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Sex Differences in Externalizing and Internalizing Symptoms in ADHD, Autism, and General Population Samples

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Abstract
Oppositional behavior, irritability, and aggression are common in autism and ADHD-Combined presentation (but less frequent in ADHD-Inattentive), and children with autism are at high risk for anxiety. No study has compared sex differences in externalizing and internalizing symptoms between ADHD-Combined, ADHD-Inattentive, autism, and general population samples. The samples comprised 1436 children with autism (with or without ADHD), 1056 with ADHD without autism, and 665 from the general population, 2–17 years. Nine externalizing, four internalizing, and nine somatic symptoms rated by mothers on the Pediatric Behavior Scale did not differ significantly between girls and boys in the autism, ADHD-Combined, and ADHD-Inattentive samples. In the general population, boys had more externalizing problems than girls (particularly hyperactivity, inattention, and aggression), whereas anxiety, depression, and somatic complaints did not differ, with the exception of more stomachaches in girls. The finding that boys have more externalizing problems than girls in the general population has implications for interpreting rating scales. Raw score to standard score conversions for most scales are based on general population sex- and age-specific norms. Therefore, standard scores mask sex differences, and the same standard score for a girl and a boy is not equivalent. A boy must have more severe externalizing problems to earn the same elevated standard score as a girl. When making diagnostic and treatment decisions, clinicians should take into consideration both symptom raw scores (e.g., "often a problem" reflecting symptom severity and the DSM threshold for clinical significance) and standard scores (symptom severity adjusted for sex and age effects).

Keywords Externalizing and internalizing symptoms · Sex differences · ADHD · Autism · General population

Prevalence of Externalizing and Internalizing Symptoms in ADHD and Autism

ADHD and autism are two of the most common disorders present in children referred to child psychiatry diagnostic clinics. ADHD is characterized by inattention, impulsivity, and hyperactivity, and the primary symptoms of autism are deficits in social communication and interaction and restricted and repetitive behaviors and interests (DSM-5). Most children with autism have ADHD. Across 13 studies reviewed by Joshi et al. (2017), 59% to 83% of children with autism met diagnostic criteria for ADHD, and ADHD percentages were even higher in clinically referred children with autism. Further, children with ADHD and children with autism have similar scores on attention tests and maternal ADHD ratings (Mayes et al. 2012a). Oppositional behavior, irritability, tantrums, and aggression are common in ADHD-Combined presentation (ADHD-C) and in autism, and oppositional defiant disorder (ODD) criteria are met by most children (51% to 68%) with autism and with ADHD-C (Biederman et al. 1996; Efron and Scriberras 2010; Faraone et al. 1998; King and Waschbusch 2010; Mayes et al. 2015). Rates for conduct disorder (CD) in youth with ADHD are lower (20% to 22%), but still far above the norm (Biederman et al. 1996; King and Waschbusch 2010). In contrast to ADHD-C and autism, children with ADHD-Inattentive presentation (ADHD-I) have lower rates of irritability/anger, tantrums, aggression, and oppositional behavior (Connor et al. 2010; Mayes et al. 2011a, 2012a, b, 2015; Milich et al. 2001).

Parent ratings of anxiety and depression in their children are also significantly higher in children with autism (Gadow et al. 2005; Kim et al. 2000; Mayes et al. 2011a) and in children with

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ADHD (Mayes et al. 2011a) than in typical controls. In the study by Mayes et al. (2011a), maternal ratings of anxiety, but not depression, were higher in autism than in ADHD and the difference in anxiety and depression ratings between children with ADHD-C versus ADHD-I was not significant. Faraone et al. (1998) also reported that children with ADHD-I were not at greater risk of anxiety than children with ADHD-C.

