Gender Differences in Self-Reported Symptomatology and Working Memory in College Students with ADHD

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Abstract

The purpose of this study was to examine gender differences in self-reported symptomatology and working memory (visuospatial and auditory) in college students with Attention Deficit Hyperactivity Disorder (ADHD). Forty-seven college students with ADHD and 44 non-affected control participants completed two self-report questionnaires and six tests of auditory and visuospatial working memory. For self-report measures, we found significantly larger differences in self-reported inattention and internal restlessness between female participants with and without ADHD than between male participants with and without ADHD. In working memory, regardless of diagnosis, women significantly outperformed men on one test of visuospatial working memory. Women with ADHD had more difficulty than their non-affected peers on one test of auditory working memory but, surprisingly, men with ADHD performed better than their comparison peers on this measure. Our results indicate that gender may interact with an ADHD diagnosis to impact both subjective and objective symptomatology of the disorder.

Keywords: Attention Deficit Hyperactivity Disorder, college student, working memory, gender differences, self-reports

Attention Deficit Hyperactivity Disorder (ADHD) is usually diagnosed in childhood but often persists across the lifespan, with numerous implications for adulthood (Babinski, et al., 2011; Barkley, 1998; Barkley, Murphy & Kwasnik, 1996; Cahill, et al., 2012; Reimer, Mehler, D'Ambrosio, & Fried, 2010; Shekim, Asarnow, Hess, Zaucha & Wheeler, 1990; Waite, 2007; Yen, Yen, Chen, Tang & Ko, 2009). ADHD affects between 2% and 11% of the college student population (DuPaul, Weyandt, O'Dell & Varejao, 2009; Weyandt & DuPaul, 2008). College students who are diagnosed with ADHD are at increased risk of being placed on academic probation, having a lower grade point average, experiencing more academic problems, and failing repeatedly than students without this disorder (Blase et al., 2009; Heiligenstein, Guenther, Levy, Savino & Fulwiler, 1999; Norvilitis, Sun & Zhang, 2010; Norwalk, Norvilitis & MacLean, 2009). Because young adults with ADHD are enrolling in postsecondary education in increasing numbers despite their academic struggles (Dipeolu, 2011; DuPaul et al., 2009; Weyandt & DuPaul, 2008), gaining a better understanding of how ADHD affects young adult college students will equip both the students who are seeking a collegiate education and the universities mandated by law to help them (Americans With Disabilities Act Amendments Act, 2008; Section 504 of the Rehabilitation Act, 1973) with the information they need for these students to find success in the college classroom.

One area that has received less attention than warranted in the literature is the examination of potential gender differences in symptomatology in college students with ADHD. Gender differences in this population have possible implications for educational and social outcomes, especially for females with ADHD (Cahill, et al., 2012; Rucklidge & Tannock, 2001; Yen et al., 2009). Traditionally, most of the diagnostic and interventional research on ADHD has focused on young boys with the disorder (Gershon, 2002; Rucklidge, 2006; Rucklidge & Tannock, 2001; Waite, 2007). The extent to which the findings of these studies generalize to older college students and to women with ADHD is, thus, an empirical question. Past studies have revealed that adolescent females with ADHD report more overall distress, anxiety, and depression; a more external locus of control; and more

conduct, cognitive, and hyperactivity symptoms than their peers who do not have ADHD (Rucklidge & Tannock, 2001). Additionally, parents and teachers describe girls with ADHD as having more difficulties in attention, hyperactivity, oppositional behaviors, conduct problems, social skills, anxiety, and depression than controls (Rucklidge & Tannock, 2001). Similarly, when adult women with ADHD were asked about their childhood, they reported their childhood relationships with others (teachers, parents, peers) more negatively than controls, felt less in control when faced with difficulties, and tended to demonstrate a "learned helplessness" attributional style (Rucklidge & Kaplan, 2000). Thus, many of the symptoms documented in males with ADHD appear to apply to females as well and many of the internalizing symptoms, impairments in relationships, and tendencies to underachieve in everyday contexts have been shown to persist beyond adolescence into adulthood (Babinski, et al., 2011).

Although the overall symptoms may be similar across females and males with ADHD when compared to their non-affected peers, most past research has documented different characteristics in females and males with ADHD when they are compared to one another. When examining the types of symptoms typically displayed by females versus males, past studies have revealed that females with ADHD are often less hyperactive and demonstrate significanlty fewer externalizing problems than their affected male peers (Gaub & Carlson, 1997; Gershon, 2002). At the same time, females with ADHD tend to show more inattention and internalizing problems, such as depression and anxiety, than males with ADHD (Gershon, 2002; Rucklidge & Tannock, 2001; Waite, 2007), except when they are part of nonreferred populations (Gaub & Carlson, 1997). Most of these studies have focused on children with ADHD. A study by DuPaul and colleagues (2001) did not find gender differences in self-reported symptoms of university students across three different countries, although they focused on the general population of college students rather than those diagnosed with ADHD. These researchers raise the possibility that gender differences may be less prevalent in higher-achieving populations, although advancing age may also reduce differences between males and females (Du Paul, et al., 2001). Lee, Oakland, Jackson and Glutting (2008) also examined prevalence rates of ADHD symptomatology in the general population of college freshman. They found differences between male and female college freshman, with male college freshmen reporting more inattention and combined symptoms than female college freshmen, but the effect sizes were considered small.

