetic, Similarities, Vocabulary, and Digit Span subtests. Although externalizing behavior did not influence language skills or academic fluency, language skills influenced both academic fluency and overall academic achievement. Although there was no connection in the 2006 study on externalizing behavior and language skills, previous research demonstrates that approximately 45% of children with ED also have deficits in language skills. Specifically, students with ED and externalizing behaviors may display significantly more deficits in receptive and expressive language skills than students with ED and internalizing behaviors (Nelson et al., 2005). Kim and Kaiser (2000) studied the language functioning of children with ADHD versus controls. They found that children with ADHD performed less well in language abilities overall in comparison with the control group. Further analysis demonstrated that children with ADHD were more likely to have deficits in expressive than receptive language skills (Kim & Kaiser, 2000).

Perceptual reasoning. Perceptual reasoning involves the brain's ability to interpret and to organize nonverbal information using visual and spatial perception in order to utilize that information for nonverbal problem solving (Sattler & Dumont, 2004). According to research conducted by Mishkin, Ungerleider, and Macko (1983), there are differing visual pathways related to object and spatial vision. The ventral pathway is related to object vision. It is an occipitotemporal projection system, which follows the inferior longitudinal fasiculus. By connecting the striate, prestriate, and inferior temporal areas, it allows the brain to determine the visual information that it is seeing. Additional links between the limbic structures in the temporal lobe and the ventral portions of the frontal lobe allow for the association of visual objects with emotions and with motor-based actions (Mishkin et al., 1983; Miller, 2013).

The dorsal pathway mediates spatial vision. This pathway of the occipitotemporal projection system follows the superior longitudinal fasiculus. By connecting the striate, prestriate, and inferior parietal areas, it allows for the identification of spatial location of objects. Thus, the dorsal pathway tells the brain where an object exists. Additional links of the occipitoparietal pathway with the dorsal limbic structures and the dorsal frontal cortex may play a role in the development of spatial maps and may visually guide some motor acts (Miskin et al., 1983; Miller, 2013).

Recent research has suggested that there is a connection between right hemisphere dysfunction, nonverbal learning disabilities (NVLD), poor social skills, problems with emotional processing, and visual-spatial deficits in children (Semrud-Clikeman & Hynd, 1990). Children with NVLD have deficits in visual-spatial organization, perceptual skills, psychomotor skills, nonverbal problem solving, and increased levels of psychopathology. Specific visual-spatial deficits may involve the spatial location of objects in space (Forrest, 2004). Gross-Tsur, Shalev, Manor, and Amir (1995) found that right hemisphere syndrome, nonverbal learning disability, social, emotional, and behavioral problems, language problems, and impaired visuospatial skills coexisted in a sample of children. A visuospatial processing disorder can impact many facets of a child's life, including learning, social functioning, and recognition of emotions and facial expressions (Miller, 2013).

ED and ADHD profiles using the Wechsler scales. Research on the cognitive factors of students with ED has focused primarily on use of the WISC-III. Calhoun and Mayes (2005) examined cognitive profiles of 980 children with ADHD and other clinical diagnoses, using the WISC-III. They found that children with ADHD and bipolar disorder demonstrated Full Scale IQ scores that were lower than the overall group mean, and also indicated lower processing speed scores, relative to their verbal and perceptual skills. Subtest analysis revealed that these children performed more poorly on the Coding subtest than on the Symbol Search subtest. Children with depressive disorders also demonstrated lower processing speed scores, but did not demonstrate lower Full Scale IQ scores. Conversely, children diagnosed with Anxiety disorders and Oppositional Defiant Disorder did not demonstrate processing speed weakness. McHale, Obrzut, and Sabers (2003) also studied the relationship between cognitive factors and students with ED, using the WISC-III. The ED population in the study consisted of students with Conduct Disorder and/or displays of aggressive behaviors. Upon initial testing, using the WISC-III, students with ED and/or aggressive behaviors demonstrated verbal reasoning scores (VIQ) lower than nonverbal reasoning scores (PIQ). However, with retesting, these students demonstrated an overall decrease in FSIQ and also in VIQ. The researchers suggested that the cognitive results may have been a function of the presence of aggressive behavior.

More comprehensive research has been conducted using the WISC-IV to examine cognitive profiles of students with ADHD. With the standardization of the WISC-IV, a sample of 45 children between the ages of 8 and 13 with a Learning Disability and with ADHD were assessed (Wechsler, 2003). It was reported that 65% of the children were taking medication for ADHD. The results demonstrated that when compared with the control group, the children with a Learning Disability and ADHD obtained significantly lower scores for FSIQ, VCI, PRI, PSI, and WMI, ($p<.01$). An additional sample of 89 children between the ages of 8 and 13, identified as having only ADHD were assessed. Similar to the LD/ADHD group, approximately 64% were reported to be taking medication for ADHD. The results demonstrated that children with ADHD showed the lowest performance on the PSI ($p<.01$), when compared with controls. Performance on FSIQ and WMI was also significantly lower ($p<.05$). VCI performance demonstrated a small effect size, but PRI was not affected. At the subtest level, significant differences were found on the Coding subtest ($p<.01$), on the PSI, and the Arithmetic subtest ($p<.01$), which is a supplemental WMI subtest. Further subtest analysis found significant differences between children with ADHD and matched controls ($p<.05$) on the core WMI subtests, Digit Span and Letter-Number Sequencing, and a core PSI subtest, Symbol Search (Wechsler, 2003). These findings demonstrate that children with ADHD display the greatest cognitive differences with working memory and processing speed, when compared with typical peers. One limitation of the studies is that the research did not distinguish between the performance of medicated and non-medicated children on the WISC-IV.