Sex Differences

General Population Samples In population-based samples, externalizing disorders are more common in boys than in girls, including a higher prevalence of ADHD (Bauermeister et al. 2007; Waschbusch and King 2006), ODD (Waschbusch and King 2006), and CD (Maughan et al. 2004). General population and rating scale normative studies analyzing data at a symptom level also show more parent-rated externalizing problems in boys than in girls, including ADHD symptoms (Conners 2008; Newcorn et al. 2001; Waschbusch and Willoughby 2008), ODD symptoms (Waschbusch and Willoughby 2008), irritability/anger and tantrums (Mayes et al. 2019), and aggression (Card et al. 2008). However, some inconsistencies in published reports are apparent and worth noting. In one community study, sex differences in irritability, anger, and temper outbursts were not found in 6- to 18-year-olds (Stringaris et al. 2012), whereas other studies have shown greater irritability in girls than in boys (Leadbeater and Homel 2014; Leibenluft et al. 2006). Although normative data for Conners-3 parent ratings indicated higher raw scores for boys than girls on the CD and ODD scales, the difference was not significant (Conners 2008). In a survey of 1285 youth aged 9–17 years, sex differences were not significant for oppositional behavior, but boys had more conduct problems (Lahey et al. 2000).

Rating scale normative data reveal small effect sizes for sex differences in internalizing symptoms. Although self-ratings of anxiety and somatic complaints on the Revised Children's Manifest Anxiety Scale-2 (Reynolds and Richmond 2008) were somewhat higher in females than in males, the difference was not clinically meaningful ($d = 0.07–0.18$) and resulted in a median T-score difference of less than 2 points. Relatedly, parent ratings of anxiety, depression, and physical problems were slightly higher in girls than in boys in the Pediatric Behavior Scale (PBS) normative sample (Lindgren and Koeppl 1987), but effect sizes were again small and not clinically significant ($d = 0.09–0.17$).

ADHD Samples A meta-analysis by Gershon (2002) revealed that boys with ADHD had higher ratings of inattention, impulsivity, hyperactivity, and externalizing problems than girls with ADHD. Incidence rates of ODD and CD were higher in boys than in girls among 32,308 children diagnosed with ADHD in Denmark (Ottosen et al. 2019). A research review revealed that aggression and other externalizing behaviors were more common in boys than in girls with ADHD, although results across studies were inconsistent (Rucklidge 2008). Studies have shown that girls with ADHD have more anxiety and depression than boys with ADHD (Gershon 2002; Ottosen et al. 2019; Rucklidge 2008), but results across studies were again inconsistent (Rucklidge 2008).

Autism Samples Sex differences in externalizing symptoms for children with autism are typically not found. In most studies, girls and boys with autism do not differ in temper outbursts, irritability, and behavior problems (Lecavalier 2006; Mayes and Calhoun 2011; Mayes et al. 2019), aggression (Murphy et al. 2009), and anxiety and depression (Brereton et al. 2006; Hurtig et al. 2009; Mayes et al. 2011b; Sukhodolsky et al. 2008).

Purpose

The study objective was to compare differences in maternal ratings of externalizing, internalizing, and somatic symptoms between girls and boys in four diagnostic groups (autism, ADHD-C, ADHD-I, and general population). Findings will have important implications for how rating scale scores are interpreted for diagnostic and treatment purposes. Clinical diagnoses in our study were based on comprehensive evaluations considering all possible child psychiatric diagnoses. This is important because many children with autism are initially diagnosed with only ADHD without ruling in or out autism (Miodovnik et al. 2015). Most prior studies also failed to analyze ADHD-C and ADHD-I separately, which is critical because of significant differences in comorbidity and sex differences between the two subtypes. For example, girls are more likely to have ADHD-I than boys, boys are more likely to have ADHD-C than girls, and girls with ADHD-C score more highly for aggression than girls with ADHD-I (King and Waschbusch 2010).

Methods

The study was approved by the Institutional Review Board (IRB). Informed consent was obtained from the parents and assent from the children in the general population sample. Informed parent consent and child assent were waived by the IRB for the ADHD and autism samples because analyses were conducted retrospectively on existing clinical data for these children.

Samples

Autism and ADHD The clinical sample comprised 2492 children (1436 with autism with or without ADHD and 1056 with ADHD without autism) referred to a psychiatry diagnostic

clinic at a university affiliated hospital and college of medicine in the United States. The children were 2–17 years of age ($M = 7.4$, $SD = 3.2$) with IQs ranging from 9 to 149 ($M = 96.6$, $SD = 22.5$). IQs below those available in test manuals were calculated using the ratio IQ formula. In all, 90.7% were white, 74.1% were male, 36.6% had a parent with a professional or managerial occupation, and 33.8% were treated with a psychotropic medication. Demographic data for each diagnostic group are reported in Table 1.

