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Attention Deficit Hyperactivity Disorder with Comorbid Anxiety/Depression in Adults: Impacts on Neuropsychological Functioning

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ATTENTION DEFICIT HYPERACTIVITY DISORDER WITH COMORBID

ANXIETY/DEPRESSION IN ADULTS: IMPACTS ON

NEUROPSYCHOLOGICAL FUNCTIONING

by

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ABSTRACT

ATTENTION DEFICIT HYPERACTIVITY DISORDER WITH COMORBID ANXIETY/DEPRESSION IN ADULTS: IMPACTS ON NEUROPSYCHOLOGICAL FUNCTIONING

Cristina V. Bain
Virginia Consortium Program in Clinical Psychology, 2018
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ADHD comorbidity with other disorders is high in the adult population (over 44% of individuals carry a second diagnosis, 25% anxiety, 18.6% in depression). Separately, these disorders can impact scores on neuropsychological assessments. Little research has investigated how comorbidity among ADHD and other disorders impacts test scores collectively. Given high rates of comorbidity between ADHD and anxiety/depressive disorders and the potential impact on neuropsychological functioning, the current study examined how these comorbid disorders collectively impact cognition. Specifically, the present study investigated differences in full scale intelligence, general ability, and cognitive proficiency on the WAIS-IV between those diagnosed with ADHD only and those who also have a comorbid anxiety/depressive disorder. This study also investigated the impact of these comorbid diagnoses on working memory, processing speed, executive functioning, and inattention/impulsivity. Specifically, this study tested whether the relationship between ADHD and these four outcome variables could be predicted by the presence of a comorbid anxiety/depressive disorder. Results indicated that there were no significant differences between the two groups for full scale intelligence or general ability. Across both groups, participants had lower cognitive processing scores when compared to general ability scores. With regards to the predictive ability of a comorbid diagnosis, only

two of the analyses were significant. The presence of an anxiety or depressive disorder predicted the relationship between ADHD and working memory and a measure of visual scanning, sequencing, and psychomotor speed (Trailmaking A). In other words, scores on these two outcome variables differentiated participants who had a co-occurring anxiety or depression diagnosis from those with only ADHD. This study addresses a gap that exists in the current literature by focusing on ADHD comorbid with other disorders, a highly common occurrence that has been infrequently studied. This study also investigates these disorders in an adult population, contrasting previous research that focused solely on children and adolescent populations.

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CHAPTER I

INTRODUCTION

Although the *Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition,

Text Revision (DSM-IV-TR; American Psychiatric Association, 2000) allowed for the

diagnosis of ADHD in adults, the updated *Diagnostic and Statistical Manual of Mental*

Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013) provides clearer

criteria and information on this disorder in adulthood. According to the DSM-V, ADHD

affects approximately 2.5% of the adult population. There is evidence that prevalence rates

may actually be higher, as adults tend to underreport symptoms of ADHD experienced in

childhood (Barkley, Fischer, Smallish, & Fletcher, 2002) making some ineligible for a full

diagnosis due to diagnostic criteria requiring presence of symptoms prior to age 12

(American Psychological Association, 2013). Research has indicated that there is a

significant rate of symptom continuation and impairment well into adulthood (Mitchell,

Nelson-Gray, & Anastopoulos, 2008). Another issue arising with adults suffering from

ADHD is high comorbidity with other disorders, which presents unique challenges to

diagnosis and treatment (Mitchell, Nelson-Gray, & Anastopoulos, 2008). In addition, these

comorbid disorders also contribute to poorer functioning (Wilens, Biederman, & Spencer,

2002). In adults, as many as 25% of adults with ADHD also meet criteria for an anxiety

disorder (Jarrett & Ollendick, 2008) and 18.6% with ADHD meet criteria for a depressive

disorder (Kessler, et al., 2006).

ADHD

Attention Deficit/ Hyperactivity Disorder (ADHD) was historically regarded as a

childhood and adolescent disorder, impacting 3-5% of children (American Psychological

Association, 1994). More recently, research has conclusively shown that ADHD is a

developmental disorder that, for many, persists over the lifespan (Schmidt & Petermann,

2009). ADHD impacts many areas of functioning, including behavioral, cognitive,

emotional, and neuropsychological (American Psychiatric Association, 1994). The most

commonly associated symptoms of ADHD are related to inattention, impulsivity, and

hyperactivity. These symptoms often lead to difficulties in school, work, social, and family

contexts. According to the DSM-5, diagnosis of ADHD requires a persistent pattern of

inattention and/or hyperactivity and impulsivity that interferes with function and

development. There are specifiers corresponding to the predominant symptoms:

predominantly inattentive presentation, predominantly hyperactive/impulsive

presentation, and combined presentation (American Psychological Association, 2013). See

Table 1 for more information on specific symptoms of ADHD.

Table 1.

Symptoms of ADHD

Inattention	Hyperactivity/Impulsivity
Fails to pay close attention to details or makes careless mistakes in schoolwork, at work, or during other activities	Fidgets with or taps hands or feet or squirms in seat
Difficulty sustaining attention in tasks or play activities	Leaves seat in situations when remaining in seat is expected
Does not seem to listen when spoken to directly	Runs about or climbs in situations where it is inappropriate, is restless
Does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace	Unable to play or engage in leisure activities quietly
Has difficulty organizing tasks and activities	Is often "on the go" acting as if "driven by a motor"
Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort	Talks excessively
Loses things necessary for tasks or activities	Blurts out an answer before a question has been completed
Is easily distracted by extraneous stimuli	Has difficulty waiting his or her turn
Often forgetful in daily activities	Interrupts or intrudes on others

Note. In addition, several of these symptoms must be present prior to age 12 and be present in two or more settings. There also should be clear evidence that the symptoms interfere with individual's ability to function in social, academic, or occupational settings. Lastly, six or more symptoms must be present for six months or longer (American Psychological Association, 2013).

ADHD in Adulthood

Barkley (1998) found that 50-70% of children who experience ADHD in youth

continue to exhibit signs of the disorder in adulthood. While it is clearly a disorder that

persists well beyond childhood or adolescence, ADHD can present differently in adulthood.

Whereas primary symptoms in childhood and adolescence are often related to

hyperactivity and problems in school, for adults, areas of functioning effected include work

and social relationships/partnerships (Soren & Petermann, 2009). While hyperactivity and

impulsivity remain core symptoms of ADHD in adults, they present as feelings of agitation

or attempts to avoid inactive tasks (Burke and Vorster, 2016). Adults may report feeling

restless or overwhelmed, talk excessively, and choose jobs or tasks that require a lot of

energy (McIntosh et al., 2009). Impulsivity can present in different ways as well. Adults

may shift jobs impulsively, drive too fast, or be quick to anger. Inattention may appear in

adults as difficulty reading or keeping up with paperwork, distractibility, forgetfulness,

poor time management, and difficulty finishing tasks (McIntosh et al., 2009).

Although more attention has been given to this disorder across the lifespan, there is

still difficulty establishing prevalence rates in the adult population. One issue is that ADHD

has been previously viewed as a childhood disorder. Another primary issue is the high

comorbidity rates of ADHD with other disorders in adulthood (Burke & Vorster, 2016).

