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ORIGINAL ARTICLE

How Common are Academic Overachievement and Underachievement in Children with Autism or ADHD?

Susan Dickerson Mayes[1] · Daniel A. Waschbusch[1] · Susan L. Calhoun[1] · Richard E. Mattison[1]

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Abstract

The prevalence of academic underachievement or learning disabilities in children with autism or ADHD (two groups at increased risk for such problems) has been extensively researched, but little is known about overachievement in these groups. The frequency of overachievement across academic domains compared to nondiscrepant achievement and underachievement in children with autism versus ADHD was determined. WISC-III/-IV and WIAT/-II scores were analyzed in 164 children with autism and 499 children with ADHD (6–16 years of age, IQ $\geq$ 80). Academic overachievement (achievement test standard scores $\geq$1 SD above IQ) in word reading, reading comprehension, math, and written expression was rare in autism (14.6%, 9.1%, 5.5%, and 1.8%) and in ADHD (4.2%, 3.6%, 2.4%, and 0.8%, respectively). Academic underachievement (achievement test scores $\geq$1 SD below IQ) was more common, with percentages of 12.8%, 17.7%, 15.2%, and 52.4% for autism and 27.9%, 21.4%, 24.0%, and 57.1% for ADHD. Overachievement was more common in autism than in ADHD. In contrast, underachievement was greater in ADHD than in autism, except that underachievement in written expression was similar and found in the majority of both groups.

Keywords Academic overachievement · Academic underachievement · ADHD · Autism

The prevalence of academic underachievement or learning disabilities in autism or ADHD (two of the most commonly diagnosed childhood disorders and two groups at increased risk for such problems, Mayes and Calhoun 2006), has been extensively researched, but surprisingly little is known about academic overachievement. When academic achievement skills have been studied in children with autism or ADHD, the

✉ Susan Dickerson Mayes
smayes@psu.edu

[1] Department of Psychiatry H073, Penn State College of Medicine, 500 University Dr., Hershey, PA 17033, USA

emphasis has understandably been on underachievement and its subsequent intervention and programming implications. However, increasing knowledge of overachievement (academic achievement significantly exceeding IQ) in these childhood disorders could have its own educational applications.

No published studies were located investigating the prevalence of academic overachievement in ADHD or autism, but a few studies examined overachievement in general population samples. Group IQ scores were compared with academic grades in 1398 Spanish high school students showing that 17.6% were overachieving and 16.4% were underachieving (Iniesta et al. 2017). Among 519 elementary school students, 13.9% performed 1 standard deviation or more above their WASI IQ in word reading and 8.7% in math on the WRAT-3 (Mayes et al. in press). WISC-R Verbal IQ and Woodcock Reading Mastery scores were analyzed in 300 1st - 3rd graders (Berninger et al. 1992) and revealed that 4.3% scored significantly above expectancy in word reading (compared to 5.7% below expectancy) and 6.0% scored above expectancy in reading comprehension (5.3% below expectancy). Overachievement and underachievement rates were higher in a study of 58 typical 1st and 2nd graders, with 37% scoring 6 months or more above expectancy for their WISC-R IQ on the Peabody Individual Achievement Test word reading subtest and 23% scoring 6 months or more below expectancy (Short et al. 1986). The considerable differences in rates of over- and underachievement reported in these studies is likely due to methodological differences, specifically how IQ and achievement were measured and/or the threshold chosen for a significant difference between IQ and achievement. Furthermore, none of the studies examined overachievement in written expression or overachievement in children with autism or ADHD. Our study is the first to determine the prevalence of overachievement (achievement test standard scores significantly above IQ) across academic domains (word reading, reading comprehension, math, and written expression) compared to nondiscrepant achievement and underachievement in children with normal intelligence diagnosed with autism or ADHD.

Methods

Samples

All children were consecutively referred to a Psychiatry child diagnostic clinic at a university hospital for suspected autism or ADHD or for behavior problems, and all had a Full Scale IQ $\geq$ 80. The children underwent a comprehensive diagnostic evaluation by licensed PhD psychologists. The evaluation included a diagnostic interview with the parents, parent and teacher questionnaires and rating scales (Pediatric Behavior Scale/PBS, Lindgren and Koeppl 1987 and Checklist for Autism Spectrum Disorder/CASD, Mayes 2012), review of educational records, administration of psychological tests (IQ, achievement, and neuropsychological), and clinical observations of the child during the evaluation. The 165 items on the PBS were rated by mothers and teachers on a 4-point scale from *never* to *very often* a problem. The PBS assesses multiple problem areas including ADHD, oppositional behavior, conduct problems, irritability, anxiety, depression, autism symptoms, somatic complaints, and social, cognitive, language, motor, learning, and health problems. The PBS corresponds well with established measures of ADHD and other psychopathology (Bixler et al. 2009;

Mayes et al. 2012a) and has been used to diagnose and differentiate psychological problems in several studies (Calhoun et al. 2017; Conrad et al. 2010; Mattison and Mayes 2012; Max et al. 1997; Mayes et al. 2009a, 2012b, 2018; Nichols et al. 2000; Waxmonsky et al. 2017; Wolraich et al. 1994).