Less research has focused on gender differences in the cognitive symptomatology associated with ADHD. Some studies have revealed that girls with ADHD fare more poorly intellectually than boys with ADHD (Gaub & Carlson, 1997; Gershon, 2002), but others have not supported this contention (Rucklidge, 2006; Rucklidge & Tannock, 2001). Rucklidge and Tannock (2001) administered the Wechsler Intelligence Scale for Children-Third Edition, as well as academic achievement measures, to adolescent boys and girls with and without ADHD. Girls with ADHD performed more poorly than their non-affected female peers on tasks involving processing speed, reading, spelling, and arithmetic. They also displayed poorer vocabulary scores than boys with ADHD, although they outperformed boys with ADHD in processing speed. In a later study, Rucklidge (2006) found that both male and female adolescents with ADHD were impaired compared to their non-affected peers in naming, processing abilities, and inhibitory processes. However, the two gender groups did not differ from each other across a large battery of neuropsychological tests except that boys with ADHD were more impaired than girls with ADHD on two measures involving response inhibition. These results supported an earlier study by the same research group (Rucklidge & Tannock, 2002), which also found that adolescents with ADHD showed deficits in processing speed, naming, behavioral inhibition and response consistency relative to controls, but that boys and girls with ADHD did not differ from each other in their cognitive abilities.

One area of common difficulty for young adults with ADHD is working memory. Working memory is the capacity to simultaneously store and manipulate information (Baddeley, 2003). This ability is responsible for the short-term storage and online manipulation of information necessary for higher cognitive functions particularly in the presence of distractions (Baddeley, 1986, 2003; Berti & Schroger, 2003; Shallice, 1988; Swanson & Seigel, 2001) and is essential to learning in a classroom environment (Alloway, 2006). Researchers have examined two primary types of working memory: visuospatial working memory and auditory working memory. Although results are mixed across studies, most agree that young adults with ADHD demonstrate impairments in visuospatial working memory (Barkley, et al., 1996; Clark et al., 2007; Dowson et al., 2004; Karatekin & Asarnow, 1998; McLean et al., 2004; Murphy, Barkley & Bush, 2001; Roberts, Milich & Fillmore, 2012; Young, Morris, Toone & Tyson, 2007), with some, but not all, researchers also documenting deficits on auditory working memory tasks (Barkley et al., 1996; Biederman et al., 2009; Karatekin

& Asarnow, 1998; Murphy et al., 2001; Schweitzer, Hanford & Medoff, 2006; White, Hutchens & Lubar, 2005). A recent meta-analysis concluded that both auditory and visuospatial working memory is impaired in adults with ADHD and that methodological variability accounts for the inconsistent results across past studies (Alderson, Kasper, Hudec & Patros, 2013).

Very few studies have examined gender differences in working memory in individuals with ADHD. Those that have directly addressed this issue have focused on adolescents (Rucklidge, 2006; Rucklidge & Tannock, 2001). Neither of these studies found gender differences in either visuospatial or auditory working memory, but the range of working memory tests examined in these studies was limited (Digit Span, Arithmetic, Spatial Span) because working memory was only one of many cognitive and psychosocial areas assessed. Two other studies included gender in analyses when comparing adults with ADHD to adults without the disorder on several working memory measures (Murphy et al., 2001; Schweitzer et al., 2006). Across these studies, men in general (regardless of diagnosis) outperformed women on some auditory working memory tests (Letter-Number Sequencing and the Paced Auditory Serial Addition Test (PASAT)), but women outperformed men in smell identification and information processing speed. The only gender difference to interact with diagnosis was on the PASAT in the Schweitzer et al. (2006) study, where males with ADHD performed more poorly than males without ADHD, but no gender difference emerged for females with and without the disorder. The researchers did not directly compare males with ADHD to females with ADHD on this or any other tests, so gender differences within the ADHD group were not reported.

The current study attempts to better delineate gender differences in self-reported symptomatology and working memory (visuospatial and auditory) in college students with ADHD. We asked college students with ADHD and age-matched controls to complete two self-report measures of their ADHD symptomatology to help clarify the somewhat inconsistent findings of the DuPaul et al. (2001) and the Lee et al. (2008) studies. Additionally, we administered three tests of visuospatial working memory and three tests of auditory working memory to determine whether male and female college students with ADHD are impaired relative to their non-affected peers and, more importantly, whether gender differences exist in the visuospatial or auditory working memory abilities of college students with ADHD.

Method

Participants

Recruitment of college student participants with and without an ADHD diagnosis spanned several college campuses. We placed advertisements in campus newspapers and requested that Student Disability Services (SDS) Offices send emails informing their registered students of the study. Fliers in doctor's offices, at local college student gathering places, and on campus bulletin boards also informed potential participants about the research project, and we announced the study in psychology courses that offered extra credit for research study participation.

Students with ADHD who volunteered to participate provided written documentation approved by the SDS office. The documentation included a medical record review conducted by the SDS office and a structured clinical interview form that included DSM-IV criteria for ADHD that had to be completed by a physician or a clinical psychologist. Those not registered with the SDS office provided a formal testing report and/or a current prescription for an ADHD medication. Students who had inadequate documentation or reported only a past history of ADHD symptomatology without a current diagnosis were excluded from the study.

Forty-seven college students with ADHD (19 male and 28 female) volunteered to participate in the study. The majority of the ADHD group (97.9%) was Caucasian and 57.4% (n = 27) were receiving academic accommodations at the time of this study. Although students were not directly queried about their medication regimen, the Student Disabilities Office verified that at least 36% (n = 17) of these students had a prescription for and reported taking medication at the time that they registered their disability. An additional 43% (n = 20) included a current prescription as proof of their diagnosis. Thus, the majority of the ADHD participants (at least 79%) likely had access to psychostimulant medications at the time of the study. We did not ask participants to alter their regular medication schedule at the time of their participation.