Adults with ADHD have more lifetime psychopathology, with over 87% reporting

symptoms of another psychiatric disorder (McGough et al., 2005). Further, ADHD has been

found to be associated with greater disruptive behavior, substance use, mood and anxiety

disorders, and an earlier onset of major depressive disorder (McGough et al., 2005).

Although present with a number of other psychiatric diagnoses, ADHD has specifically high

comorbidity rates with anxiety and depressive disorders. For this reason, the current study will focus on these disorders co-occurring with ADHD.

Comorbidity with Anxiety/Depression

According to the DSM-5 (American Psychiatric Association, 2013), ADHD comorbidity with depressive and anxiety related disorders is higher than found in the general population. Although no causal link has been demonstrated between ADHD, anxiety, and depressive disorders, it is clear that there is a relation between these areas of psychological functioning and therefore a need for the ability to assess, intervene, and treat the comorbid disorders (Soren & Petermann, 2009). One model used to understand ADHD, executive dysregulation, also offers an explanation of how this disorder would become highly comorbid with anxiety and/or depression. Executive dysregulation posits that individuals with ADHD have poor regulatory control of both inhibition and activation (Brown, 2000). This poor regulation of attention and affect can lead to an increased attention to negative or harmful stimuli and decreased regulation of the accompanying emotional response (Brown, 2000; Scahtz & Rostain, 2006).

Much of the research investigating ADHD with comorbid disorders has focused on child and adolescent populations. In samples of children with ADHD diagnoses, almost 33% also exhibit anxiety related symptoms and up to 52% exhibit depressive symptoms (Managing ADHD Comorbidity, 2007; Mayes, Calhoun, Chase, Mink, & Stagg, 2008; McGough et al., 2005). However, there has been a shift towards focusing on the impact of ADHD with comorbid disorders in adults. Specifically, there is interest in how functioning is impacted in adults who experience ADHD with another psychiatric diagnosis. Some researchers posit that these co-occurring disorders and the effects of the comorbidity are

additive (Geller, Biederman, Faraone, Spencer, Doyle, & Mullin, 2004; King, Waschbusch, Frankland, Andrade, Thurston, & McNutt, 2005). In other words, instead of simply having overlapping symptomology or features, the presence of the two disorders produces distinct effects that happen together. Researchers have identified the need to study the impact of comorbidity on diagnosis, treatment, and outcome in children as well as adults (Brown 2000; Mayes et al., 2008).

Anxiety. ADHD and anxiety disorders are highly comorbid. In some samples, as many as 25% of adults with ADHD also meet criteria for an anxiety disorder (Jarrett & Ollendick, 2008; Schatz & Rostain, 2006). There also appears to be an age-related increase in prevalence rates of anxiety disorders appearing with ADHD (Managing ADHD Comorbidity, 2007). In one study of adults who experienced symptoms of ADHD that persisted from childhood, as many as 40% of men and 50% of women had anxiety disorders (Biederman, Faraone, Spencer, Wilens, Mick, & Lapey, 1994). These findings show that the prevalence rate of anxiety disorders is higher for those with ADHD than those without as prevalence rates based on nationally representative survey data indicate a lifetime prevalence rate of 28.8% for anxiety disorders and 20.8% for mood disorders (Kessler, Berglund, Demier, Jin, Merikangas, & Walters, 2005).

Symptoms of anxiety can often mirror and exacerbate those associated with ADHD. According to the DSM-5, anxiety disorders involve anticipation of a future threat and the accompanying emotional, behavioral, and physiological symptoms (American Psychological Association, 2013). Individuals experience excessive and persistent worry that makes it difficult to maintain control and to concentrate. In addition, individuals likely experience

the physical symptoms of restlessness, difficulty concentrating, irritability, and sleep

disturbance (American Psychological Association, 2013).

      Depression. ADHD and depressive disorders are also highly comorbid. In children,

comorbidity rates are as high as 52% (Mayes et al., 2008). Children who experience both

disorders have also demonstrated greater impairment in social and academic functioning

when compared with controls and those with only ADHD or depression (Blackman,

Ostrander, & Herman, 2005). In a national study of adult ADHD comorbidity, major

depressive disorder had a prevalence rate of 18.6% in adults with ADHD (Kessler, et al.,

2006). This is compared to a prevalence rate of 7.8% in adults without ADHD. Higher rates

of dysthymia were also found. For adults, co-occurring ADHD and depression leads to poor

long-term outcomes, including negative impacts on occupational and social functioning

(McIntosh et al., 2009).

      Like anxiety, symptoms of depression can have an increasingly damaging impact

when combined with those of ADHD. According to the DSM-5 (2013), common features of

depression include sad or irritable mood accompanied by somatic and cognitive changes

that impact functioning. Individuals may experience fatigue and sleep disturbance. They

also are likely to experience difficulty concentrating, maintaining focus or concentration,

and difficulty making decisions. These challenges, combined with symptoms of ADHD, can

prove detrimental to many areas of adult life and ability to function effectively (McIntosh et

al., 2009).

Neuropsychological Impact

ADHD

Some researchers have questioned the utility of neuropsychological assessment in diagnosing ADHD, particularly, the use of executive function measures. However, research has consistently shown that some tests differentiate children with ADHD from controls as detailed below (Pritchard, Nigro, Jacobson, & Mahone, 2012).

Intelligence. While some studies have recently begun to focus on adult ADHD and intellectual functioning, much of the past research in this domain has involved children. This is primarily due to the age of onset of ADHD and the historical view of ADHD as a disorder of childhood and adolescence. Studies have identified that children with ADHD demonstrate lower overall intelligence quotient (IQ) (Lee et al., 2008), working memory, and processing speed scores (Hervey, Epstein, & Curry, 2004; Mayes & Calhoun, 2006; Thaler, Bello, & Etcoff, 2013) when compared to healthy controls. These deficits are consistently able to differentiate those with ADHD diagnoses from those without.

Studies examining the impact of ADHD on Weschler Adult Intelligence Scale- IV (WAIS-IV) scores point to consistent deficits. A meta-analytic review by Bridgett and Walker (2006) found that adults with ADHD have lower WAIS-IV FSIQ scores. The review found that, on average, adults with ADHD have Full Scale Intelligence Quotient (FSIQ) scores that are 2.94 points lower than adults without ADHD. This difference motivated researchers to consider other measures of intelligence, including the General Ability Index (GAI), a measure of intellectual ability that excludes working memory and processing speed subtests. Harrison, DeLisle, & Parker (2008) examined the GAI in adults with ADHD and found significantly higher performance when compared to FSIQ.

In a review by Seidman (2006) 72% of studies that examined cognitive deficits in ADHD found impaired performance on the WAIS-IV, with working memory deficits most prominent. In a 2014 study (Theiling & Petermann), researchers found that adults with ADHD showed significantly lower scores on subtests involving working memory and processing speed when compared to adults with no diagnosis. They also compared the GAI to the FSIQ. Those with ADHD had significantly higher GAI scores when compared to their FSIQ scores, primarily due to the fact that the GAI offers an estimate of general intellectual ability with a reduced emphasis on working memory and processing speed. The authors of this study concluded that the WAIS-IV reliably differentiated between controls and individuals with ADHD and that deficits in those with ADHD were robust and consistent. Lastly, this study provided evidence for consideration of the GAI in patients with ADHD as it may allow for a better understanding of current intellectual functioning in individuals with ADHD.