Autism Children with autism ($n = 164$) were 6–15 years of age ($M = 8.7$, $SD = 2.0$), 95.1% were white, 92.7% were male, and 50.0% had a parent with a professional or managerial occupation. All had a clinical diagnosis of autism and a score in the autism range on the CASD. The CASD is a 30-item diagnostic instrument normed and standardized on 2469 children (1–18 years, IQs 9–146) with autism, other clinical disorders, and typical development (Mayes 2012). The CASD differentiates children with autism from children with intellectual disability, learning disability, traumatic brain injury, language disorder, ADHD, oppositional defiant disorder, and anxiety disorder (Mayes 2012), apraxia of speech (Tierney et al. 2015), reactive attachment disorder (Mayes et al. 2016), and ADHD (Mayes et al. 2012b). In the standardization study conducted by the Stoelting Company, the CASD differentiated children with and without autism with 99.5% accuracy. Diagnostic agreement of 93% to 98% has been shown between the CASD and the Childhood Autism Rating Scale, Gilliam Asperger's Disorder Scale, and Autism Diagnostic Interview-Revised (Mayes et al. 2009c; Murray et al. 2011). Children with autism who also had an ADHD diagnosis were only included in the autism sample.

ADHD Sample The 499 children with ADHD were 6–16 years of age ($M = 9.9$, $SD = 2.3$); 94.8% were white, 71.9% were male, and 40.9% had a parent with a professional or managerial occupation. All had (1) a DSM diagnosis of ADHD, (2) symptoms of ADHD observed during psychological testing, (3) low scores on psychometric measures of attention and impulsivity, (4) ratings of short attention span or distractible as *often* or *very often* a problem on the PBS by at least two raters (mother, father, or teacher), and (5) score below the autism range on the CASD. Children were classified with ADHD-Combined type if the majority of the mother, father, and teacher impulsive or hyperactive ratings were *often* or *very often* a problem ($n = 356$). Children were classified with ADHD-Inattentive type if the majority of impulsive and hyperactive ratings were less than *often* a problem ($n = 143$).

IQ and Achievement Tests

Children were administered the Wechsler Intelligence Scale for Children (WISC-III or WISC-IV, whichever test was current when the children were evaluated) and the Wechsler Individual Achievement Test (WIAT or WIAT-II) Word Reading, Reading Comprehension, Numerical Operations, and Written Expression subtests. On the Word Reading subtest, the child reads aloud a list of words. On Reading Comprehension, the child reads a passage and, while viewing the passage, answers questions posed by the examiner about what was read. Numerical Operations is a paper-and-pencil math computation test, and Written Expression requires children to write a composition scored for length of text, theme development, organization, grammar, spelling, capitalization, and punctuation.

Achievement Groups

Children were divided into three achievement groups: overachievers (children whose achievement test standard scores were ≥ 1 SD above IQ), nondiscrepant achievers, and underachievers (children whose achievement test scores were ≥ 1 SD below IQ). A standard deviation discrepancy is commonly used in research, is statistically defensible, and allows for the easy replication of our findings by other researchers. The Wechsler Full Scale IQ was used because several studies demonstrate that Full Scale IQ is the best single predictor of achievement compared to other ability measures (e.g., Breaux 2010; Keith 1993; Mayes et al. 2009b; Mayes and Calhoun 2007a, 2008) and correlates better with achievement test scores than Index scores (Breaux 2010).

Data Analysis

Achievement group frequencies did not differ significantly between children with ADHD-C and ADHD-I for all four academic areas ($\chi^2 < 5.7$, $p > .05$). Therefore, the two ADHD subtypes were combined in the analyses. Achievement group frequencies in each academic area were compared using χ^2 and phi coefficients for children with ADHD versus children with autism. Single sample *t*-tests determined if achievement differed significantly from IQ in each academic area. Differences in IQ and achievement test scores and IQ-achievement discrepancy scores between children with ADHD versus autism were determined with *t*-tests and Cohen's *d*. A Pearson correlation matrix was generated using IQ-achievement discrepancy scores to ascertain the degree to which over- or under-achievement relative to each child's IQ in one academic area correlated with that in another academic area. The extent to which overachievement in one academic area co-occurred with overachievement in other areas was calculated.