Friedman (2006) conducted research similar to that of the WISC-IV standardization study with children with ADHD. However, Friedman's (2006) research distinguished 109 medicated and non-medicated males with ADHD from their matched controls. The results demonstrated no significant differences for FSIQ between groups of children with ADHD and without ADHD. Children with ADHD who were not taking medication demonstrated significantly lower performance on the WMI than those children without ADHD. Subtest analysis revealed that medicated children with ADHD performed significantly better than non-medicated children with ADHD on the Digit Span subtest. In contrast to Wechsler's (2003) research with the WISC-IV standardization, Friedman (2006) did not find significant differences between groups with the PSI. Additionally, there were no significant differences between groups for the VCI or PRI (Friedman, 2006).

McLaughlin (2009) sought to replicate and to expand Friedman's (2006) study, by examining not only significant differences between Index scores, but also the amount of difference between scores. McLaughlin (2009) found results similar to Friedman (2006), with no significant differences between groups for FSIQ, VCI, and PRI scores; however, children with ADHD demonstrated significantly lower WMI and PSI when compared with matched controls (McLaughlin, 2009).

Further analysis by McLaughlin (2009) revealed score splits between the WMI and VCI and the PSI and PRI. Children with ADHD demonstrated better performance on VCI, with greater splits between VCI and WMI. The results indicated that approximately 37% of non-medicated children with ADHD demonstrated a 10-point split between VCI and WMI, but only 21% of the control group demonstrated this same split. Further, the medicated ADHD group demonstrated significantly more 10 and 15-point splits than the control group. Nearly 45% of children medicated for ADHD showed a 10-point split, and nearly 25% of children medicated for ADHD showed a 15-point split between VCI and WMI. In contrast, 14% of the matched control group demonstrated a 10-point split and 10% demonstrated a 15-point split between VCI and WMI (McLaughlin, 2009).

Children with ADHD also demonstrated higher performance on PRI than on the PSI when compared with the control group. Specifically, nearly 43% of medicated children with ADHD demonstrated a 15-point split, versus approximately 20% of matched controls. Approximately 29% of medicated children with ADHD showed a 20-point split, versus 12% of matched controls (McLaughlin, 2009).

The results of McLaughlin's (2009) research provide important implications for further research. This research exemplifies the importance of examining not only group mean differences, but also the relative degree of difference between Indices for the groups. Without such analysis, an understanding of the cognitive profiles of children with ADHD may be flawed.

Wimpenny (2012) continued the research of Friedman (2006) and McLaughlin (2009), with findings indicating that children with ADHD performed significantly lower on FSIQ and on all Index scores with the exception of VCI. Medicated children with ADHD performed better overall than non-medicated children with ADHD. Similar to McLaughlin (2009), Wimpenny (2012) also examined Index score splits. The results revealed that children with ADHD consistently demonstrated higher VCI than WMI scores, and showed more score splits at 10, 15, 20, and 25 points than their matched controls. Examination of the PRI and PSI Indices showed that children with ADHD demonstrated consistently higher PRI than PSI scores, with splits significant at 15, 20, and 25-point differences (Wimpenny, 2012).

Wimpenny (2012) also sought to continue the analysis of the cognitive profiles of children with ADHD at an even greater level, by examining subtest pair score differences. Subtest level analyses revealed that children with ADHD performed better on tasks of verbal reasoning than on tasks related to working memory, and better on tasks of perceptual reasoning than on tasks related to processing speed. Specifically, examination of VCI versus WMI subtests and PRI versus PSI subtests showed that children with ADHD displayed significantly more score splits of 3 and 6 points when compared with matched controls (Wimpenny, 2012). Such in-depth research conducted by Wimpenny (2012) highlights to an even greater degree, the importance of accurate assessment and analysis in order to understand further how ADHD affects cognition in children.

Limited research indicates the potential for lower overall FSIQ, PSI, and VCI scores for children with ED, using the WISC-III. No research could be found, using the WISC-IV that provides information on the cognitive profiles of children with ED. Further, the WISC-IV clinical standardization studies did not include students with ED. More extensive research has been conducted with the WISC-IV on the cognitive profiles of children with ADHD, indicating the potential for differences at the Index and Subtest levels, with the potential for intra-individual splits. The question of whether or not these same score differences and splits exist for children with ED has yet to be explored.

There are two purposes of the current study. First, the current study will conduct research similar to Friedman (2006) and McLaughlin (2009), by examining Index scores to determine overall group mean differences. Second, the current study will conduct research similar to McLaughlin (2009) and Wimpenny (2012), looking for evidence of Index score splits within groups. Looking only at differences for group means alone may cause researchers to miss significant differences that may be evident through a greater in-depth analysis of Index score splits within the groups. Finally, the current study will add a new population to the cognitive profile analyses by examining not only children with ADHD, but also children with ED. Because children with ADHD and ED typically display a high level of internalizing and externalizing symptoms, it will be important to examine both diagnoses to look for similarities and differences. This will assist school psychologists with providing optimal assessment and intervention supports for students with ADHD and ED within school settings.

Chapter 3: Method

Overview

The current study sought to examine the cognitive profiles of students with ED and ADHD, using the WISC-IV Index scores.