As a whole, the adult ADHD literature involving WAIS-IV scores demonstrates that this assessment tool clearly discriminates between healthy controls and adults with ADHD. The identification of strengths and weaknesses through this measure is important as it can be useful to facilitate successful intervention (Woods, Lovejoy, & Ball, 2002).

Attention/Impulsivity. Two hallmark symptoms of ADHD include inattention and impulsivity. A type of measure called a continuous performance test has been utilized widely in the assessment and diagnosis of ADHD to assess for deficits in these functioning areas. The continuous performance test is a vigilance task used to study sustained attention and also to assess for any deficits (Ballard, 2001). These tasks typically require individuals to perform a mundane task that requires sustained attention and

inhibition of impulsive responses. On the Gordon Diagnostic System (GDS), which is a continuous performance task used to assess attention deficits and executive functioning skills (i.e. vigilance), children with inattentive symptoms of ADHD had impaired scores related to those without.

In a separate study comparing the scores of adults with ADHD with healthy controls, White, Hutchens, and Lubar (2005) found that those with ADHD demonstrated more impaired performance on the IVA CPT, a continuous performance test used to assess both adults and children. Another similar task, the Conner's Continuous Performance Test, has repeatedly been shown to differentiate ADHD from normal or control groups (Epstein, Erkanli, Conners, Klaric, Costello, & Angold, 2003). In a sample of 817 children, the Conner's CPT consistently differentiated between those with ADHD diagnoses and those without. Children with ADHD consistently made more errors of commission and omission. They also demonstrated more variable reaction times.

Executive Functioning. Executive functioning (EF) is a term used to encompass various complex cognitive processes and sub-processes (Elliot, 2003). Broadly, it refers to the ability to manage cognitive functioning and is defined somewhat differently by various researchers/theories. It is comprised of several different skill areas or domains, including organization/problem solving, time management, emotion regulation, restraint, motivation, set-shifting, activation, working memory, and inhibition (Jarratt, 2015; Stuss & Levine, 2002). EF involves the coordination of various processes, like those listed, to reach a goal in a flexible manner (Funahashi, 2001). When EF systems break down, behavior can become disinhibited and poorly controlled. The coordination of these processes and their cohesive contribution toward a goal are key in understanding the concept of EF.

In a study of 421 college students with a mean age of 18.83, Jarratt (2015) examined ADHD symptoms in relation to EF. Approximately 10% of the sample was taking medication to address their ADHD symptoms at the time of the study. Participants completed self-report measures of ADHD symptomology, anxiety related symptoms, and executive dysfunction. Overall, inattention was found to be strongly related to deficits in executive functioning (Jarratt, 2015). Specifically, inattention was related to deficits in self-motivation, self-organization and problem solving, and emotional control. Hyperactivity/impulsivity was also related to deficits in executive functioning, although to a lesser extent.

These deficits are also found in studies involving children and adolescents. Chhabildas, Pennington, & Willcutt, (2001) found that children with inattention issues related to ADHD displayed impaired processing speed on the Wechsler Intelligence Scale for Children. On the Trails assessment, a measure of executive functioning, children with inattentive ADHD had higher total completion times, suggesting impairment in EF domains such as cognitive flexibility and vigilance. A separate study of children with ADHD found that those with and without hyperactive symptoms performed poorly on the STROOP test compared to controls. In particular, the clinical groups demonstrated deficits on interference portions of the test (Barkley, Grodizinsky, & DuPaul, 1992). Overall, executive functioning measures have consistently been used with those with ADHD and have offered interesting findings on specific deficits. Research suggests that using neuropsychological test batteries, rather than individual measures, offers a more sensitive and specific approach to diagnosis of ADHD (Pritchard, Nigro, Jacobson, & Mahone, 2011).

Depression and Anxiety

      Intelligence. Depression and anxiety have been found to impact intellectual testing in several ways. One study (Hill, Smitherman, Pella, O'Jile, & Gouvier, 2008), which examined the impact of self-reported depression and anxiety on the third edition of the WAIS (WAIS-III), found that scores on the Working Memory and Processing Speed indices successfully differentiated between those with symptoms and healthy controls. Deficits in these two areas of the WAIS were more significant for individuals who reported depressive symptoms. A significant weakness of this study was that depressive and anxiety symptoms were self-reported, and no diagnosis was necessary for inclusion in the clinical subgroups. This finding was, however, consistent with other research indicating deficits in working memory on neuropsychological testing for those with DSM diagnosed depressive symptoms (Castaneda et al., 2008). A more recent study (File, 2013) examining working memory differences between healthy controls and depressed individuals found that performance deficits were present on all Working Memory Index subtests for those who reported depressive symptoms. A 2010 review (Marzatti, Consoli, Picchetti, Carlini, & Faracelli, 2010) of cognitive impairment in major depression also highlighted consistent deficits in full scale IQ scores for depressed individuals, primarily due to deficits in working memory and attention.

      In a study (Butters et al., 2011) focusing on individuals with Generalized Anxiety disorder (GAD), deficits were also demonstrated between clinical group functioning and healthy controls. Utilizing the WAIS-III as part of a testing battery to examine working memory and processing speed, participants with a diagnosis of GAD performed poorly and significantly worse than those without GAD. The authors concluded that GAD is associated

with neuropsychological impairments and that further research should investigate how other anxiety disorders and related symptoms impact functioning.

Attention/Impulsivity. Deficits in attention and impulsive behavior/thinking can have numerous causes. In addition to ADHD, depression and anxiety have been found to impact these areas of functioning (White, Hutchens, & Lubar, 2005). Continuous performance tests have consistently shown that individuals with anxiety and depression demonstrate deficits in areas attention and impulsivity. In a study comparing performance among depressed individuals (n= 33) to healthy controls (n=33), researchers found that those with depression performed significantly worse on the Continuous Performance Test-Identical Pairs (CPT-IP; Mohn & Rund, 2016). This task requires participants to respond only when two identical stimuli appear during rapidly flashing trials of numerical strings. There was a strong correlation between severity of depressive symptoms and scores on the continuous performance test, with those with more severe symptoms demonstrating larger deficits.

Similar deficits have been found among individuals with anxiety disorders. Ballard (2001) reviewed continuous performance test literature and concluded that those with diagnoses of ADHD, anxiety, depression, and PTSD all demonstrated significantly impaired performance on these measures. Another study examined continuous performance test results among children with anxiety (n= 158). Utilizing the Conner's CPT, researchers found that those with cognitive anxiety, characterized by worrying and oversensitivity, performed more poorly on this measure when compared to those without anxiety (Epstein, Goldberg, Conners, & March, 1997). This finding was especially true for male children.

Executive Functioning. Executive dysfunction appears to be a key factor in individuals with depressive disorders (Castaneda et al., 2008) regardless of age (Marazziti et al., 2010). In a review of research (Castaneda et al., 2008) involving young adults with depressive disorders in inpatient and outpatient settings, researchers concluded that the majority of studies found deficits in most areas of executive functioning compared to healthy controls. Measures of EF that showed impairment for depressed individuals include the Trail Making Test (TMT), Controlled Oral Word Association Test (COWA), and the Wisconsin Card Sorting Task (WCST; Castaneda et al., 2008).