Results

Mean achievement test scores did not exceed mean IQ in any academic area for children with autism and ADHD (Table 1). Achievement was significantly below IQ in all academic areas for children with autism and with ADHD ($t = 2.6$ to 28.1, $p < .009$, $d = 0.2$ to 1.3), with the exception of word reading for autism ($t = 0.1$, $p = .96$, $d = 0.0$). The pattern of over-achievement (Table 2) was similar for children with autism and for children with ADHD (word reading > reading comprehension > math > written expression). Overachievement in word reading was 8.1 times more common than written expression in the autism sample and 5.2 times more common than overachievement in written expression in the ADHD sample. More than half of children with autism and ADHD were underachieving in written expression, in contrast to less than one-third in all other academic areas.

Children with autism had greater overachievement in all areas (2.2 to 3.5 times) than children with ADHD, and children with ADHD had greater underachievement in all areas (1.1 to 2.2 times) than children with autism (Table 2). Achievement group frequencies differed significantly between children with autism and ADHD in word reading ($\chi^2 = 31.7$, $p < .0001$, $\phi = .22$), reading comprehension ($\chi^2 = 8.5$, $p = .01$, $\phi = .11$), and math ($\chi^2 = 8.6$, $p = .01$, $\phi = .11$), but not written expression ($\chi^2 = 2.1$, $p = .35$, $\phi = .06$).

Table 1 Mean IQ and achievement test scores in children with ADHD ($n = 499$) and autism ($n = 164$)

	ADHD		Autism				
	M	*SD*	*M*	*SD*	*t*	*p*	*d*
IQ	105.8	12.7	104.9	14.0	0.8	.414	0.1
Word reading	98.4	13.7	104.8	15.4	5.1	<.0001	0.4
Reading comprehension	100.2	15.4	101.9	17.6	1.2	.230	0.1
Math	98.7	14.3	101.2	15.1	1.9	.052	0.2
Written expression	88.9	12.9	90.1	14.7	1.0	.310	0.1
IQ-Word reading	7.4	12.7	0.0	13.9	6.3	<.0001	0.6
IQ-Reading comprehension	5.6	12.5	2.9	14.3	2.3	.021	0.2
IQ-Math	7.2	11.5	3.6	11.7	3.4	.001	0.3
IQ-Written expression	16.9	13.5	14.8	13.9	1.8	.074	0.2

IQ-achievement discrepancy score correlations were large and positive between word reading and reading comprehension for autism ($r = .75$, $p < .0001$) and ADHD ($r = .70$, $p < .0001$), explaining 56.2% and 49.0% of the variance. All other correlations between academic areas were moderate to large (.33 to .54, $p < .0001$, explained variance 10.9% to 29.2%), with the exception of a smaller correlation (.21, $p = .006$, explained variance 4.4%) between reading comprehension and math in autism.

For children with autism or ADHD, overachievement in word reading had a relatively high rate of co-occurrence (33.3% to 66.7%) with overachievement in reading comprehension and vice versa (Table 3). For autism only, overachievement in written expression was also associated with overachievement in math (66.7%). In contrast, overachievement in all other areas was associated with low rates of overachievement in other areas for both samples (0% to 25.0%). No child was an overachiever in all four academic areas in either the autism or ADHD sample.

Discussion

For children with autism or ADHD, the frequency of underachievement exceeded overachievement in all academic areas, with the exception of word reading in autism.

Table 2 Percent of children in each achievement group

	ADHD ($n = 499$)			Autism ($n = 164$)		
	Over-achiever	Non-discrepant	Under-achiever	Over-achiever	Non-discrepant	Under-achiever
Word reading	4.2	67.9	27.9	14.6	72.6	12.8
Reading comprehension	3.6	74.9	21.4	9.1	73.2	17.7
Math	2.4	73.5	24.0	5.5	79.3	15.2
Written expression	0.8	42.1	57.1	1.8	45.7	52.4

Table 3 Overachievement in one area corresponding to frequency of overachievement in other areas

	ADHD overachiever %				Autism overachiever %			
	WR	RC	M	WE	WR	RC	M	WE
Overachiever in WR		33.3%	9.5%	4.8%		41.7%	8.3%	0%
Overachiever in RC	38.9%		11.1%	0%	66.7%		6.7%	0%
Overachiever in M	16.7%	16.7%		0%	22.2%	11.1%		22.2%
Overachiever in WE	25.0%	0%	0%		0%	0%	66.7%	

WR word reading, *RC* reading comprehension, *M* math, *WE* written expression

Children with autism had greater overachievement than children with ADHD, and children with ADHD had greater underachievement than children with autism. Even so, more than half of children with autism or ADHD (68% to 79%) were nondiscrepant achievers in word reading, reading comprehension, and math. In contrast, less than half (42% and 46%, respectively) were nondiscrepant achievers in written expression.