Participants

Participants included a total of 58 children between the ages of 6:0 and 16:11 (age limits of the WISC-IV) with ED and/or associated DSM-IV-TR diagnoses and ADHD. Demographic information that was collected included children's age, gender, ethnicity (if known), and current grade. Participants' birthdates were not collected in order protect personally identifying information. Each student's data were assigned an ID number to ensure anonymity.

Inclusion/exclusion criteria. Criteria for inclusion in the study:

1. A child identified as having ED and/or associated DSM-IV-TR diagnosis or ADHD.
2. Scaled scores available for all 10 Subtest scores of the WISC-IV needed to produce Index scores.
3. Children between the ages of 6:0 and 16:11.

Criteria for exclusion from the study:

1. A child not identified as having ED and/or associated DSM-IV-TR diagnosis or ADHD.
2. Scores from some, but not all of the required areas.
3. Children below age 6:0 years old and above age 16:11.
4. Children with comorbid ADHD and ED.

Recruitment

Data were recruited from certified School Psychologists, and were accepted for students identified as having Emotional Disturbance and/or DSM-IV-TR diagnoses such as Oppositional Defiant Disorder, Conduct Disorder, Anxiety Disorders, Mood Disorders, and Depressive Disorders. Data were also accepted from students classified within the school setting as having OHI due to the presence of ADHD symptoms, and/or those students with a DSM-IV-TR diagnosis of ADHD.

Measures and Materials

WISC-IV. The Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV), is an individually administered assessment of cognitive abilities for children between the ages of 6:0 and 16:11. Individual subtest reliability coefficients range from .69 to .92 (Wechsler, 2003).

Full scale IQ. The Full Scale IQ is formulated from the ten subtests that make up the PSI, WMI, VCI, and PRI scores. Reliability coefficients for the FSIQ range from .96 to .97 for ages 6-16, with an overall average of .97.

Processing speed. The Processing Speed Index (PSI) consists of the Coding and Symbol Search core subtests. Reliability coefficients for the Coding subtest range from .72 to .89. Symbol Search reliability coefficients range from .78 to .82. The Index reliability coefficients range from .81 to .90 for ages 6-16, with an overall average of .88.

Working memory. The Working Memory Index (WMI) consists of the Digit Span and Letter-Number Sequencing core subtests. Digit Span may be broken down into Digit Span Forward and Digit Span Backward. Reliability coefficients for overall Digit Span range from .81 to .92; Digit Span Forward ranges from .78 to .88 and Digit Span Backward ranges from .68 to

.86. Reliability coefficients for Letter-Number Sequencing range from .85 to .92. The Index reliability coefficients range from .90 to .93 for ages 6-16, with an overall average of .92.

Verbal comprehension. The Verbal Comprehension Index (VCI) consists of the Similarities, Vocabulary, and Comprehension core subtests. Reliability coefficients for Similarities range from .82 to .89; for Vocabulary, they range from .82 to .94, and for Comprehension they range from .74 to .86. The Index reliability coefficients range from .91 to .95 for ages 6-16, with an overall average of .94.

Perceptual reasoning. The Perceptual Reasoning Index (PSI) consists of the Block Design, Picture Concepts, and Matrix Reasoning core subtests. Reliability coefficients for Block Design range from .83 to .88; for Picture Concepts they range from .76 to .85, and for Matrix Reasoning they range from .86 to .92. The Index reliability coefficients range from .91 to .93 for ages 6-16, with an overall average of .92.

ED and ADHD reliability coefficients. Data on reliability coefficients for children with ED were unavailable. However, a sample of 87 to 89 children with ADHD was assessed using 8 out of 10 core subtests. Reliability coefficients are as follows: unavailable for Symbol Search and Coding, Digit Span (.87), Digit Span Forward (.83), Digit Span Backward (.81), Letter-Number Sequencing (.94), Similarities (.90), Vocabulary (.93), Comprehension (.87), Block Design (.89), Picture Concepts (.82), and Matrix Reasoning (.92).

Variables

Independent variables. The independent variables in this study include diagnostic status (ADHD and ED).

Dependent variables. Dependent variables included the WISC-IV Index scores (i.e., VCI, PRI, WMI, PSI), and the differences or splits between Index scores (i.e., VCI and WMI; PRI and PSI; VCI and PRI; and PSI and WMI).

Overview of the Research Design

Participants were assigned to groups based on diagnosis. Mean scores for each of the Index scores were computed. Mean differences between WISC-IV Index scores (i.e., VCI and WMI; PRI and PSI; VCI and PRI; and PSI and WMI) were calculated for the groups.

Procedure. School psychologists of selected schools were sent a letter requesting participation in the study. The school psychologists recorded WISC-IV test scores and demographic information for ADHD and ED students on a data collection form. The information requested included the following: Standard scores of the 10 core WISC-IV subtests, as well as Index scores; chronological age of the child; grade; gender; ethnicity; and any known diagnoses.

Statistical analyses. To test the first research question regarding mean Index score differences between ADHD and ED groups, Univariate Analysis of Variance (ANOVA) was utilized. This allowed multiple group comparisons to be made, using one dependent variable. In order to examine the second research question regarding the patterns of score differences between Indexes (score splits), cumulative percentages were calculated. Fisher's Exact Test was used to analyze the score differences between the ADHD and ED groups. Calculations for z and p values were made for each pair comparison (VCI>WMI, WMI>VCI, PRI>PSI, PSI>PRI, VCI>PSI, PSI>VCI, PRI>WMI, WMI>PRI, VCI>PRI, PRI>VCI, WMI>PSI, PSI>WMI) at the 10, 15, 20, and 25 point levels. Scores were determined to be significant at $p<.05$, using a two-tailed test. Because some levels of comparison showed n counts of less than 5, an equal proportion of cases was added to enable comparisons between the ED and ADHD groups. The tables shown reflect the actual n counts, because the additional n counts were used only to ensure accurate calculations for proportion of differences between groups.