All children underwent a diagnostic evaluation by a licensed PhD psychologist. The evaluation included a diagnostic interview with the parents, parent and teacher questionnaires and rating scales (Pediatric Behavior Scale/PBS, Lindgren and Koeppl 1987), review of educational records, administration of psychological tests (IQ, achievement, and neuropsychological), and clinical observations of the child during the evaluation. All children in the ADHD group had a DSM-IV or DSM-5 (whichever version was current when the child was evaluated) diagnosis of ADHD and fulfilled the following criteria: (1) symptoms of ADHD observed during psychological testing and (2) short attention span or distractible rated as *often* or *very often* a problem on the PBS by at least two informants (mother, father, teacher). Children were classified with ADHD-C if the median mother, father, and teacher rating on the PBS impulsive and hyperactive items was *often* or *very often* a problem. Children were classified with ADHD-I if the median impulsive and hyperactive rating was less than *often* a problem.

Children in the autism sample had a DSM-IV or DSM-5 diagnosis of autism (i.e., autistic disorder, Asperger's disorder, or autism spectrum disorder) and a score in the autism range on the Checklist for Autism Spectrum Disorder (CASD, Mayes 2012). The CASD is a 30-item diagnostic measure normed and standardized on 2469 children (1–18 years, IQs 9–146) with autism, other clinical disorders, and typical development (Mayes 2012). In the national standardization study, the CASD identified children with and without autism with 99.5% accuracy. The CASD differentiates children who have autism (with or without comorbid disorders) from children who do not have autism and only have other disorders, including intellectual disability, learning disability, traumatic brain injury, language disorder, ADHD, ODD, anxiety disorder, apraxia of speech, and reactive attachment disorder (Mayes 2012; Mayes et al. 2012a, 2017; Tierney et al. 2015). Concurrent validity is strong with high diagnostic agreement (93%–98%) between the CASD and the Childhood Autism Rating Scale, the Gilliam Asperger's Disorder Scale, and the Autism Diagnostic Interview-R (Mayes et al. 2009; Murray et al. 2011).

Children with autism who also had ADHD symptoms were only included in the autism sample. These children were not given an additional clinical diagnosis of ADHD if they were evaluated at the time of the DSM-IV, which did not permit an ADHD diagnosis with autism. In the autism sample, 79.5% had elevated (*often* or *very often* a problem) maternal ratings on the total ADHD subscale and 9.1% had elevated ratings on attention deficit but not on impulsivity/hyperactivity.

General Population The general population sample comprised 665 children 6- to 12-years of age from a population-based epidemiologic study of the prevalence of sleep disorders (Bixler et al. 2009). The children were from the same US geographic region (comprising rural, urban, and suburban communities) as the autism and ADHD samples. Demographic data are reported in Table 1.

Instrument and Variables

The 165 items on the PBS were rated by mothers on a 4-point scale (0 = *almost never or not at all*, 1 = *sometimes*, 2 = *often*, and 3 = *very often* a problem). The PBS assesses multiple diagnostic and symptom categories including ODD, conduct disorder, irritability/anger, ADHD, anxiety, depression, and somatic complaints. The PBS corresponds well with established measures of psychopathology (Bixler et al. 2009; Mayes et al. 2014) and has been used to diagnose and differentiate psychological problems in several published studies (e.g., Conrad et al. 2010; Mattison and Mayes 2012; Mayes et al. 2011a, 2012a, b; Waxmonsky et al. 2017). The nine PBS externalizing items were: (1) inattentive (short attention

Table 1 Demographic Data for Youth with Autism, ADHD-C, and ADHD-I

	Autism $n = 1436$	ADHD-C $n = 747$	ADHD-I $n = 309$	General population $n = 665$
Age (*M/SD*)	6.6/3.3	8.2/2.7	9.2/2.8	8.7/1.7
IQ (*M/SD*)	92.1/24.9	102.7/17.0	103.0/16.8	106.5/12.9
Male	79.0%	72.0%	56.3%	52.6%
Parent occupation[a]	34.1%	36.7%	48.5%	48.9%
White	90.6%	90.1%	92.9%	80.5%
On psychotropic medication	34.1%	38.9%	20.4%	6.3%