In a comprehensive population based study of cognitive functioning in adults with depressive disorders, Airaksinen and colleagues (2004) used the Trail Making Test and a measure of verbal fluency, among other tests. Their large sample consisted of adults aged 20 to 64 years with MDD (n = 68), dysthymia (n = 28), mixed anxiety-depressive disorder (n = 25), minor depression (n = 66), and a group of healthy control participants (n = 175). Overall, the researchers found that depressed individuals as a whole were impaired on a measure of mental flexibility (Trail Making Test Part B), but perceptual motor speed (Trail Making Test Part A) and verbal fluency were not affected by depression. Additionally, individuals with minor depression did not have significantly impaired scores.

Lastly, in a study comparing 30 depressive out-patient participants to 38 healthy controls (Den Hartog, Derix, Van Bemmel, Kremer, & Jolles, 2003), depressed individuals demonstrated cognitive deficits in the automatic processing of words and colors on the Stroop Color Word Test compared to healthy controls. The authors concluded that individuals with depression had impairment in efficient information processing.

Similar deficits in executive functioning have been found in young adults with anxiety and, more specifically, panic and obsessive compulsive disorders (OCD; Boldrini et al., 2005). In a sample of 55 adults (25 with OCD, 15 with panic disorder, and 15 healthy controls), those with OCD demonstrated significant deficits on EF measures including the COWA. The authors concluded that this suggested deficits in the EF domains of cognitive flexibility and verbal fluency. However, researchers (Airaksinen, Larsson, & Forsell, 2005; Castaneda et al., 2008) argued that more research is needed on various subtypes of anxiety as most previous work has focused on trauma related anxiety and obsessive compulsive disorders.

Jarratt (2015) found that executive functioning deficits, as measured by self-report questionnaires, were significantly related to anxiety symptoms. Deficits were demonstrated across executive functioning domains, including time management, problem-solving, restraint, and emotional regulation. Similar results were found by Airaksinen and colleagues (2005) who found that anxiety related symptoms were associated with significant impairments in executive functioning. In this study, a sample of 112 individuals who met DSM-IV criteria for an anxiety disorder were administered EF measures. These scores were then compared to the performance of a control group of 175 people with no current psychiatric disorder or history of mental illness. On the Trail Making Task, there were no significant differences in psychomotor speed (Part A) between those with anxiety disorders and those without. Overall, those with anxiety disorders needed significantly more time to complete Part B, a complex set-shifting task than control participants. More specifically, individuals with panic disorder and OCD were slower than controls, while individuals diagnosed with specific phobia, social phobia, or generalized anxiety disorder

(GAD) were not. However, further analyses suggested this impairment may have been related to alcohol use. Individuals taking medication for anxiety were slower to complete Trail Making Test Part B than individuals with anxiety, but not taking medication and control participants; the latter two groups were not significantly different. They also found impairment in verbal fluency among those with social phobia, while individuals with panic disorder, specific phobias, and GAD were not significantly different from control participants. The authors concluded that this suggests obvious deficits in psychomotor speed and verbal fluency in individuals with anxiety disorders (Airaksinen et al., 2005).

Lastly, previous research has suggested that anxiety impacts executive functioning by interfering with cognitive processing (Eysenck, Derakshan, Santos, & Calvo, 2007). Anxiety impacts efficient functioning of individuals' goal directed attentional system. By decreasing attentional control, anxiety has adverse impacts on the EF domains of inhibition and set shifting.

Comorbid ADHD and Depression/Anxiety

There is a paucity of research investigating how disorders comorbid with ADHD impact neuropsychological test performance. Some of the research investigating comorbidity between ADHD and depression/anxiety disorders involves children and adolescents. Tannock, Ickowicz, and Schachar (1995) investigated the impact of ADHD medication on working memory functioning in children with anxiety and ADHD. When compared to children with only an ADHD diagnosis, the comorbid group had significantly lower scores on measures of working memory. After introducing stimulant medication, working memory improved in the nonanxious ADHD group but not in the comorbid group. The researchers suggested that these findings indicated that ADHD comorbid groups

constitute a distinct subtype of those with ADHD and that further research should

investigate the neuropsychological impacts of these co-occurring disorders (Tannock,

Ickowicz, & Schachar, 1995).

One study investigated the relationship between ADHD and anxiety related

symptoms in emerging adults (Jarrett, 2015). In a sample of 421 college students, ranging

in age from 17-21, researchers assessed executive functioning, via self-report, in those with

ADHD, those with anxiety, and those with comorbid ADHD and anxiety. Results indicated

that executive functioning skills were more significantly impaired in participants with

comorbid disorders. Further, those with ADHD and anxiety demonstrated increased

difficulties with self-regulation, self-organization, and problem solving. These difficulties

fall in the domains of executive functioning and working memory. The researcher

indicated the need for further assessment of these comorbid disorders in adults to allow

for better understanding of deficits and a more tailored approach to intervention.

The Current Study and Hypotheses

The purpose of the present study is to enhance understanding of how comorbid

ADHD and depression/anxiety disorders impact neuropsychological functioning.

Specifically, the present study investigates differences in full scale intelligence, general

ability, and cognitive proficiency on the WAIS-IV between those diagnosed with ADHD only

and those who also have a comorbid anxiety/depressive disorder. This study also

investigates the relationship between comorbid diagnoses and working memory,

processing speed, executive functioning, and inattention/impulsivity. Specifically, this

study tests the effects of working memory, processing speed, executive functioning, and

inattention/impulsivity on the likelihood that participants have a comorbid anxiety or depression disorder.

This research contributes to the literature by examining how comorbid ADHD and anxiety/depressive disorders impact cognitive functioning in an adult population. This study addresses a gap in the literature by focusing on ADHD comorbid with other disorders, an occurrence with a high prevalence rate but one that has been infrequently studied. This study also investigates these disorders in an adult population, contrasting previous research that focused solely on child or adolescent populations.

Fostering a better understanding of the relationship between these disorders, specifically when comorbid, can inform clinical interventions as well as future research endeavors. Based on the rationale featured above, this study will investigated differences between those with ADHD only and ADHD with a comorbid depressive/anxiety disorder in areas of cognitive ability, including full scale IQ, general ability, and cognitive proficiency. The study also tested whether the presence of a comorbid anxiety or depression disorder could be predicted from participant's scores on measures of working memory, processing speed, executive functioning, and inattention/impulsivity. The following hypotheses were be tested:

- H1. Adults with a comorbid anxiety/depressive disorder will have lower FSIQ and GAI when compared with those who have ADHD only.
- H2. Adults in both groups (adults with ADHD comorbid and ADHD only) will demonstrate lower CPI scores when compared to the GAI scores (H2.a.). CPI will be lower in the ADHD comorbid group when compared to the ADHD only group (H2.b.).

- H3.   Test scores on measures assessing working memory (H3.a.), processing speed (H3.b.), executive functioning (H3.c.), and attention/impulsivity (H3.d.) will predict the presence of a comorbid anxiety or depression disorder.