Forty-four (14 male and 30 female) college students enrolled in either a four-year college or a graduate program served as age- and education-matched controls. Students with a past or current diagnosis of either ADHD or a learning disability were excluded from the control group. Similar to the ADHD group, the majority (88.6%) of these participants were Caucasian.

Materials

Self-Report Measures

Conners' Adult ADHD Rating Scale (CAARS). The CAARS is a reliable and valid self-report measure of ADHD symptoms for use with adults. It requires participants to respond to 66 items by rating themselves on behaviors and characteristics commonly associated with ADHD (Conners, Ehrhard, & Sparrow, 1999). Scores total onto several primary subscales, each of which is normed by gender. For the purposes of this study, we focused on four subscales that represent areas of common difficulty for adults with ADHD (Inattention, Hyperactivity, Emotional Lability, and Self-Concept),

Internal Restlessness Scale (IRS). The IRS (Weyandt et al., 2003) assesses the construct of "mental restlessness" frequently reported by adults with ADHD. A self-report measure, the IRS presents 24 statements such as "Thoughts race through my mind," "I feel internally restless," and "While listening to others my attention drifts to unrelated thoughts." Participants rate each item on a 7-point Likert scale, ranging from 1 = "none of the time" to 7 = "all of the time." A study by Weyandt et al. (2003) evaluated the reliability and validity of the IRS. The IRS correlates significantly with other rating scales such as the Adult Rating Scale and demonstrates adequate test–retest reliability (r = .89). More importantly, the IRS successfully differentiates college students with ADHD from their non-affected peers ($\eta 2$ = .431; Weyandt et al., 2003).

Tests of Auditory Working Memory

Digit Span (DS). On the DS subtest from the Wechsler Memory Scale-Third Edition (Wechsler, 1997), participants hear increasingly longer sequences of single digit numbers. For the first portion of this test, participants repeat the sequence out loud in order of presentation (forward span). For the second portion, they recite the sequence in reverse order (backward span). Correct sequences across the two portions of the test are totaled to determine the Digit Span raw score.

Paced Auditory Serial Addition Test (PASAT). During the PASAT (Gronwall & Sampson, 1974), participants hear a sequence of single digit numbers. They add adjacent digits together and verbally report the sum. While calculating the sum, they must also remember the last digit they heard in order to add it to the next number presented. The digits occur three seconds apart during the first trial and two seconds apart during the second trial. Correct responses across the two trials are totaled to determine the PASAT raw score.

Letter-Number Sequencing (LNS). During the LNS subtest from the Wechsler Memory Scale–Third Edition (Wechsler, 1997), the examiner reads a series of intermixed letters and single digits aloud at a rate of one item per second. The participant verbally reports the numbers in numerical order, followed by the letters in alphabetical order. Sequences begin with three items (two letters and one number or two numbers and one letter) and become increasingly longer until the participant fails all three trials of a given sequence length. Raw scores on the LNS test reflect the number of sequences correctly reported.

Tests of Visuospatial Working Memory

Spatial Span (SS). Also from the Wechsler Memory Scale-Third Edition (Wechsler, 1997) and a visual analog of the DS test, during the SS subtest participants watch the examiner tap increasingly longer sequences of raised, blue blocks positioned arbitrarily on a white board. Participants tap the blocks in the same order they witnessed (forward span) or in the reverse order (backward span). Correct responses across forward span and backwards span trials are totaled to determine the Spatial Span raw score.

N-Back. During the N-Back (Awh et al., 1996, Cohen et al., 1994, 1997; Smith & Jonides, 1997), participants view a series of letters that appear serially on a computer screen. Their task is to inform the examiner whenever a letter is identical to the letter that came immediately before it (1-back). In subsequent trials, the task becomes more difficult as the participant attempts to inform the examiner when the letter matches the one that came two before it (2-back) or three before it (3-back). The total number of correct target detections across 1-back, 2-back and 3-back trials comprises the N-Back raw score.

Conners' Continuous Performance Test (CPT). During the CPT, participants watch a long sequence of letters appear individually on a computer screen. They hit the space bar as quickly as they can whenever a letter appears unless the letter is an X, in which case they withhold their response. Across the 20-minute-long task, the computer varies the rate of presentation of stimuli. Both omissions (failing to respond to a letter other than an X) and commissions (responding to an X) count as errors. The computer also records reaction times (Conners, 2000). All CPT scores represent T-scores normed based on a large standardization sample.

Procedure

As part of a larger study examining distractibility in college students with ADHD (Lineweaver, et al., 2012), participants completed two individual testing

sessions two weeks apart. To encourage participation and prevent attrition, they received $30 in compensation after they completed both testing sessions. The first testing session involved the two questionnaires evaluating symptoms of ADHD (the CAARS and the IRS) and four of the tests of working memory: two auditory (DS and the PASAT), and two visuospatial (SS and the N-back). During the second testing session, participants completed the remaining two working memory tests: the auditory LNS test and the visuospatial CPT.

Results

Demographic Comparisons

Table 1 summarizes the demographic characteristics of the male and female participants with and without an ADHD diagnosis. The ADHD group and control group were statistically equivalent in their gender distribution, χ^2 (n = 91) = 0.73, p = .39. The four groups were also statistically equivalent in age and education. Additionally, the racial composition of the sample was similar across genders within each diagnostic group, ADHD group: $\chi^2 2$ (n = 47) = 0.69, p = .41; control group: $\chi^2 2$ (n = 43) = 2.13, p = .55.