Chapter 4: Results

Overview

The results of the statistical tests described in the statistical analyses section of Chapter 3 are presented in this chapter. This chapter also includes demographic information about the participants.

Demographics. The sample for this study included a total of 58 male and female children between the ages of 6:0 and 16:11 (age limits of the WISC-IV) with ED and/or associated DSM-IV-TR diagnoses and ADHD. All children had previously been administered the WISC-IV. The total sample was divided into two groups. The first group consisted of 36 participants who had previously been determined to have a diagnosis of ADHD and no additional diagnoses. The second group consisted of 22 participants who had previously been determined to have ED according to a school district evaluation, or who had a qualifying diagnosis other than ADHD. Those children who had comorbid diagnoses of ADHD and ED were not included in the study.

Tables 1-6 provide a summary of the total numbers and percentages of children in the current study within the ADHD and ED sample groups with regard to sample size, grade, age, gender, ethnicity, and special education classifications.

Table 1

ADHD and ED Samples

	Sample	
	ADHD	ED
n	36.00	22.00
%	62.10%	37.90%

Table 2

Frequency Distributions for Grade

Group		1	2	3	4	5	6	7	8	9	10
ADHD											
	n	3.00	2.00	1.00	5.00	6.00	5.00	5.00	6.00	2.00	1.00
	%	8.30	5.60	2.80	13.90	16.7	13.90	13.90	16.70	5.60	2.80
ED											
	n	2.00	4.00	2.00	1.00	0.00	2.00	3.00	2.00	2.00	4.00
	%	9.10	18.20	9.10	4.50	0.00	9.10	13.60	9.10	9.10	18.20

Table 3

Frequency Distributions for Age

		Age										
Group		6	7	8	9	10	11	12	13	14	15	16
ADHD												
	n	2	2	2	5	3	6	5	6	3	2	0
	%	5.60	5.60	5.60	13.90	8.30	16.70	13.90	16.70	8.30	5.60	0.00
ED												
	n	1	4	2	1	1	2	3	1	1	5	1
	%	4.50	18.20	9.10	4.50	4.50	9.10	13.60	4.50	4.50	22.70	4.50

Table 4

Frequency Distributions for Gender

		Gender	
Group		Male	Female
ADHD			
	n	35	1
	%	97.20	2.80
ED			
	n	17	5
	%	77.30	22.70

Table 5

Frequency Distributions for Ethnicity

		Ethnicity				
Group		Unknown	Caucasian (non-Hispanic)	African American	East Indian	Asian
ADHD						
	n	21	9	4	0	1
	%	58.30	25.00	11.10	0.00	2.80
ED						
	n	4	14	3	1	0
	%	18.20	63.60	13.60	4.50	0.00

Table 6

Frequency Distribution for Special Education Classification

		Special Education Classification						
Group		None	ED	OHI	Autism	OHI/ED	ED/Autism	OHI/SLI
ADHD								
	n	3	4	28	0	0	0	1
	%	8.30	11.10	77.80	0.00	0.00	0.00	2.80
ED								
	n	3	14	1	1	1	2	0
	%	13.60	63.60	4.50	4.50	4.50	9.10	0.00

Note. SLI = Speech/Language Impaired

Results of statistical analyses. Tables 7-10 provide the means and standard deviations of each of the four Indexes (VCI, PRI, WMI, and PSI) according to ADHD and ED groups.

Table 7

Verbal Comprehension Index Scores by Group

Group	*M*	*SD*
ADHD	93.94	15.28
ED	104.55	16.82

Table 8

Perceptual Reasoning Index Scores by Group

Group	*M*	*SD*
ADHD	98.94	13.19
ED	102.59	18.06

Table 9

Working Memory Index Scores by Group

Group	*M*	*SD*
ADHD	95.03	10.65
ED	95.23	13.04

Table 10

Processing Speed Index Scores by Group

Group	*M*	*SD*
ADHD	91.78	16.66
ED	87.23	18.93

To test the first research question regarding mean Index score differences between ADHD and ED groups, Univariate Analysis of Variance (ANOVA) was utilized. Table 11 provides ANOVA results within and between the ADHD and ED groups.

Table 11

Analysis of Variance for WISC-IV Index Scores

	$SS_{between}$	SS_{within}	*Df*	$MS_{between}$	MS_{within}	*F*	*Sig*
VCI	1534.59	14113.34	1	1534.59	252.02	6.09	.017
PRI	181.57	12939.21	1	181.57	231.06	0.79	.379
WMI	0.54	7532.84	1	0.54	134.52	0.004	.950
PSI	282.76	17236.09	1	282.76	307.79	0.92	.342

In order to examine the second research question regarding the patterns of score differences between Indexes (score splits), cumulative percentages were calculated. Table 12 provides cumulative percentages of ADHD and ED groups for each pair comparison (VCI>WMI, WMI>VCI, PRI>PSI, PSI>PRI, VCI>PSI, PSI>VCI, PRI>WMI, WMI>PRI, VCI>PRI, PRI>VCI, WMI>PSI, PSI>WMI) at the 10, 15, 20, and 25 point levels. Table 13 provides the n count for Index score differences by ADHD and ED groups.