[a] One or both parents have a professional or managerial position

span/distractible), (2) impulsive, (3) hyperactive, (4) disobedient/defiant, (5) irritable/angry/tantrums, (6) aggressive, (7) bully/starts fights/mean/cruel, (8) lies/cheats, and (9) steals. The four internalizing items were (1) generalized anxiety (anxious/worried/fearful), (2) social anxiety (shy), (3) separation anxiety (clings to adults/too dependent), and (4) depressed/sad. Somatic complaint items associated with anxiety or depression were (1) makes self-sick with worry/nausea or vomiting when nervous or upset, (2) stomachaches, (3) headaches or other body aches and pains, (4) complains of feeling sick, (5) trouble falling asleep, (6) wakes during the night, (7) nightmares, (8) sleeps more than normal, and (9) sluggish/lacks energy.

Data Analyses

Raw scores and not standard scores were used in our analyses so that possible sex differences were not masked by the use of sex-specific standard scores. Differences in symptom scores between girls and boys were investigated using independent *t*-tests and Cohen's *d*. It was not necessary to control for demographic differences between girls and boys within the autism, ADHD-C, ADHD-I, and general population samples because all differences had very small effect sizes ($d = 0.0–0.2$ and $\phi = 0.0–0.1$) and were statistically nonsignificant ($p > .01$), including age ($t = 0.5$, 0.8, 1.6, and 0.2, respectively), intellectual disability (ID, $\chi^2 = 1.5$, 11.4, 0.0, and 3.9), race ($\chi^2 = 0.0$, 1.4, 1.4, 2.1), and parent occupation ($\chi^2 = 1.4$, 4.6, 2.2, and 6.2). Differences between the frequency of girls versus boys treated with a psychotropic medication were also nonsignificant ($\chi^2 = 1.6$, 0.1, 0.0, and 6.4, $\phi = 0.0–0.1$). All reported *p*-values are 2-tailed. A Bonferroni correction for the number of comparisons made was applied when analyzing *p*-values within each of the four diagnostic groups in the externalizing and internalizing/somatic symptom categories. The binomial test was used to investigate score patterns by sex.

Results

Externalizing Symptom Scores

As shown in Table 2, the nine externalizing symptom mean scores did not differ significantly between girls and boys in the autism, ADHD-C, and ADHD-I samples. In the general population sample, three of the symptom scores (inattentive, hyperactive, and aggressive) were significantly higher in boys than in girls ($d = 0.2–0.3$). Further, all nine mean externalizing symptom scores were higher in boys than in girls (binomial $p = .004$), which was not the case for the autism, ADHD-C, and ADHD-I samples.

Internalizing and Somatic Symptom Scores

The four anxiety and depression and nine somatic symptom scores did not differ significantly between girls and boys in all four diagnostic groups (Table 2), with the exception that girls in the general population sample were more likely to have stomachaches than boys ($d = 0.3$).

Discussion

None of the externalizing, internalizing, or somatic mean symptom scores differed significantly between girls and boys in the autism, ADHD-C, and ADHD-I samples. In the general population sample, boys had higher externalizing problem scores than girls, particularly in the areas of inattention, hyperactivity, and aggression. In contrast, anxiety, depression, and somatic complaints did not differ between boys and girls, with the exception of an increased frequency of stomachaches in girls. The finding of externalizing symptom differences by sex in the general population is expected because ADHD and autism (and their associated externalizing problems) are significantly more common in boys than in girls, resulting in higher externalizing symptom ratings in boys than girls. Such an effect was not found in the clinical samples because all children were diagnosed with ADHD or autism. Interestingly, the higher prevalence of externalizing disorders in males than in females did not translate into increased symptom severity for males in our clinical samples (i.e., boys diagnosed with autism or ADHD did not have more severe symptoms than girls). Last, societal expectations and norms for girls versus boys may also contribute to sex differences in parent ratings of externalizing problems.