Gender Differences in Self-Reported Symptomatology

Self-reported ADHD symptomatology on both the CAARS and the IRS are also summarized in Table 1. We included scores on the four CAARS subscales and total scores on the IRS in a multivariate analysis of variance with two between-subjects factors: group (control versus ADHD) and gender (male versus female). Scores on all of these self-report measures were available for 37 participants from the control group and 37 participants from the ADHD group.

Not surprisingly, the main effect associated with group was highly significant, F (5, 66) = 11.76, p < 001, η_p^2 = 0.47. Univariate analyses indicated that students with ADHD reported significantly greater ADHD symptomatology across all four CAARS subscales as well as on the IRS. The main effect associated with gender neared significance, F (5, 66) = 2.33, p = .052, η_p^2 = 0.15. Female participants described themselves as significantly more emotionally labile on the CAARS than male participants regardless of diagnosis. Finally, although the group by gender interaction did not reach significance in the multivariate analysis (F (5, 66) = 1.48, p = .21, η_p^2 = 0.10), univariate comparisons demonstrated significantly larger differences in self-reported inattention and internal restlessness between female participants with and without ADHD than between male participants with and without ADHD (see Figure 1). Follow-up simple main effect analyses revealed that male control participants reported more inattention and internal restlessness than female control participants, with both effects nearing statistical significance, CAARS Inattention: t (35) = 1.95, p = .059; Internal Restlessness: t (35) = 1.86, p = .072. For participants with ADHD, women with ADHD reported more inattention and internal restlessness than men with ADHD, but only the difference in self-reported inattention neared significance, CAARS Inattention: t (35) = 1.81, p = .080; Internal Restlessness: t (35) < 1, ns.

Gender Differences in Auditory and Visuospatial Working Memory

Scores on the six tests of working memory are summarized in Table 2. We included total scores on Digit Span, PASAT, LNS, Spatial Span, and N-Back, as well as omission errors, commission errors and hit reaction times from the CPT in a multivariate analysis of variance (MANOVA). Similar to the analysis of self-reported symptomatology, the MANOVA included two between-subjects factors: group (control versus ADHD) and gender (male versus female). Scores on all of the working memory measures were available for 40 participants in the control group and 41 participants in the ADHD group.

Unlike for self-reported symptomatology, none of the main or interaction effects reached significance in the multivariate analysis, group: F (8, 70) = 0.89, p = .53, η_p^2 = 0.09; gender: F (8, 70) = 1.09, p = .38, η_p^2= 0.11; group x gender: F (8, 70) = 1.08, p = .39, η_p^2 = 0.11. Univariate comparisons indicated that the control group and the ADHD group performed similarly on all working memory tests. Surprisingly, female participants significantly outperformed male participants on the visuospatial Spatial Span test. Finally, group and gender interacted to affect scores on the LNS test. Specifically, women with ADHD had more difficulty on the LNS test than their non-affected peers, but men with ADHD outperformed men without ADHD on this auditory working memory test (see Figure 2). Follow-up simple main effect analyses indicated that male and female control participants performed similarly on the LNS test (t unequal variances (35.59) = 1.21, p = .23), but men with ADHD performed better than women with ADHD on this measure, t unequal variances (22.31) = 2.03, p = .055.

Table 1

Demographic Characteristics and Self-Reported Symptomatology Means (SEs) of the Male and Female Participants in the Control and ADHD Groups

	Control Group		ADHD Group			Test of Hypotheses (F Values)		
	Male	Female	Male	Female	df	Group x Gender Interaction	Group Main Effect	Gender Main Effect
Age	20.0 (0.43)	19.37 (0.29)	19.95 (0.37)	20.14 (0.30)	1, 87	1.40	1.07	0.39
Years of College	2.14 (0.37)	1.90 (0.25)	2.32 (0.31)	2.39 (0.26)	1, 87	0.28	1.22	0.08
CAARS								
Inattention	52.27 (2.34)	47.27 (1.52)	58.64 (2.07)	63.74 (1.62)	1, 70	6.95*	35.57***	0.00
Hyperactivity	51.82 (2.75)	47.46 (1.79)	58.50 (2.43)	57.57 (1.90)	1, 70	0.58	13.92***	1.38
Emotional Lability	43.73 (2.52)	46.27 (1.64)	50.64 (2.23)	58.26 (1.74)	1, 70	1.51**	20.90***	6.05
Self-Concept	45.36 (3.06)	45.77 (1.99)	52.21 (2.72)	55.30 (2.12)	1, 70	0.28	10.63**	0.48
Internal Restlessness	80.64 (4.88)	70.00 (3.17)	102.36 (4.33)	107.78 (3.38)	1, 70	4.03*	55.32***	0.42

Note: CAARS = Conners' Adult ADHD Rating Scale; Internal Restlessness= Internal Restlessness Scale; PASAT = Paced Auditory Serial Addition Test; LNS = Letter Number Sequencing