Table 12

Cumulative Frequency Percentages of Index Score Differences by Group

		Diagnostic Group	
Index Score Differences		ADHD (N=36)	ED (N=22)
VCI > WMI		Cumulative Percentages	
	10 points	27.80	40.90
	15 points	13.90	40.90
	20 points	11.10	36.40
	25 Points	2.80	31.80
WMI > VCI			
	10 points	33.30	4.50
	15 points	22.20	0.00
	20 points	11.10	0.00
	25 Points	2.80	0.00
PRI > PSI			
	10 points	44.40	63.60
	15 points	38.90	50.00
	20 points	25.00	36.40
	25 Points	13.90	27.30
PSI > PRI			
	10 points	16.70	4.50
	15 points	11.10	0.00
	20 points	11.10	0.00
	25 Points	2.80	0.00
VCI > PSI			
	10 points	33.30	68.20
	15 points	25.00	63.60
	20 points	19.40	45.50
	25 Points	8.30	36.40
PSI > VCI			
	10 points	25.00	4.50
	15 points	19.40	4.50
	20 points	16.70	0.00
	25 Points	13.90	0.00
PRI > WMI			
	10 points	30.60	40.90
	15 points	22.20	31.80
	20 points	11.10	31.80
	25 Points	8.30	27.30

		Diagnostic Group	
Index Score Differences		ADHD (N=36)	ED (N=22)
WMI > PRI		Cumulative Percentages	
	10 points	11.10	18.20
	15 points	8.30	13.60
	20 points	0.00	0.00
	25 Points	0.00	0.00
VCI > PRI			
	10 points	22.20	27.30
	15 points	6.70	13.60
	20 points	5.60	9.10
	25 Points	2.80	0.00
PRI > VCI			
	10 points	36.10	13.60
	15 points	27.80	9.10
	20 points	19.40	9.10
	25 Points	11.10	4.50
WMI > PSI			
	10 points	33.30	50.00
	15 points	30.60	27.30
	20 points	27.80	22.70
	25 Points	5.60	9.10
PSI > WMI			
	10 points	27.80	13.60
	15 points	16.70	13.60
	20 points	5.60	4.50
	25 Points	2.80	4.50

Table 13

N Counts of Index Score Differences by Group

		Diagnostic Group	
Index Score Differences		ADHD (N=36)	ED (N=22)
		N Count	
VCI > WMI			
	10 points	10	9
	15 points	5	9
	20 points	4	8
	25 Points	1	7
WMI > VCI			
	10 points	12	1
	15 points	8	0
	20 points	4	0
	25 Points	1	0
PRI > PSI			
	10 points	16	14
	15 points	14	11
	20 points	9	8
	25 Points	5	6
PSI > PRI			
	10 points	6	2
	15 points	4	0
	20 points	4	0
	25 Points	1	0
VCI > PSI			
	10 points	10	15
	15 points	9	14
	20 points	7	10
	25 Points	3	8
PSI > VCI			
	10 points	9	1
	15 points	7	1
	20 points	6	0
	25 Points	5	0
PRI > WMI			
	10 points	11	9
	15 points	8	7
	20 points	4	7
	25 Points	3	6

	Diagnostic Group	
Index Score Differences	ADHD (N=36)	ED (N=22)
WMI > PRI	N Count	
10 points	4	4
15 points	3	3
20 points	0	0
25 Points	0	0
VCI > PRI		
10 points	8	6
15 points	6	3
20 points	2	2
25 Points	1	1
PRI > VCI		
10 points	13	3
15 points	10	2
20 points	7	2
25 Points	4	1
WMI > PSI		
10 points	12	11
15 points	11	6
20 points	10	5
25 Points	2	2
PSI > WMI		
10 points	10	3
15 points	6	3
20 points	2	1
25 Points	1	1

To examine the Index score differences between the ADHD and ED groups further, Fisher's Exact Test was utilized. Calculations for z and p values were made for each pair comparison (VCI>WMI, WMI>VCI, PRI>PSI, PSI>PRI, VCI>PSI, PSI>VCI, PRI>WMI, WMI>PRI, VCI>PRI, PRI>VCI, WMI>PSI, PSI>WMI) at the 10, 15, 20, and 25 point levels. Table 14 provides the z and p values for each of the score differences. Scores were determined to be significant at $p<.05$, using a two-tailed test.

Table 14

Fisher's z Test of Significance for Index Score Differences by Group

		Diagnostic Group	
Index Score Differences		ADHD (N=36) vs. ED (N=22)	
		z value	*p value (two-tailed)*
VCI > WMI			
	10 points	1.03	0.30
	15 points	2.33	0.02*
	20 points	2.33	0.02*
	25 Points	2.33	0.02*
WMI > VCI			
	10 points	-2.26	0.02*
	15 points	-1.67	0.09
	20 points	-0.86	0.39
	25 Points	-0.20	0.84
PRI > PSI			
	10 points	1.42	0.16
	15 points	0.83	0.41
	20 points	0.92	0.36
	25 Points	1.26	0.21
PSI > PRI			
	10 points	-0.65	0.52
	15 points	-0.86	0.39
	20 points	-0.86	0.39
	25 Points	-0.20	0.84
VCI > PSI			
	10 points	3.02	0.00*
	15 points	2.92	0.00*
	20 points	2.11	0.03*
	25 Points	2.33	0.02*
PSI > VCI			
	10 points	-1.67	0.09
	15 points	-1.27	0.20
	20 points	-1.27	0.20
	25 Points	-1.07	0.29
PRI > WMI			
	10 points	0.81	0.42
	15 points	0.81	0.42
	20 points	1.99	0.05*
	25 Points	1.64	0.10