CHAPTER II

METHOD

Participants

Data was accumulated from archival testing records from the neuropsychology clinic at a large academic medical center in the mid-Atlantic United States. All participants are adults referred for neuropsychological testing to further evaluate for the presence of an attention related disorder. Only participants over the age of 18 and without any comorbid cognitive disorder were considered for this study. Testing occurred between 2007 and 2016. Data available for each participant was drawn from the intake history form, initial intake session, neuropsychological testing scores, and the final report. This study utilizing this testing data was approved by the committee on human subjects research prior to data extraction and analysis. The study participants were divided into two groups, those with ADHD only and those with ADHD and a comorbid anxiety/depressive disorder. Groups were divided based on the clinician's diagnosis, which is based on the clinical interview, patient history, behavioral observation, and test scores. Additional measures used in diagnosing ADHD included the Wender Utah Rating Scales (WURS; (Ward, Wender, & Reimherr, 1993) and Conners Adult ADHD Rating Scale-Self Report: Long Version (CAARS-S:L; Conners, Erhardt, & Sparrow, 1999). Measures used to diagnose anxiety and depression related symptoms include the Beck Anxiety Inventory (BAI; Beck & Steer, 1993) and the Beck Depression Inventory Second Edition (BDI-II; Beck, Brown, & Steer, 1996).

To evaluate the minimum sample size needed for this study power analyses were conducted. Using G*Power, a power analysis for the ANOVA was completed (Faul, Erdfelder, Buchner, & Lang 2009). This analysis was used to compare differences between

those with ADHD only and those with ADHD and a comorbid anxiety/depressive disorder on several neuropsychological assessments. With an α of .05, a sample size of 208 participants achieves a power of .95. With an α of .05, a sample size of 128 participants achieves a power of .8.

To test the third hypothesis, binary logistic regression was utilized. Using G*Power, a power analysis for an a priori logistic analysis was calculated. With an α of .05, a sample size of 145 participants achieves a power of .95.

A total of 141 participants were included in the study based on the previously discussed inclusion criteria. Data were then examined for missing values. Due to the analyses to be utilized, cases were only excluded if scores necessary for hypotheses proposed were missing. In total, 12 participants were excluded due to missing data bringing the sample to 129.

Demographics. Demographic variables of participants are displayed in Table 1. Participants' ages ranged from 18 to 67, with a mean age of 32.76 years. The sample was predominantly Caucasian (76.7%) and African American (17%) with the remainder identifying as Hispanic (7%) and Asian (6%). The sample was almost evenly split among male (45.7%) and female (54.3%) participants. Education level varied from 7 years to 20 years, with an overall average of 13.82. The majority of participants were single (58.1%), with the rest either married (34.9%) or divorced (7%). Of the 129 participants, 56 were on a psychoactive medication at the time of testing. Of those, 29 (52%) were on medication to treat anxiety or depression symptoms, 21 (38%) were on medication to treat ADHD symptoms, 5 (9%) were on medication for pain, and 1 (1%) was on a sleep medication. In

total, 80 participants carried a comorbid anxiety or depression diagnosis while 49 only

received an ADHD diagnosis.

Table 2

Demographic Variables of Participants

Variable	N	Percentage
Gender		
Male	59	45.7
Female	70	54.3
Ethnicity		
Caucasian	99	76.7
African American	17	13.2
Hispanic	7	5.4
Asian	6	4.7
Marital Status		
Single	75	58.1
Married	45	34.9
Divorced	9	7

Measures

      Demographic Information. Participants were asked to report demographic information on the intake form and during the initial interview. Information gathered includes age, race, ethnicity, gender, marital status, current medication use, and highest education level attained.

      Premorbid Functioning. In order to estimate cognitive abilities, the Test of Premorbid Functioning (TOPF) was used (Psychological Corporation, 2009). This assessment is a revised version of the Wechsler Test of Adult Reading (WTAR; Wechsler, 2001) and provides an estimate of an individual's premorbid cognitive and memory functioning. The TOPF is based on a reading paradigm (Psychological Corporation, 2009). It requires participants to read and pronounce words that have unusual or irregular grapheme to phoneme transitions (Psychological Corporation, 2009). The total score is the number of words correctly pronounced. An estimated WAIS-IV FSIQ is obtained based on demographic information and test score.

      Intellectual Functioning. Intellectual functioning was assessed using the Wechsler Adult Intelligence Scale- Fourth Edition (WAIS-IV; Wechsler, 2008). The WAIS-IV provides several different scales that measure different areas of intellectual ability. General intellectual functioning is expressed in a Full Scale Intelligence Quotient (FSIQ), with four specific cognitive areas represented by separate index scores: Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Working Memory Index (WMI), and Processing Speed Index (PSI; M=100, SD=15). All index scores contribute to the FSIQ. Several subtests (M=10, SD=3) then make up each index score. In this study, two other index scores will be utilized. One is the General Ability Index (GAI), which measures general mental ability

(Wechsler, 2008). This index is derived from the core VCI and PRI subtests. It is useful as it provides a measure of general mental ability with a reduced emphasis on working memory and processing speed (relative to the FSIQ). In contrast, the Cognitive Proficiency Index (CPI), as developed on the Wechsler Intelligence Scale for Children-Fourth Edition (Wechsler, 2014), will be derived from WMI and PSI subtests (Wechsler, 2008). This index represents an individual's proficiency at cognitive processing. This study will use the FSIQ, GAI, and CPI.

  Executive Functioning. Several measures were used to assess executive functioning. The Controlled Oral Word Association test (COWA; Benton, 1969) measures both verbal fluency and executive functioning. In this task individuals are given one minute to spontaneously generate words that begin with a certain letter for three trials. Test-retest reliability for this assessment falls between .70 and .88 (Spreen & Straus, 1998). Internal consistency was also high (α =.83; Ruff, Light, Parker, & Levin, 1996). For the current study the internal consistency was α =.77. The total score is the number of words generated across all trials.

  The Stroop Neuropsychological Screening Test (SNST; Trennery, Crosson, DeBoe, & Leber, 1988) measures response inhibition and selective attention. During the Color Task, the individual reads aloud a list of color names as quickly and accurately as possible. In the Color-Word Task, the individual names the color of the ink in which the color names are printed, which is not congruent with the printed word, as quickly and accurately as possible. Test-retest reliability is strong (α= .90) for this measure. The score used was the total score for the Color-Word Task.

The Trail Making Test (Army Individual Test Battery, 1944) measures executive functioning domains of cognitive flexibility, divided attention, and visual tracking (Reitan, 1992). The task consists of two parts, A and B, with each part timed by the test administrator. In part A, individuals are tasked with connecting numbered dots in numerical order. In part B, the task is slightly more complex and requires individuals to connect dots alternating between letters and numbers (i.e. 1-a, 2-b, 3-c; Retain, 1992). Reliability coefficients for both tasks A and B fall between .60 and .90 (Spreen & Straus, 1998). The Trail Making Test also demonstrates strong interrater reliability (Trails A= .94, Trails B= .90; Fals-Stewart, 1992). The scores used were T scores based on the individual's total time to complete each part.

Attention/Impulsivity. The Integrated Visual and Auditory Continuous Performance Test (IVA+Plus; Sanford & Turner, 2004) was developed to assess sustained attention and impulsivity via a mundane automated task (Sanford & Turner, 2004; Arble, Kuentzel, & Barnett, 2014). The task requires participants to monitor information presented both visually and auditory. They are tasked with responding to predetermined target stimuli while at the same time refraining from responding to distractor stimuli (Arble, Kuentzel, & Barnett, 2014). The measure provides scores for inattention and impulsivity for both visual and auditory attention (Sanford & Turner, 2004). The IVA + Plus continuous performance task has strong empirical support for its clinical sensitivity and validity in measuring attentional functioning (Tinius, 2003; White, Hutchins, & Lubar, 2005).