* $p < .05$, ** $p < 0.01$, *** $p < .001$

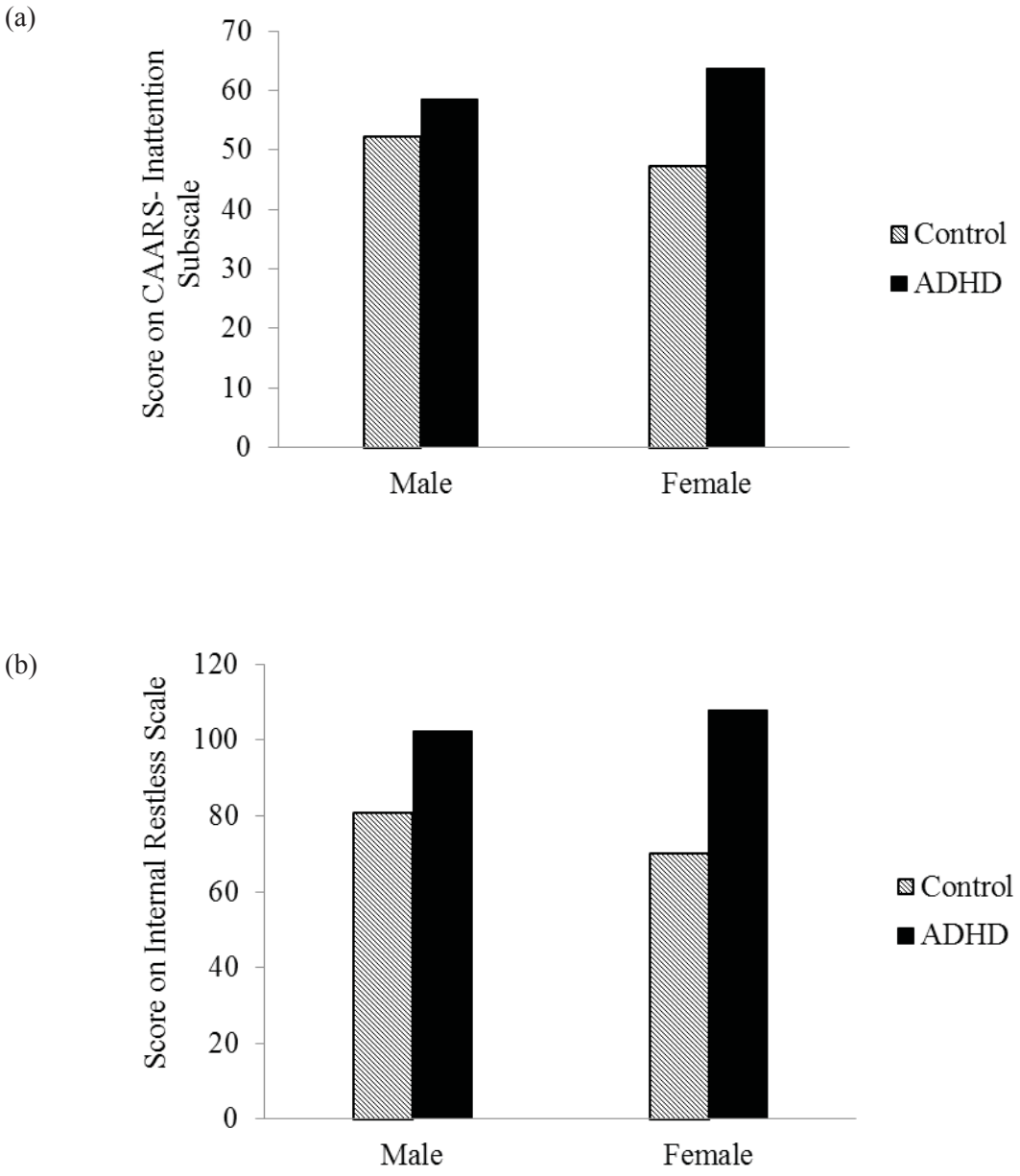

Figure 1. Significant Group x Gender interaction on the CAARS Inattention subscale (a) and the Internal Restlessness Scale (b). Participants with ADHD (black bars) reported more Inattention and Internal Restlessness than controls (hashed bars). Additionally, females with and without ADHD differed more in their self-reported inattention and internal restlessness (right side of both graphs) than males with and without ADHD (left side of both graphs).

Table 2

Working Memory Means (SEs) of the Male and Female Participants in the Control and ADHD Groups

	Control Group $n = 40$		ADHD Group $n = 41$		Test of Hypotheses F (1, 77)		
	Male $n = 14$	Female $n = 26$	Male $n = 16$	Female $n = 25$	Gender x Group Interaction	Group Main Effect	Gender Main Effect
Auditory WM							
Digit Span	19.21 (0.96)	19.77 (0.70)	18.56 (0.90)	18.28 (0.72)	0.26	1.68	0.03
PASAT	94.57 (4.62)	87.96 (3.39)	86.38 (4.32)	82.00 (3.46)	0.08	3.16	1.90
LNS	11.71 (0.70)	12.62 (0.51)	13.38 (0.65)	11.44 (0.52)	5.60*	0.16	0.74
Visuospatial WM							
Spatial Span	17.71 (0.66)	19.31 (0.48)	17.69 (0.61)	18.52 (0.49)	0.45	0.52	4.60*
N Back	56.86 (0.79)	56.23 (0.58)	55.81 (0.74)	55.56 (0.59)	0.08	1.60	0.20
CPT-Omits	55.24 (4.38)	47.88 (3.21)	52.00 (4.09)	56.79 (3.28)	2.60	0.57	0.12
CPT-Commits	52.11 (2.77)	51.84 (2.03)	52.92 (2.59)	54.36 (2.07)	0.13	0.49	0.06
CPT-Hit RT	43.64 (2.42)	42.34 (1.77)	41.14 (2.26)	43.16 (1.81)	0.64	0.16	0.03

Note: WM = Working Memory; CPT = Conners' Continuous Performance Test; RT = reaction time; *$p < .05$.