Index Score Differences		Diagnostic Group ADHD (N=36) vs.	ED (N=22)
WMI > PRI			
	10 points	0.57	0.57
	15 points	0.57	0.57
	20 points	0.05	0.96
	25 Points	0.05	0.96
VCI > PRI			
	10 points	0.44	0.66
	15 points	-0.20	0.84
	20 points	0.30	0.76
	25 Points	0.05	0.96
PRI > VCI			
	10 points	-1.67	0.09
	15 points	-1.47	0.14
	20 points	-0.86	0.39
	25 Points	-0.65	0.52
WMI > PSI			
	10 points	1.26	0.21
	15 points	-0.27	0.79
	20 points	-0.43	0.67
	25 Points	0.30	0.76
PSI > WMI			
	10 points	-1.07	0.29
	15 points	-0.20	0.84
	20 points	-0.20	0.84
	25 Points	0.05	0.96

Note. Items with an asterisk are statistically significant.

Chapter 5: Discussion

Summary and Discussion of Results

The current study examined the cognitive profiles of children with ED and ADHD, using WISC-IV Index Scores. This chapter includes a discussion of the results presented in Chapter 4, a comparison with prior studies, limitations, and implications for future research.

The current study utilized the prior research of Friedman (2006), McLaughlin (2009), and Wimpenny (2012), using the WISC-IV Index scores to examine cognitive profiles of children. Although the previous researchers identified clinical (ADHD) and non-clinical (matched controls) participants for their studies, the current study identified solely clinical participants (ED and ADHD). The current study conducted similar analyses by looking for patterns of score differences between clinical groups.

The first research question sought to determine whether or not significant differences exist between the Index scores for children with ED versus children with ADHD. The results demonstrated that there are differences in some, but not all, of the Index score comparisons.

The second research question sought to determine not only which pairs of Index scores were significantly different for the ED versus ADHD groups, but also to determine which pairs demonstrated significant splits for the ED versus ADHD groups.

With the first comparison (VCI-WMI), the ED group demonstrated a statistically significant proportion of difference scores at the 15, 20, and 25 point levels than the ADHD group for VCI>WMI ($p<.05$, two-tailed test). This means that the ED group displayed significant splits more often than the ADHD group, with VCI being greater than WMI. The ED group demonstrated splits at the 15-point level at a cumulative percentage of 40.90% (versus

13.90% ADHD), and at the 20-point level at a cumulative percentage of 36.40%, (versus 11.10% ADHD), and at the 25-point level at a cumulative percentage of 31.80% (versus 2.80% ADHD).

Upon examination of WMI>VCI, the ADHD group had a significantly greater proportion of difference scores than the ED group at the 10 point difference level ($p<.05$, two-tailed test). This means that children with ADHD demonstrated WMI greater than VCI at the 10-point level at a proportion of 33.30% as compared with the ED group, which demonstrated the same level of difference scores at a proportion of 4.50%.

With the next comparison, involving PRI-PSI, there were no statistically significant differences found between the ED and ADHD groups when examined for statistical significance with PRI>PSI and PSI>PRI.

Examination of VCI-PSI in the current study showed that the ED group demonstrated a statistically greater proportion of difference scores than the ADHD group at all levels of comparison (10, 15, 20, and 25) for VCI>PSI ($p<.05$, two-tailed test). This means that the ED group showed greater cumulative percentages of splits, with VCI being greater than PSI at all levels of comparison. The results demonstrated difference scores of 68.20% for ED versus 33.30% for ADHD at the 10-point level; 63.60% for ED versus 25.00% for ADHD at the 15-point level; 45.50% for ED versus 19.40% for ADHD at the 20-point level, and 36.40% for ED versus 8.30% for ADHD at the 25-point level. No statistically significant differences were found between the ED and ADHD groups for PSI>VCI found in the current study.

The next comparison sought to determine differences with PRI-WMI. The ED group demonstrated a statistically greater proportion of difference scores at the 20 point level for PRI>WMI ($p=.05$, two-tailed test). This means that the ED group demonstrated PRI>WMI more often than the ADHD group. This split was demonstrated for 31.80% of children with ED versus

11.10% for children with ADHD. No statistically significant differences were found in the current study between the ED and ADHD groups for WMI>PRI.

The next comparison looked at potential differences for VCI-PRI. There were no statistically significant differences found between the ED and ADHD groups for VCI>PRI or PRI>VCI.

The final comparison examined WMI-PSI difference scores. There were no statistically significant differences found between the ED and ADHD groups for WMI>PSI or PSI>WMI.

Overall, significant differences were found more often with the ED group than with the ADHD group. This is especially meaningful because the ED group had a smaller n count than the ADHD group (ED=22 versus ADHD=36). The ED group demonstrated VCI>WMI at 3 of 4 point levels, VCI>PSI at all 4 point levels, and PRI>WMI at 1 of the point levels.

One explanation for the reason why the ED group demonstrated stronger verbal and non-verbal reasoning abilities than working memory and processing speed abilities may be due to the different brain regions utilized for the different cognitive factors. Working memory and processing speed require the use of the pre-frontal cortex and intact executive function skills, including the ability to sustain attention. Verbal reasoning abilities are known to be controlled by the left side of the brain, typically involved with language; however, non-verbal reasoning abilities are known to be mediated by the right side of the brain, involving perceptual reasoning and visuospatial abilities. Children with ED often display internalizing and externalizing behavioral problems with poor emotional regulation, difficulty with impulse control, and overall self-regulation, which may be more complex than the difficulties displayed by children with ADHD alone.