CHAPTER III

RESULTS

Preliminary Analyses

Preliminary analyses assessed for missing data, outliers, coding errors, and assumptions of statistical analyses. Individuals who were missing necessary data points were removed from analyses, with 12 cases removed. See table 3 for average scores for measures.

An initial cross tabulation analysis was computed to determine if there was a difference between the groups based on level of education attained, current medication use, and estimated full scale intelligence quotient. There were no outliers in the data utilized for this analysis, as assessed by inspection of a boxplot. Variables were normally distributed across both ADHD and ADHD comorbid groups, as assed by Shapiro-Wilks' test (p>.05). There was homogeneity of variances for highest education level (p=.966), medication use (p=.786), and estimated full scale IQ (p=.171) for both ADHD and ADHD comorbid groups, as assessed by Levene's test for equality of variances. There were no significant differences between groups based on education level or estimated full scale IQ. There was a statistically significant difference in medication use among ADHD only and ADHD comorbid groups, X^2(1,129)=7.25, p< .05). Due to this difference between groups, medication use was used as a covariate in statistical analyses.

Hypothesis One

We hypothesized that there would be significant differences between groups based on both FSIQ (H1a) and GAI (H12), with the ADHD comorbid group having lower scores on

Table 3

Average Scores for Test Measures

Variable	ADHD Only (*n* = 49)	ADHD with Comorbid Disorder (*n* = 80)	Total (*N* = 129)
Intellectual Ability			
FSIQ	102.04 (13.61)	100.68 (14.59)	101.19 (14.19)
GAI	103.43 (14.95)	105.41 (16.05)	104.66 (15.61)
CPI	97.96 12.35)	94.85 (11.89)	96.03 (12.12)
PSI	96.82 (12.47)	95.15 (13.24)	95.78 (12.9)
WMI	100.22 (12.59)	94.44 (14.25)	96.64 (13.89)
Executive Functioning			
COWAT	46.36 (9.38)	44.08 (10.13)	44.94 (9.88)
SNST	95.67 (19.13)	88.94 (20.66)	91.50 (20.82)
Trailmaking A	47.57 (10.39)	43.89 (10.25)	45.29 (10.42)
Trailmaking B	48.41 (11.57)	46.41 (10.39)	47.17 10.86)
Attention/ Impulsivity			
IVA FSRCQ	75.87 (24.11)	73.59 (22.82)	74.50 (23.22)
IVA FSAQ	57.77 (30.01)	60.09 (31.97)	59.15 (31.13)

Note: Intellectual ability and Attention/Impulsivity scores are standard scores with a mean=100, SD=15. The COWAT and Trailmaking tests utilize T scores with a mean=50, SD=10. SNST scores are raw scores for time. Standard deviations presented following each value in parenthesis.

both indices when compared to the ADHD only group. In order to evaluate the first hypothesis regarding the differences between the two groups (ADHD only and ADHD comorbid) an analysis of covariance (ANCOVA) was conducted. Assumptions were tested prior to analysis. There was a linear relationship between variables across both groups, as assessed by visual inspection of a scatterplot. There was homogeneity of regression slopes as the interaction term was not statistically significant, $F(1,125)= .131$, $p= .718$. Standardized residuals were normally distributed, as assessed by Shapiro-Wilk's test ($p>.05$). There was homoscedasticity, as assessed by visual inspection of the standardized residuals plotted against the predicted values. There was homogeneity of variances, as assessed by Levene's test of homogeneity of variance ($p= .765$).

There was one outlier for FSIQ, and this value was Winsorized (Wilcox, 2005) to the next highest value on the scale. For the ANCOVA, the grouping variable was based on diagnosis (ADHD only and ADHD comorbid). The dependent variables were FSIQ (H1a) and GAI (H1b). Current medication use was included as a covariate. There was no significant difference in FSIQ scores between the two groups, $F(1,126)=.673$, $p= .413$, partial $\eta^2=.005$. There was also no significant difference in GAI scores between the two groups $F(1,125)=.303$, $p= .583$, partial $\eta^2=.009$.

Hypothesis Two

Hypothesis two posited that across both groups, ADHD only and ADHD comorbid, participants would have lower Cognitive Proficiency Index (CPI) scores when compared to their General Ability Index (GAI) scores (H2.a.). It was also hypothesized that the ADHD comorbid group would have lower CPI scores when compared to the ADHD only group

(H2.b.). To test these hypotheses a one sample T-test and Analysis of Covariance were utilized.

The first part of hypothesis two (H2.a.) was addressed using a one sample T test. Prior to data analyses assumptions were tested. The test scores (CPI and GAI) represent independent scores and variables are appropriate for this analysis. No significant outliers were detected as assessed by inspection of a boxplot. CPI and GAI scores were normally distributed, as assessed by Shapiro-Wilk's test (p> .05). As predicted, CPI was significantly lower than GAI scores, t(128)= 89, p< .001. Across both groups the average CPI score was 96.03, while the average GAI score was 104.66.

To test the second part of the hypothesis (H2.b) we utilized an Analysis of Covariance. Assumptions were tested before data analysis. The independent variable of group membership is categorical and the two groups were independent of each other. Test observations were also independent. There was a linear relationship between the covariate (medication use) and CPI scores as assessed by a visual inspection of a scatterplot. There was homogeneity of regression slopes as the interaction term was not statistically significant, F(1, 125)= 1.39, p= .241. Standardized residuals for the groups were normally distributed, as assessed by Shapiro-Wilk's test (p> .05). There was homoscedasticity, as assessed by visual inspection of the standardized residuals plotted against the predicted values. There was homogeneity of variances, as assessed by Levene's test of homogeneity of variance (p= .662). No outliers were detected. After adjustment for medication use, there was not a statistically significant difference in CPI scores between the ADHD only and ADHD comorbid groups, F(1,126)= 2.337, p= .129, partial η^2 = .018.

Hypothesis Three

Lastly, it was hypothesized that test scores measuring several different areas (working memory, processing speed, executive functioning, and attention/impulsivity) would predict the presence of a comorbid anxiety or depression disorder. To test all parts of this hypothesis (H3.a., H3.b., H3.c., H3.d.), binary logistic regression was utilized. This analysis tested the relationship between ADHD diagnosis, presence of a comorbid anxiety/depressive disorder, and predictor variables. Outcome, or dependent, variables included in this analysis included group membership, either to the ADHD only group or the ADHD comorbid group. Predictor variables include working memory (H3.a.), processing speed (H3.b.), executive functioning (H3.c.), and inattention/impulsivity (H3.d.)

Prior to analyses assumptions were tested. Linearity of the continuous variables with respect to the logit of the dependent variable was assessed via the Box-Tidwell (1962) procedure. A Bonferroni correction was applied using all fifteen terms in the model resulting in statistical significance being accepted when $p < .00333$ (Tabachnick & Fidell, 2007). Based on this assessment, all continuous independent variables were found to be linearly related to the logit of the dependent variable. The logistic regression model was statistically significant, $\chi^2(14) = 24.502$, $p < .05$. Nagelkerke equals 26.7% of the variance in diagnoses and correctly classified 64.9% of cases. Sensitivity was 46.7%, specificity was 77.3%, positive predictive value was 58.3% and negative predictive value was 68%. Of the six predictor variables only two were statistically significant: Working Memory Index and Trailmaking A (as shown in Table 2). Individuals with lower Working Memory Index scores were 14.64 times more likely to feature an anxiety or depression diagnosis than those with higher scores. Lower Trailmaking A scores, a measure of executive functioning,

was associated with an increased likelihood of an anxiety or depression diagnosis in

addition to ADHD.