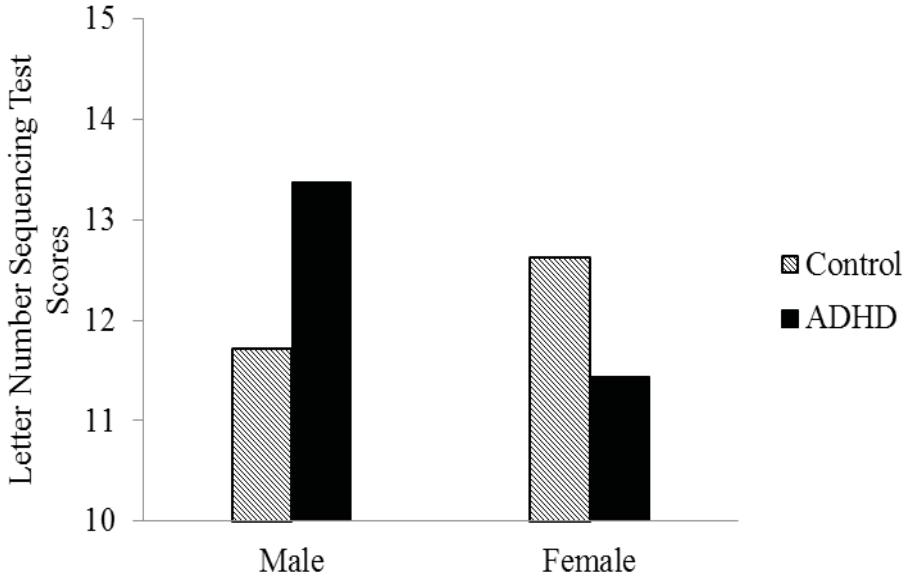

Figure 2. Significant Group x Gender interaction on the Letter Number Sequencing Test. Women with ADHD performed more poorly than women without ADHD on this auditory working memory test (right side of graph), whereas men with ADHD performed better on this test than their non-affected male counterparts (left side of graph).

Discussion

The purpose of our study was to explore gender differences in self-reported symptomatology as well as in visuospatial and auditory working memory in college students with ADHD. Not surprisingly, college students with ADHD reported significantly greater ADHD symptomatology across all four CAARS subscales and the IRS than their non-affected peers, consistent with the purpose and design of these self-report measures (Conners, et al., 1999; Weyandt, et al., 2003). Additionally, female participants described themselves as more emotionally labile than male participants, regardless of whether they were diagnosed with ADHD or not. Although the interaction of gender and diagnosis did not reach significance for this subscale, an examination of the means suggests that women with ADHD (whose average T-score was nearly one standard deviation above the normed mean of 50) had a bigger influence on this gender main effect than women without ADHD (who also outscored their male counterparts on the emotional lability scale, but whose scores averaged only 46, which is below the normed mean T-score of 50). In fact, a follow-up analysis indicated that our women with ADHD did report being significantly more emotionally labile than our women without ADHD ($t(47) = 5.03$, $p < .001$), consistent with prior research that has demonstrated that females with ADHD tend to have elevated emotional lability such as poor temper control, variable mood, and emotional over-reactivity (Robison et al., 2008).

Perhaps more importantly, we found that diagnosis interacted with gender to impact some, but not all, aspects of self-reported symptomatology. Female participants with and without ADHD differed more from each other in their self-reported inattention and internal restlessness than male participants with and without the disorder. This effect emerged because females without ADHD reported lower levels of inattention and internal restlessness than males without ADHD and because females with ADHD reported more difficulty with inattention and, to a lesser and non-significant extent, internal restlessness than their ADHD male counterparts. In combination, this resulted in a larger divide in the self-reported symptomatology for females than males based on the presence or absence of an ADHD diagnosis. Prior research has indicated that females with ADHD primarily have the inattentive subtype

with less hyperactivity than males, leading them to be under-identified at young ages (Grskovic & Zentall, 2010). Thus, it is not surprising that inattention and internal restlessness were the two areas where gender differentially affected self-reports of college students with and without ADHD. In contrast, males with ADHD tend to exhibit greater levels of hyperactivity than females and are, thus, identified more frequently (Abikoff, et al., 2002; Reid et al., 2000). However, even within the general population, males tend to be more physically active and to derive greater self-worth from physical activities (Fairclough & Ridgers, 2010; Trew, Scully, Kremer, & Ogle, 2009). This gender difference in the general population is taken into account with the gender norms applied to CAARS raw scores, reducing the hyperactivity scores of the ADHD males as a result. Thus, this factor was less vulnerable to the interaction of gender and diagnosis.

Our results do not align with those of either DuPaul et al. (2001) or Lee et al. (2008). DuPaul and colleagues did not identify gender differences in self-reported ADHD symptomatology in university students. Although Lee and colleagues did find some gender differences in ADHD symptomatology amongst college freshmen, they found that males reported more inattention and combined symptoms than females. Our results instead suggest that women college students with ADHD report more inattention than men college students with ADHD and that women with ADHD differ more from their non-affected women peers in their internal restlessness than men college students with ADHD differ from men without the disorder. One reason for the discrepancy between our results and those of the two previous studies may be due to the comparisons being made. Both the DuPaul et al. (2001) and the Lee et al. (2008) studies examined the prevalence rates of symptoms in the general population of college students instead of making specific comparisons between students with and without ADHD. Our results identify gender differences in self-reported symptomatology and suggest that, like for children, ADHD may affect young adult men and women differently. Thus, gender differences that emerge in childhood ADHD (Gershon, 2002; Rucklidge & Tannock, 2001; Waite, 2007) may persist throughout adulthood.