Comparison to Similar Studies

The current study examined clinical groups (ED and ADHD); Wimpenny (2012), and McLaughlin (2009), however, examined ADHD medicated and non-medicated groups, and compared them with matched controls. To determine how the results of the current study compared with previous similar studies, the current study's ADHD group (n=36) was compared with the ADHD non-medicated and medicated groups, and also the control groups from the Wimpenny (2012) and McLaughlin (2009) studies. Wimpenny (2012) had sample sizes of 50 for both the ADHD non-medicated and matched control groups, and 53 for both the ADHD medicated and matched control groups. McLaughlin's (2009) study had groups similar to Wimpenny (2012), with even larger sample sizes within the groups. McLaughlin (2009) had a sample of 62 non-medicated children with ADHD and 62 matched controls, and 49 medicated children with ADHD and 49 matched controls. McLaughlin's (2009) results examined some of the same Index level comparisons as Wimpenny (2012) and the current study. McLaughlin (2009) did not examine the following comparisons: VCI>PSI, PSI>VCI, PRI>WMI, and WMI>PRI. McLaughlin's study focused more closely on comparisons with the General Ability Index (GAI), which this study did not examine.

In looking at VCI>WMI, the ADHD group of the current study did not reach the same level of index score differences as the ADHD non-medicated and medicated groups in Wimpenny (2012). Although Wimpenny (2012) demonstrated index score differences at the 10-point level of 62.00% and 69.80% for non-medicated and medicated groups respectively, the current study demonstrated 27.80% for the same comparison. The current study's ADHD group demonstrated 27.80% for VCI>WMI at the 10-point level, which was more similar to the matched control groups identified by Wimpenny (2012), (22.00% and 22.60%) at the 10 point level for VCI>WMI. McLaughlin (2009) found that 37.1% of the non-medicated ADHD group demonstrated 10-point differences, and 44.9% of the medicated ADHD group showed the same differences (McLaughlin, 2009).

When considering WMI>VCI, the current study’s ADHD group demonstrated higher levels of difference overall. At the 10-point level of difference, the current ADHD group reached 33.30%, and the prior study by Wimpenny demonstrated 8.00% and 13.20% for non-medicated and medicated ADHD groups, respectively. The current study’s level of difference for the ADHD group was higher than Wimpenny’s (2012) control groups, which demonstrated differences of 22.00% and 24.50% at the 10-point level. McLaughlin (2009) found that the medicated ADHD group demonstrated a 16.3% proportion of difference at the 10-point level. The non-medicated ADHD group did not show any differences when compared with the matched control groups (McLaughlin, 2009).

Upon examination of PRI>PSI, the current study’s ADHD group demonstrated levels of difference similar to those at the 10-point level found by Wimpenny (2012). The current study’s ADHD group demonstrated PRI>PSI at 44.40%; Wimpenny’s ADHD non-medicated group demonstrated difference scores of 40.00% and the ADHD medicated group demonstrated difference scores of 43.40% at the 10-point level. All scores were higher than the proportion of differences found with both control groups, which demonstrated 34.00% proportion of difference at the 10-point level. When examining PRI>PSI, McLaughlin (2009) found that children in the ADHD medicated group showed twice the number of 15-point differences (42.9%) than matched controls. No differences were found between the non-medicated group and the control group.

With the PSI>PRI comparison, the current study demonstrated a higher proportion of difference scores for the ADHD group at the 10-point level (16.70%), than the ADHD non-medicated (6.00%) and the ADHD medicated (15.10%) groups (Wimpenny, 2012). The control groups demonstrated 16.00% and 15.10% proportions of difference scores at the 10-point level. The current study demonstrated results more similar to the control groups. For PSI>PRI, McLaughlin (2009) found that there were no significant differences found between ADHD non-medicated and medicated groups and their matched controls (McLaughlin, 2009).

An examination of VCI>PSI indicated that the current study's proportion of difference at the 10- point level for the ADHD group was found to be 33.30%. This is lower than Wimpenny's (2012) ADHD non-medicated and medicated groups, which demonstrated 52.00% and 54.70% proportions of difference, respectively. The current study's ADHD group demonstrated results that were more similar to the results of the control groups reported by Wimpenny (2012); these were 32.00% and 24.50%.

Similar results regarding the control groups were found with PSI>VCI when comparing the current study's ADHD group with Wimpenny's (2012) ADHD groups. The current study's proportion of difference for the PSI>VCI comparison was found to be 25.00% for the ADHD group. This was more similar to the control groups reported by Wimpenny (2012), at 20.00% and 30.20%, than it was to the ADHD non-medicated (8.00%) and ADHD medicated (11.30%).

With PRI>WMI, all of the groups appeared to perform similarly. The current study found a 30.60% proportion of difference for the ADHD group at the 10-point level. Wimpenny (2012) found that the ADHD non-medicated group demonstrated 28.00% proportion of difference at the same level; the ADHD medicated group demonstrated 30.20% at the same level, and the control groups demonstrated 24.00% and 32.10%.

In looking at the WMI>PRI comparison, the current study's ADHD group demonstrated a lower proportion of difference at the 10 point level (11.10%). Wimpenny (2012) found that the

ADHD non-medicated group demonstrated a 20.00% proportion of difference, and the medicated group demonstrated 17.00% level of difference. The control groups demonstrated even higher levels of difference, at 24.00% and 22.60%.