The absence of significant sex differences in our autism sample is consistent with previous studies (Brereton et al. 2006; Hurtig et al. 2009; Lecavalier 2006; Mayes and Calhoun 2011; Mayes et al. 2011b, 2019; Murphy et al. 2009; Sukhodolsky et al. 2008). In contrast to findings for autism, reviews and studies (Gershon 2002; Ottosen et al. 2019) reported more externalizing problems and less anxiety and depression in boys than in girls with ADHD, although results across studies were inconsistent (Rucklidge 2008). Differences in how symptoms are measured (e.g., with parent interview data, rating scale raw scores, or sex-specific rating scale standard scores) might result in inconsistencies across studies. Further, most studies did not distinguish between ADHD-C and ADHD-I, which would affect findings because boys are more likely to have ADHD-C than girls and externalizing problems are more common in ADHD-C than in ADHD-I. Therefore, symptom uniformity is greater within each ADHD subtype (versus ADHD-C and ADHD-I combined), making sex differences less likely. The absence of sex differences within the autism, ADHD-C, and ADHD-I

Table 2 Mean Symptom Scores ($N = 3157$)

Symptom	Autism				ADHD-C				ADHD-I				General Population			
	Girls $n = 301$	Boys $n = 1135$			Girls $n = 209$	Boys $n = 538$			Girls $n = 135$	Boys $n = 174$			Girls $n = 315$	Boys $n = 350$		
	M	*M*	*t*	*p*	*M*	*M*	*t*	*p*	*M*	*M*	*t*	*p*	*M*	*M*	*t*	*p*
Inattentive	2.16	2.14	0.3	.74	2.45	2.41	0.8	.43	1.89	1.95	0.3	.75	0.76	0.99	3.1	.002[a]
Impulsive	1.89	1.92	0.4	.68	2.27	2.25	0.3	.79	1.04	0.81	2.5	.01	0.70	0.86	2.4	.02
Hyperactive	1.72	1.79	0.8	.40	1.94	2.05	1.4	.18	0.42	0.52	1.3	.19	0.61	0.88	3.6	<.001[a]
Disobedient/defiant	1.43	1.54	1.9	.06	1.63	1.69	0.9	.37	0.92	0.88	0.5	.60	0.70	0.84	2.6	.01
Irritable/tantrums	1.59	1.65	0.9	.38	1.43	1.52	1.1	.28	0.78	0.71	0.8	.42	0.56	0.68	2.1	.04
Aggressive	0.84	0.97	2.1	.04	0.65	0.72	1.0	.32	0.18	0.15	0.6	.56	0.13	0.24	3.2	.002[a]
Bully/fight	0.54	0.58	0.9	.37	0.59	0.68	1.4	.17	0.20	0.18	0.3	.76	0.17	0.24	2.3	.02
Lie/cheat	0.58	0.59	0.2	.88	1.15	0.99	2.0	.04	0.59	0.45	1.5	.14	0.38	0.38	0.0	.96
Steal	0.18	0.21	1.0	.30	0.40	0.26	2.4	.02	0.06	0.09	0.9	.35	0.05	0.09	1.7	.09
Anxious/worried/fearful	1.31	1.26	0.7	.48	1.05	1.04	0.1	.93	0.84	0.94	1.0	.34	0.67	0.64	0.5	.63
Shy	1.18	1.05	1.9	.06	0.78	0.61	2.3	.02	1.01	0.96	0.5	.60	0.75	0.66	1.5	.13
Clings to adults	1.39	1.22	2.2	.03	0.97	0.74	2.7	.01	0.83	0.61	2.0	.04	0.48	0.39	1.7	.10
Depressed/sad	0.60	0.61	0.2	.88	0.57	0.62	0.6	.51	0.47	0.59	1.2	.21	0.30	0.31	0.2	.87
Vomits when nervous	0.35	0.38	0.7	.49	0.34	0.28	1.3	.20	0.34	0.32	0.3	.73	0.26	0.21	1.2	.24
Stomachaches	0.56	0.43	2.5	.01	0.71	0.54	2.5	.01	0.52	0.57	0.6	.57	0.54	0.35	3.5	<.001[a]
Head or other aches	0.39	0.33	1.5	.14	0.53	0.47	1.1	.26	0.53	0.53	0.1	.92	0.40	0.40	0.0	.96
Complains feeling sick	0.50	0.37	2.3	.02	0.58	0.41	2.5	.01	0.50	0.47	0.4	.67	0.31	0.29	0.6	.57
Trouble falling asleep	1.28	1.20	1.1	.27	1.15	0.89	2.8	.01	0.63	0.70	0.7	.51	0.66	0.63	0.4	.68
Wakes during the night	1.02	0.97	0.7	.49	0.85	0.64	2.6	.01	0.43	0.42	0.1	.91	0.61	0.53	1.2	.24
Nightmares	0.70	0.64	1.2	.24	0.65	0.59	0.9	.36	0.39	0.40	0.2	.83	0.55	0.51	0.7	.46
Sleeps more than normal	0.26	0.22	1.1	.28	0.22	0.13	1.8	.07	0.23	0.25	0.2	.81	0.18	0.17	0.4	.69
Sluggish/lacks energy	0.44	0.40	0.7	.49	0.39	0.26	2.2	.03	0.49	0.55	0.6	.56	0.19	0.21	0.6	.52