The pattern of overachievement was the same for autism and for ADHD (word reading > reading comprehension > math > written expression), with overachievement in word reading 8 and 5 times more common than overachievement in written expression in autism and ADHD, respectively. The frequency of overachievement was lower in written expression than other academic areas, with comparably low percentages (2% and 1%) for autism and for ADHD. Conversely, underachievement in written expression was similar and found in the majority of both groups. Relatedly, in a recent study (Mayes et al. 2019), 57% of children with autism and 60% of children with ADHD had dysgraphia and 92% with autism and 92% with ADHD scored below IQ on a graphomotor test. Written expression is the ability to produce text and express thoughts on paper, and dysgraphia is impaired handwriting legibility. Difficulty with handwriting affects written expression and reduces the quality and quantity of written compositions in children with writing disabilities (Graham 1999). Both need to be addressed through intervention and accommodations in school, such as using a computer and word processor for written assignments; reducing the amount of written work; modifying tests and assignments (e.g., giving true/false, multiple choice, and fill-in-the-blank questions instead of open-ended written questions); providing class notes, outlines, and study guides; and allowing dictated performance and testing, such as oral spelling tests and speech recognition software for written assignments (Mayes et al. 2018).

Overachievement was highest in word reading compared to other academic areas. Strikingly, 15% of children with autism were overachieving in word reading. Relatedly, special abilities or splinter skills significantly above IQ (e.g., hyperlexia or reading at a very young age at a level far above expectancy for age and IQ) have long been recognized in individuals with autism (Kanner 1943; Mayes and Calhoun 1999; Rimland and Fein 1988; Shah and Frith 1983).

Previous research is consistent with our findings that children with ADHD are at high risk for academic underachievement or learning disability (using the discrepancy definition) in reading and math (e.g., Cantwell and Baker 1991; Fletcher et al. 1999; Semrud-Clikeman et al. 1992) and that children with autism are at a lower risk for

underachievement or learning disability than children with ADHD (Mayes and Calhoun 2006, 2007b). In contrast to findings of greater reading and math underachievement in our ADHD versus autism sample, the two groups did not differ from each other in underachievement in written expression.

IQ-achievement discrepancy scores were significantly interrelated for children with autism and ADHD. This was especially the case for word reading and reading comprehension, as expected, explaining approximately half the variance in scores. In contrast, explained variance was low (4% to 29%) for all other academic area comparisons, suggesting the moderate independence of learning ability relative to IQ between academic areas.

In a related study including many children from the present study, demographic correlates of academic overachievement, nondiscrepant achievement, and underachievement in reading and math were investigated in general population, ADHD, and autism samples. The percentage of overachievers, nondiscrepant achievers, and underachievers did not differ significantly from each other as a function of sex, race, and parent occupation (controlling for IQ) in all three samples and these demographic variables were not significant predictors of the three achievement groups in regression analysis (Mayes et al. in press).

As noted in the studies reviewed in our Introduction, several different definitions have been used to define academic over- and under-achievement, including the definition used in our study. However, this definition does not take into consideration regression to the mean and test measurement error, which is a limitation. Future research needs to replicate our findings using the predicted achievement method to determine if an achievement test score is significantly above or below IQ using achievement and IQ tests that have standardization linking samples.

In summary, underachievement in word reading, reading comprehension, math, and written expression was relatively common (13% to 52% across areas for autism and 21% to 57% for ADHD) and overachievement was rare in ADHD (1% to 4%) and autism (2% to 9%, with the exception of 15% in word reading). Overachievement in one area (reading, math, or written expression) did not translate into overachievement in other areas. This is important because overachievement in one area (e.g., word reading) might lead parents or teachers to place unrealistic academic expectations on the child in another area (e.g., reading comprehension) and mistakenly think the child is lazy or unmotivated and not working up to his or her potential. This, in turn, could impair the parent-child or teacher-student relationship and the child's morale, motivation, and self-esteem, as well as reduce the chance that the child is referred for needed academic support services.

Clinicians and educators should be aware of and program for the high prevalence of underachievement, especially in written expression, in children with autism and children with ADHD, while recognizing that a small minority may be overachievers. Gaining a better understanding of the characterization of over- and underachievement in children with autism and ADHD and the recognition of academic achievement patterns will assist in the search for effective targets for individualized intervention and educational programming. Recognizing an area of overachievement may help identify a strength on which educators can build to help compensate for the problems students will face because of their autism or ADHD.

Compliance with Ethical Standards

Conflict of Interest The authors declare they have no conflicts of interest.

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 waived by the Institutional Review Board because analyses were conducted retrospectively on existing clinical data.

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