In examining gender differences in auditory and visuospatial working memory in college students with and without ADHD, we found that women significantly outperformed men in our sample on the visuospatial Spatial Span test regardless of the presence or absence of an ADHD diagnosis. Existing literature has been inconsistent in establishing gender specific strengths in visuospatial working memory. When school-aged children completed the Corsi Block-Tapping Test, boys performed better than girls (Orsini, Schiappa, Chiacchio & Grossi, 1982), but when the same test was administered to young adults aged 20-29, no gender differences were observed (Ruggiero, Sergi, & Iachini, 2008). In another study that utilized a test of both the processing and the storage components of spatial working memory, males were found to have greater visuospatial working memory spans than females, and the authors used this finding to explain males outnumbering females in science courses and programs (Geiger & Litwiller, 2005). In contrast, on a novel multi-trial test, female college students made significantly fewer visuospatial working memory errors and took significantly less time to reach criterion than males (Duff & Hampson, 2001). Thus, studies have reached conflicting conclusions with regard to whether male or female college students demonstrate stronger visuospatial working memory skills. We expect that because our sample exclusively included college students, our young adult females may have had ample opportunities to develop advanced visuospatial working memory skills compared to the general population of young women the same age. We did not query our participants about their college major or future career plans but, because of our recruitment procedures, many of our non-ADHD student participants were likely psychology majors with at least some interest and background in the sciences. Thus, our student sample may have included a large number of women who utilize visuospatial working memory skills in their academic areas of study, thereby contributing to our finding that women outperformed men on the Spatial Span test.

Beyond this gender difference, we found a group by gender interaction on the auditory working memory Letter Number Sequencing test. Women with ADHD had more difficulty on the LNS test than their non-affected peers. Although these results are not particularly surprising, previous studies have not documented this difference in auditory working memory between women with and without ADHD (Schweitzer et al., 2006). What was even more unexpected and counterintuitive was that the results were the opposite for men; men with ADHD performed better than their comparison peers. Although we did not anticipate this effect, similar to our study, the limited existing research on auditory working memory and ADHD has documented better performance by men with ADHD than women with the disorder, particularly on the LNS test (Schweitzer et al., 2006). However, it is unclear as to why the male students with ADHD in our sample performed better than their non-affected peers on this measure. Future studies will be necessary to further investigate this issue.

Limitations

Our study extends prior research on ADHD by exploring and identifying gender differences in both self-reported symptomatology and auditory and visuospatial working memory among male and female students with and without attentional difficulties. However, our results may or may not generalize to all adults with ADHD due to a few limitations. First, our sample was comprised of college students from an urban private university who may not be representative of all adults with ADHD. Our participants have likely been successful at developing strategies for overcoming the academic obstacles imposed by their ADHD symptoms given their successful enrollment at a private university. Secondly, we did not ask the students to provide any information about their age of diagnosis, years of remediation, presence of other mental health issues such as anxiety or depression, or current medication regimen. Each of these variables could have a possible influence on self-reported symptomatology and working memory skills. Approximately 70% of adult women with ADHD report mental health issues such as depression, anxiety, phobias, or substance abuse (Rucklidge & Kaplan, 2000). Thus, a large percentage of our participants may have been on medications for their mood or for their attention problems. Although we have reported that medications do not strongly affect the working memory skills of college students with ADHD in distraction free environments (Kendall, Dye, Lineweaver & Kercood, 2013), other past studies have demonstrated that psychostimulant medications improve working memory in both children (Kobel, et al., 2009; Strand, Hawk, Bubnik, Shiels, Pelham & Waxmonsky, 2012) and young adults (Agay, Yechiam, Carmel & Levkovitz, 2010) with ADHD. Because we did not ask participants to report their current medication regimens, we cannot directly examine the influence of medications on self-reports and working memory on self-reports and working memory across the participants in our study, nor can we determine whether medication effects may differ by gender.

Future Research

Our study paves the way for future research expanding our understanding of gender differences in self-reported symptomatology and working memory in college students with and without ADHD. Because our results suggest that the types of subjective symptoms experienced and reported by boys versus girls with ADHD during childhood may persist into adulthood, additional research with larger and more diverse adult ADHD samples designed to directly examine gender differences in self-reported symptomatology appears warranted. Many of the gender differences we documented emerged when young adult college students with ADHD were compared to their same-sex peers without the disorder (i.e., young men with ADHD showed a different pattern of strengths and weaknesses relative to their non-affected peers than young women with ADHD did). This indicates that future studies examining subjective and objective symptomatology in students with ADHD should include control groups of peers without an ADHD diagnosis to better control for gender differences in the general population.

Although our findings answer several questions related to gender differences in young adult college students with ADHD, there are several issues and lingering questions that our results cannot address. Because our study was cross-sectional in design, the developmental trajectory of gender differences in individuals with ADHD remains unknown. Future longitudinal studies should examine whether gender differences are stable or dynamic across early to late childhood, adolescence, and young adulthood. Additionally, we utilized laboratory tasks to evaluate working memory in our study. Future research will be necessary to examine whether our results generalize to the broader context of academic and behavioral tasks more similar to those encountered on a daily basis by college students with ADHD. Another interesting question we were unable to address with our study is whether gender affects the impact medications have on subjective symptomatology and working memory in students with ADHD. Designing a future research study that randomly assigns students to take or withhold their medications before completing subjective and objective test measures could help shed light on potential interactions between gender and medications in influencing self-reported symptoms, as well as auditory and visuospatial working memory. Finally, we did not introduce any interventions in our study, but it is possible that young adult men with ADHD may differ from young adult women with ADHD in their response to both medical and non-medical interventions targeting their subjective symptomatology and working memory. Future studies focused on the efficacy of various treatments for ADHD should include gender as a key variable to directly evaluate this possibility.