0 = almost never or not at all a problem, 1 = sometimes a problem, 2 = often a problem, and 3 = very often a problem. [a] Bonferroni $p < .05$

samples might also in part reflect that these are genetic neurobiological disorders which may override sex differences found in the general population.

In contrast to findings for autism and for ADHD, boys had more externalizing problems than girls in the general population sample. Relatedly, in a study by Waschbusch and King (2006), mothers and teachers were instructed to rate elementary school students on ADHD and ODD symptoms comparing the children to same-sex and same-age peers. Results showed that a small subset of girls had higher than average ADHD and ODD symptoms and impairment than other girls but did not meet DSM criteria for ADHD and ODD. The authors argued that DSM criteria may under identify girls who could benefit from further assessment and possible treatment and that lower thresholds may be needed to identify DSM symptoms in girls than in boys. This contrasts with the current standard of practice in which clinical diagnoses using DSM-5 criteria are based on uniform symptom severity and not a different severity threshold for girls and boys. For example, according to the DSM-5, ODD symptoms must occur "often" for a diagnosis of ODD and not often for boys and less than often for girls.

The cost of using sex-specific criteria, whether in the DSM or in rating scale norms, is that it masks actual differences in symptom severity between boys and girls. For example, using norms for children 6–12 years of age on the PBS, girls had lower mean raw scores than boys on the Conduct Problems and ADHD subscales, so that boys with an elevated T-score ($\geq$ 65) had more severe conduct and ADHD symptoms than did girls who had the same T-score. As such, removing sex effects by using sex-specific norms may result in standard scores that do not represent equivalent symptom severity for girls and for boys and limits the ability to draw inferences about differences between girls and boys. Further, if this practice is accepted for externalizing

disorders such as ADHD and ODD, should it also be applied to other disorders for which males significantly outnumber females (e.g., learning disability and autism)? It seems illogical to require more severe learning problems and autistic symptoms for a diagnosis of these disorders in boys than in girls.

Limitations and Directions for Future Research

The study clinical samples were predominantly white and from a single practice site, so future studies are needed to replicate the findings in more racially diverse groups and in other clinical settings. Potential sex differences should be investigated in children with disorders other than autism and ADHD as well. Further, research using informants other than mothers (e.g., father, teacher, and self-report) is also needed.

Conclusion and Clinical Implications

The finding that boys have more externalizing problems than girls in the general population has implications for interpreting rating scale scores (which are based on general population norms). Raw score to standard score conversions for most scales are based on general population sex- and age-specific norms. Therefore, standard scores mask sex differences and a boy must have more severe externalizing problems to earn the same elevated standard score as a girl. If researchers or clinicians are interested in examining differences between girls and boys, then correcting for differences between boys and girls using sex-specific norms is clearly not appropriate. If clinicians are basing diagnoses on the same symptom threshold for girls and boys, then using sex-specific norms would not be appropriate. On the other hand, if the interest is to insure that girls who are impaired relative to other girls are identified and receive intervention services, using sex-specific norms is justified. When making diagnostic and treatment decisions, clinicians should take into consideration both symptom raw scores (e.g., "often a problem," which reflects symptom severity and the DSM threshold for clinical significance) and standard scores (symptom severity adjusted for sex and age effects).

Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest Susan D. Mayes, Peter J. Castagna and Daniel A. Waschbusch declare no conflict of interest.

Experiment Participants The study was approved by the Institutional Review Board (IRB). Informed consent was obtained from the parents and assent from the children in the general population sample. Informed parent consent and child assent were waived by the IRB for the ADHD and autism samples because analyses were conducted retrospectively on existing clinical data for these children.

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