The current study's VCI>PRI comparison for the ADHD group demonstrated results similar to Wimpenny's (2012) ADHD non-medicated group and also to one of the control groups. The current study found that the proportion of VCI>PRI at the 10-point level was 22.20%; Wimpenny's (2012) ADHD non-medicated group demonstrated 26.00% proportion of difference, and a control group demonstrated 22.00% proportion of difference. The ADHD medicated group in Wimpenny's (2012) study was at 18.90%, and the other control group was at 11.30%. For VCI>PRI, McLaughlin (2009) found that the medicated ADHD group demonstrated a higher percentage of difference scores than matched controls at the 15-point level (McLaughlin, 2009).

The PRI>VCI comparison for the current study's ADHD group found higher proportions of difference than all of the groups in Wimpenny's (2012) study. The current study found PRI>VCI to have a 36.10% proportion of difference at the 10-point level. Wimpenny's (2012) ADHD non-medicated group showed a 10.00% proportion of difference; the medicated group showed a 24.50% proportion of difference, and the control groups both demonstrated a 28.00% level of difference. For PRI>VCI, McLaughlin found that 12.9% of the non-medicated ADHD group demonstrated differences at the 10-point level. There were no significant differences between the medicated ADHD group and matched controls for this comparison (McLaughlin, 2009).

The WMI>PSI comparison appeared to be the most similar of the comparisons between the current study and Wimpenny (2012). The current study found that the ADHD group demonstrated 33.30% proportion of difference at the 10-point level; the ADHD non-medicated, ADHD medicated, and one of the control groups demonstrated a 34.00% proportion of difference. The second control group demonstrated a 20.80% proportion of difference at the 10-point level. In looking at WMI>PSI, no differences were found between ADHD non-medicated and medicated groups and matched controls by McLaughlin (2009).

In looking at the PSI>WMI comparison, the current study demonstrated results that were most similar to one of the control groups in Wimpenny's (2012) study. The current study found a 27.80% proportion of difference at the 10-point level for the ADHD group, and one of the control groups in Wimpenny's (2012) study found a 24.00% difference. The other control group found a 32.10% difference; the ADHD non-medicated group found a 14.00% difference, and the ADHD medicated group found a 15.10% difference. In looking at PSI>WMI, no differences were found between ADHD non-medicated and medicated groups and matched controls by McLaughlin (2009).

Limitations

In comparing the current study's ADHD group with Wimpenny's (2012) and McLaughlin's (2009) ADHD non-medicated and medicated groups and also with matched controls, no clear patterns emerged. Some of the current study's ADHD index level comparisons were more similar to the matched controls; some were similar to prior studies' ADHD groups, and some demonstrated higher difference levels overall than did the prior studies' ADHD groups. There may be several reasons for differences between the studies. First, the current study had a smaller sample for the ADHD group, and the previous studies included greater numbers within the groups. The higher n within each of the groups in the other studies allowed for a greater sample of children than in the current study at each age level. Second, previous studies separated the ADHD groups into non-medicated versus medicated, but the current study did not. This did not allow for direct comparison between groups, because it was not known which children were taking medication or which were not taking medication for the current study. Third, the current study did not utilize matched controls, and even when comparing the current study's ADHD group with prior studies' controls, the subjects cannot be matched. Thus, the ability to make a direct comparison between the groups in the studies does not exist.

There are also limitations of the current study itself. First, the groups were separated according to reported diagnoses of ADHD or ED. Because the researchers relied on the accuracy of reporting, it is unknown whether or not these individuals truly had diagnoses of ADHD or ED. Second, the current study used samples of convenience, and the results should not be overgeneralized. Third, the majority of the sample consisted of males rather than females, and the students were unable to be selected from a wide range of geographic areas. Fourth, the ADHD versus ED groups had a disproportionate number of students (ADHD n=36 versus ED n=22). Many subjects were lost from the ED group due to comorbid diagnoses of ADHD. Fifth, there were limitations within the groups. As previously discussed with the ADHD group, it is not known which subjects were non-medicated versus those who were medicated. The type of ADHD that subjects may have been diagnosed with was also unknown. There may be differences in the cognitive profiles of individuals with inattentive versus hyperactive or combined types of ADHD. With the ED group, a broad range of diagnoses were included in the study, including Oppositional Defiant Disorder, Anxiety Disorders, Mood Disorders, Bipolar Disorder and Depression. A problem that may exist with creating a heterogeneous ED group is that different diagnoses may have cognitive profiles that should not be considered similar, and thus may yield inaccurate results. Internalizing versus externalizing disorders may present with different cognitive patterns. One final limitation of the current study is that there is no prior, similar research examining the cognitive profiles of children with ED. Therefore, it is not known how the current results would compare or if they are accurate.

Implications for Future Research

Future research may seek to examine differences between the cognitive profiles of more clearly defined groups. There continue to be many children classified within schools and are also given clinical diagnoses suggesting ED. However, much remains unknown about the cognitive profiles of these children. Future studies may identify ED groups according to diagnosis, or according to internalizing, externalizing, and comorbid groups. For the ADHD group, future studies may continue to choose to identify whether or not children are medicated, and also to further subdivide the groups into the inattentive, hyperactive, and combined types of ADHD. Identifying such specific groups will require even higher sample sizes for each group. One final suggestion for future research is to study a group of comorbid ADHD and ED students to see how their cognitive profiles may differ from those with ADHD alone or ED alone. Because so much remains unknown about how the cognitive profiles of children with ADHD and ED are similar or are different, it will be important for future researchers to consider the limitations of prior studies and to extend the research that has already been conducted.

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