Table 4

Logistic Regression Predicting Likelihood of Comorbid Anxiety/Depression Diagnosis based on Working Memory, Processing Speed, and Executive Functioning

Variables	*B*	SE	Wald	*Df*	*p*	Odds Ratio	95% CI for Odds Ratio	
							Lower	Upper
WMI	.035	.018	3.93	1	.047*	1.04	1.00	1.07
PSI	-.025	.020	1.57	1	.210	.975	.938	1.01
COWA	.003	.021	.025	1	.874	1.00	.963	1.05
TrailA	.047	.023	4.06	1	.044*	1.05	1.00	1.09
TrailB	-.025	.024	1.08	1	.299	.976	.931	1.02
Stroop	.017	.012	2.03	1	.154	1.02	.994	1.04
Constant	-4.206	1.82	5.35	1	.02	.015		

Note: * $p < .05$.

CHAPTER IV

DISCUSSION

This study tested differences in several areas of neuropsychological test scores between those diagnosed with ADHD only and those diagnosed with ADHD and a comorbid anxiety or depressive disorder. With regards to intellectual ability, this study examined scores for full scale intelligence, general ability, and cognitive proficiency. Hypotheses predicted lower full scale intelligence and general ability scores for those with ADHD and a comorbid anxiety or depressive disorder compared to those with ADHD alone. It was also hypothesized that cognitive processing scores would be lower than general ability scores for both groups, with a greater difference between the two for those with a comorbid disorder. Working memory, processing speed, executive functioning, and inattention/impulsivity scores were also examined. This study examined whether the relationship between ADHD and the scores in these domains was differentiated by the presence of a comorbid anxiety or depressive disorder. Hypotheses predicted that scores on measures assessing working memory, processing speed, and executive functioning would predict the presence of a comorbid anxiety or depressive disorder. Specific findings will be presented for each set of outcome variables. A general discussion of overall findings, limitations, and future directions for research follows.

FSIQ and GAI

In contrast to the hypotheses, the present study provides no evidence for difference in full scale intelligence and general ability between those with ADHD only and those with a comorbid anxiety or depressive disorder. As this is the first known study to explore the differences between these scores in individuals with ADHD and a comorbid disorder, these

results, while not supportive of the first hypothesis, represent a novel contribution to the understanding of how a comorbid disorder may or may not impact different areas of cognitive functioning and intellectual ability.

CPI and GAI

Results demonstrated that across both groups cognitive processing scores were significantly lower than general ability scores. This is consistent with the findings of other studies (e.g., Harrison, DeLisle, & Parker, 2008) which found that cognitive processing scores for those with ADHD were significantly lower than general ability scores, the latter of which places less focus on tasks involving working memory and processing speed. Results did not support the second part of the hypothesis. No difference was found between cognitive processing scores for the ADHD only and ADHD comorbid group. Contrary to what was hypothesized, the addition of a comorbid disorder was not associated with significantly lower cognitive processing scores.

Working Memory

Consistent with hypotheses, working memory scores predicted group membership, either ADHD only or ADHD comorbid. Lower working memory scores were associated with a significant likelihood of the individual having a comorbid anxiety or depressive disorder. Although deficits in working memory for those with ADHD is widely supported by research, the additional impacts of a comorbid anxiety or depression disorder have not been examined in adults. The results found in the present study are consistent with similar findings of more significant deficits in working memory ability in children with ADHD and anxiety (Tannock, Ickowicz, and Schachar, 1995). These findings add to the understanding

of how the collective impact of ADHD and a co-occurring anxiety or depressive disorder can impact an individual's functional ability.

Processing Speed

No significant effects were found for processing speed. Processing speed scores did not significantly predict whether or not an individual had a comorbid anxiety or depressive disorder. Previous research has shown that ADHD (e.g., Thaler, Bello, & Etcoff, 2013), anxiety (e.g., Butters et al., 2011), and depression (e.g. Hill et al., 2008) all independently are associated with impaired processing speed. However, this study was the first to look at the potential combined impact of ADHD and a comorbid anxiety or depressive disorder on processing speed. Results indicated that there was no significant difference in deficits observed in those with only an ADHD diagnosis and those with co-occurring anxiety or depression.

Executive Functioning

To assess executive functioning skills several measures were utilized, including the Controlled Oral Word Association Test (COWA), Stroop Neuropsychological Screening Test (SNST), and Trailmaking Tests A and B (TMT). Of these measures, only Trailmaking A significantly predicted whether a participant had a comorbid anxiety or depressive disorder. Trailmaking A measures visual scanning, sequencing, and psychomotor speed. Trailmaking B adds a component of set switching. This finding is in contrast to a previous study that found that depressed individuals performed more poorly on Trailmaking B (Airaksinen et al., 2004). The present study provides a unique and novel finding that shows that Trailmaking A is a tool that can successfully differentiate between individuals with ADHD only and those with a comorbid anxiety or depressive disorder.

Attention/Impulsivity

Similar to processing speed, no significant effects were found for attention/impulsivity. Research has shown deficits in attention/impulsivity for individuals with ADHD (e.g., White, Hutchins, & Lubar, 2005) and for individuals with anxiety (e.g., Ballard, 2001) or depression (e.g., Mohn & Rund, 2016). However, the results of the present study indicated that there were no significant differences in deficits observed in those with only an ADHD diagnosis and those with co-occurring anxiety or depression.

In conclusion, there were no significant differences between the two groups for full scale intelligence or general ability. Across both groups, as expected, participants had lower cognitive processing scores when compared to general ability scores. With regards to the predictive ability of a comorbid diagnosis, only two of the analyses were significant. The presence of an anxiety or depressive disorder predicted the relationship between ADHD and working memory and a measure of visual scanning, sequencing, and psychomotor speed (Trailmaking A). In other words, scores on these two outcome variables differentiated participants who had a co-occurring anxiety or depression diagnosis from those with only ADHD.

Strengths of the Current Study

This study investigated differences in full scale intelligence, general ability, and cognitive proficiency on the WAIS-IV between those diagnosed with ADHD only and those who also had a comorbid anxiety/depressive disorder. This study also examined the impact of these comorbid diagnoses on working memory, processing speed, executive functioning, and inattention/impulsivity. Though a growing body of literature examined the neuropsychological impacts of co-occurring disorders, this study was among the few to

explore these variables in a sample of adults with ADHD and comorbid anxiety or depressive disorders to inform whether insights from clinically-based research can be translated to useful information to aid in the assessment, diagnosis, and understanding of these frequently co-occurring disorders. Given the high occurrence of comorbidity between these disorders, it is critical that they are studied in terms of their combined impact on an individual's functioning. While the body of research provides a solid understanding of the ways ADHD, anxiety, and depression can impact functioning in a number of ways, there is less scientific investigation into how these disorders intersect to create new and potentially greater challenges for the individual.