Implications

The gender differences we documented in self-reported symptoms and in working memory skills have implications for practitioners who conduct diagnostic evaluations as well as those who provide services and accommodations to students with ADHD. College students with disabilities cite an accurate knowledge

of their disability, a clear explanation of the results of their psychoeducational evaluations, opportunities for self-advocacy, and strong support systems as vital to their success in college (Skinner, 2004). Some universities address these factors as part of their existing curriculum of study skills courses offered to students with learning disabilities and ADHD (Chiba & Low, 2007) to help students smoothly transition to college and find continued success within the postsecondary environment. Integrating empirically-based information about gender differences in subjective and objective symptomatology into these courses or into feedback sessions explaining the results of diagnostic evaluations and their implications to young adults with ADHD is recommended. Sharing this type of information might help increase students' understanding of their own personal struggles. Better awareness of gender differences in ADHD symptomology could also enhance students' ability to advocate for the services and accommodations they need (1) within the classroom environment, (2) when attempting complex academic tasks that place demands on working memory outside of class, and (3) in other non-academic aspects of their everyday life.

In the context of clinical or educational evaluations, our findings have strong implications for diagnosing ADHD based on subjective and objective symptomatology. Assuring that gender-specific norms are utilized when scoring both subjective and objective measures appears to be critical. Because self-reported symptoms and performance on working memory tests may depend upon gender in the general population, using normative data that take these gender differences into account will increase the meaningfulness and interpretability of the results of diagnostic measures. For example, women with ADHD do not need raw scores as high as men with ADHD on self-report scales assessing inattention or internal restlessness to indicate a clinically significant issue due to the lower base rate of these characteristics in women without than in men without the disorder. Additionally, women with ADHD and men with ADHD demonstrated a different pattern of strengths and weaknesses across multiple tests of their auditory and visuospatial working memory in our study. Thus, clinicians should be aware that young adults with ADHD may not simply demonstrate impaired scores on all tests that require working memory. Auditory and visuospatial working memory may dissociate in women or men with ADHD, and some young adults with ADHD may actually show above average performance on some tests of working memory, like our male students with ADHD did on the auditory Letter Number Sequencing Test.

Auditory working memory is important in academic settings because it is essential to comprehending, processing linguistic information when reading, remembering classroom lectures, and following multi-step instructions (Alloway, 2010; Rogers, Hwang, Toplak, Weiss, & Tannock, 2011), skills that are utilized regularly by college students. Our results suggest that male college students with ADHD have very strong auditory working memory skills, outperforming their non-affected male peers in some instances, whereas female college students with ADHD struggle with auditory working memory compared to female college students without the disorder. Our study included a select college student sample, and our participants have likely found ways to maximize their working memory despite the presence of their disorder. Because male students tend to get diagnosed with ADHD earlier in their school years than female students, our male ADHD students may have received more years of remedial training in developing their auditory working memory skills in order to be successful in the classroom. If this is the case, identifying girls with ADHD earlier in the course of their development or increasing the interventions offered to young women with the disorder when they are diagnosed at older ages may give them a similar opportunity to improve their auditory working memory. Another possible explanation for the enhanced performance of our male ADHD college students on a test of auditory working memory is that the men with ADHD in our sample enjoyed the challenge of the LNS test and were able to focus their attention and fully utilize their auditory working memory for the short duration of this complex task. In this case, helping all students with ADHD reframe academic challenges in a positive light might help them to thrive even when working memory demands are high.

One of the primary tasks facing many students during their college years is reaching a decision about an academic major and future career path. Understanding gender-specific working memory challenges can assist disability service providers in discussions they have with students about major and career choice. Some majors and careers may require more visuospatial working memory (e.g., careers in the sciences or mathematics, dance performance), whereas others may place higher demands on auditory working memory (e.g., philosophy, English, foreign languages). Understanding gender difference in these types of working memory demands could help students select career paths that fit their strengths or help plan necessary accommodations for students who may have already chosen paths that may pose challenges for them. Interestingly, our finding that women outperform men in visuospatial working memory suggests that women need not avoid disciplines in the sciences or mathematics when selecting majors or choosing a career.

Finally, we documented high levels of emotional lability in the women in our study. Emotional lability is associated with severe ADHD core symptoms and a higher prevalence of oppositional behavior, anxiety, affective symptoms, and substance abuse (Sobanski, et al., 2010, Skirrow & Asherson, 2013). Thus, the emotional lability reported by females, particularly those with ADHD, may put them at risk for behaviors and for alterations in mood that may affect their success socially and academically in college. Practitioners who work with these women on college campuses should be aware of these issues in order to provide support services that will best prevent emotional lability from putting young women with ADHD at risk for more significant behavioral, emotional and social challenges.

Conclusions

In summary, our study was able to document gender differences in both self-reported symptomatology and in performance on standardized tests of working memory. Our gender differences were revealed both through direct comparisons of young adult men and women with ADHD and through relative differences between women with versus without ADHD compared to men with versus without ADHD. Together, our results suggest that gender differences that emerge in childhood may continue into the young adult years. Understanding these gender effects can help scientists and practitioners alike in their work with young adult college students with ADHD.

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Authors' Note

This project was supported by a Faculty Research grant from the Holcolm Awards Committee at Butler University.