Specifically examining the impact of these disorders in an adult population is another strength of the current study. ADHD has traditionally been viewed as a developmental disorder impacting children and adolescents, with many of the commonly viewed consequences related to school performance. However, research has indicated that for most this disorder persists over the lifetime (Schmidt & Petermann, 2009). Difficulties related to the symptoms of ADHD are present in work, social, and family contexts in addition to the more commonly noted educational impacts (American Psychiatric Association, 1994). The current study addresses a gap in the literature, which has mostly focused on the ways ADHD and other comorbid disorders impacts the functioning of children and adolescents.

Although this study utilized existing medical and assessment records, there was a wide array of information available and accessible for each individual, including multiple measures, demographic information, medications, and detailed background information. The ability to have such in depth information available, even in a study that utilized

archival records, was helpful in allowing for appropriate analyses to answer the research questions. Executive functioning, for example, is a term used to encompass various cognitive processes (Jarratt, 2015) and having multiple measures of executive functioning allowed for a more in depth look into different skill areas or domains.

Limitations

A number of study limitations must be considered when interpreting the findings. This study could have benefited from a larger sample. The participants included for analysis in this study were pulled from archival records from a neuropsychology clinic at a large academic medical center in the mid-Atlantic United States. Participants were included after meeting a set of inclusion criteria related to age, other diagnoses, and availability of test scores needed for analyses. Overall, the study featured data for 129 participants. Preliminary power analyses indicated that with an α of .05, a sample size of 208 participants achieves a power of .95 and that with an α of .05, a sample size of 128 participants achieves a power of .8. A larger sample size would have allowed for more power in analyses and a broader understanding of the clinical impacts of these disorders on neuropsychological functioning. Another limitation related to the sample is the distribution of groups. Of the records reviewed and included in this study, 80 carried a comorbid diagnosis while 49 received only an ADHD diagnosis. While this is reflective of the overall prevalence of these disorders co-occurring with one another and the need for research examining this occurrence, it would have been preferred for the two groups to mirror each other more closely in size. The sample for this study also featured more females, which is likely reflective of the higher base rates for anxiety and depression among women as compared to men (Castanega et al., 2008).

The current study could also have benefited from more detail surrounding specific symptoms of anxiety and depression that each participant experienced. Group membership was based on diagnoses following neuropsychological assessment. This assessment consisted of a clinical interview, review of patient history, behavioral observations, and test scores. Utilizing these components, diagnoses were made in the clinician's best judgement. Several measures were used to assess ADHD, anxiety, and depressive symptoms, including the Wender Utah Rating Scales (WURS; (Ward, Wender, & Reimherr, 1993), Conners Adult ADHD Rating Scale-Self Report: Long Version (CAARS-S:L; Conners, Erhardt, & Sparrow, 1999), the Beck Anxiety Inventory (BAI; Beck & Steer, 1993), and the Beck Depression Inventory Second Edition (BDI-II; Beck, Brown, & Steer, 1996). While the components of the evaluation were sufficient in providing the clinician enough information to make informed diagnoses, from a research perspective it would have been beneficial to have more detail regarding types of symptoms experienced and the individual's perception of the impact of those symptoms. This would have allowed for further analyses exploring questions related to the impact of certain types of symptoms over others (i.e. externalizing vs internalizing). Another useful piece of information would be the age of diagnosis for ADHD, any anxiety, and/or depressive disorder. This information would have allowed for further consideration of the longevity and chronicity of symptoms and impact on neuropsychological functioning.

Implications for Assessment and Intervention

Consistent with other studies of the neuropsychological impact of anxiety, depression, and ADHD (Jarrett, 2015), the current study found deficits present in those with ADHD and a co-occurring anxiety or depression disorder. Differences were found in

areas of functioning depending on the presence of comorbid disorders or the presence of only ADHD. For assessment purposes, clinicians conducting testing on those with a diagnosis of ADHD should, as previous research has indicated, expect lower cognitive processing scores. In addition, clinicians assessing those with a co-occurring anxiety or depressive disorder should assess for more pronounced deficits in working memory and measures of visual scanning, sequencing, and psychomotor speed. The current research findings indicate that the combined impact of these commonly co-occurring groups of disorders impacts these areas specifically.

In terms of intervention, clinicians can work with their patients to address the more pronounced deficits that likely exist with the presence of ADHD and an anxiety or depressive disorder. By further understanding the impact of these disorders on working memory, clinicians can target this deficit by working with patients on specific strategies. This may include using visual prompts or reminders, encouraging "chunking" of information, utilizing visual memory, or making information that they would like to remember multisensory. Clinicians can help individuals cope with the impact of these disorders on their daily functioning.

Future Directions

This study highlights the importance of considering the combined impact of dual diagnosis, specifically when it comes to ADHD and anxiety or depressive disorders. Working memory is a complex function that plays an integral role in comprehension, learning, and reasoning (Theiling & Petermann, 2014). Given the important and complex role of working memory, the deficits found in those with ADHD and a comorbid anxiety or depression disorder can impact the individuals' daily functioning, experience of mental

health symptoms, and treatment efficacy. More research is needed to evaluate the impact of the deficits found in this study that exist in those with these co-occurring disorders. Further studies can explore if and how these deficits impact treatment, and how clinicians can take these deficits into account to alter treatments to be more efficacious.

This study was limited by the smaller sample size and the use of archival data. Due to the nature of the data, analyses were limited to those utilizing existing test measures. Future research that uses non-archival data would benefit from more thorough assessment of symptoms and also from gathering qualitative data from participants about their experience of their disorders and related deficits. This additional information would allow for a more in depth look at how these co-occurring disorders present and also how they impact functioning.

CHAPTER V

CONCLUSION

The present study examined differences in several areas of neuropsychological test scores between those diagnosed with ADHD only and those diagnosed with ADHD and a comorbid anxiety or depressive disorder. With regards to intellectual ability, this study examined scores for full scale intelligence, general ability, and cognitive proficiency. Working memory, processing speed, executive functioning, and inattention/impulsivity scores were also examined. This study examined whether the relationship between ADHD and the scores in these domains was differentiated by the presence of a comorbid anxiety or depressive disorder. There were no significant differences between the two groups for full scale intelligence or general ability. Across both groups, participants had lower cognitive processing scores when compared to general ability scores. With regards to the predictive ability of a comorbid diagnosis, only two of the analyses were significant. The presence of an anxiety or depressive disorder predicted the relationship between ADHD and working memory and a measure of visual scanning, sequencing, and psychomotor speed (Trailmaking A). In other words, scores on these two outcome variables differentiated participants who had a co-occurring anxiety or depression diagnosis from those with only ADHD.   Future research would benefit from a larger sample size and, if utilizing non-archival data, more specific measures that would assess specific symptoms experienced, severity, and gather qualitative data about the individuals' experience of these co-occurring disorders.

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SELECTED PRESENTATIONS

Bain, C.V., Arevalo, M., and McSwain, E. (April 2018). *A Group Based Harm Reduction Approach to Veterans' Alcohol Consumption in Primary Care*. Presented at the meeting of the Virginia Academy of Clinical Psychologists, Roanoke, VA.

Bain, C.V. (April 2015). Panel Discussion: *Graduate School: How to get in and what to expect.* Presented at the meeting of the Virginia Psychological Association, Norfolk, VA.

Bain, C.V., Lau-Barraco, C., and Linden-Charmichael, A. (November 2015). *Risk Perception Mediates the Relationship Between Drinking Norms and Alcohol Outcomes in Men*. Presented at the meeting of the Association for Behavioral and Cognitive Strategies, Philadelphia, PA.