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How well are children with autism spectrum disorder doing academically at school? An overview of the literature

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Abstract
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Keywords
children, autism, spectrum, literature, well, disorder, overview, doing, academically, school

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How well are children with ASD doing academically at school? An overview of the literature

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Abstract

The academic achievement of individuals with autism spectrum disorder (ASD) has received little attention from researchers despite the importance placed on this by schools, families and students with ASD. Investigating factors that lead to increased academic achievement thus would appear to be paramount. A review of the literature was conducted to identify factors related to the academic achievement of children and adolescents with ASD. Nineteen studies were identified that met the inclusion criteria for the review. Results indicated that many individuals demonstrate specific areas of strength and weakness and there is a great deal of variability in general academic achievement across the autism spectrum. Adolescents and individuals with lower IQ scores were underrepresented and few studies focused on environmental factors related to academic success. The importance of individualised assessments that profile the relative strengths and weaknesses of children and adolescents to aid in educational programming was highlighted. Further research on child-related and environmental factors that predict academic achievement is needed.

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How well are children with ASD doing academically at school? An overview of the literature

Outcomes for adolescents and adults with autism spectrum disorder (ASD), although highly variable, have generally been reported as poor (Howlin and Moss, 2012; Levy and Perry, 2011). Some individuals may increase their overall skills and adaptive behaviour as they move into adulthood (Palmen et al., 2012; Shattuck et al., 2007), while others may develop mental health disorders (White et al., 2011). Others may experience a relatively stable course and experience success in further education, employment, and personal relationships (Levy and Perry, 2011). Outcome domains usually measured in studies of older adolescents and adults include independent living, friendships, employment and occupation (Howlin et al., 2004). Other studies have highlighted the impact of school experiences and self-determination in improving employment outcomes, independent living and a better quality of life (Autism Spectrum Australia, 2012; Burgess and Gutstein, 2007). A number of factors have been found to be predictive of these outcomes, including autism symptomatology, language, and cognitive functioning.

Far fewer studies have focused on academic achievement as an outcome measure, however research interest in academic achievement may be growing. In their extensive review of the intervention literature for children with ASD, Wong et al. (2013) identified 58 studies that primarily focused on academic outcomes, with the majority of these studies published post-2007. It should be noted, however, that these studies represented only a small proportion of the total sample (N=456) and the focus of their review was primarily on the effectiveness of interventions in achieving a variety of outcomes of which academic achievement was only one.

Academic achievement has been the subject of much scrutiny in past years and

the inclusion of students with disabilities in schools has complicated matters as these students may not always participate or be included in traditional measures of achievement (Thurlow et al., 2005). Academic achievement is commonly measured through a variety of formal and informal measures with schools often including the regular use of standardised measures to track achievement in literacy and numeracy. Unfortunately research has shown that students with disabilities may be exempted from these measures (Cumming et al., 2013) and not offered appropriate alternative assessments. Thus, the status of academic achievement for students with ASD is frequently unknown. With the move to more data-based decision making in schools, this is a significant gap.

The influence of school programs on academic achievement is another area that bears scrutiny. A recent report (Autism Spectrum Australia, 2012) found that many adolescents and adults with ASD reported significant negative experiences in school that impacted not only their academic achievement, but also their future outcomes in tertiary education and work settings. In addition, research has suggested that parents are reporting low rates of satisfaction with the academic achievement in educational programs for their children with ASD (Mackintosh et al., 2012; McDonald and Lopes, 2012; Starr and Foy, 2012). Parents also report frustration with the ways their child's progress is measured and reported at school, particularly for children who may be performing below grade level. Finally, little is known about how the type of program in which a child is enrolled impacts on the academic engagement or performance of children with ASD, although some research (Kurth and Mastergeorge, 2012) indicates that there may be a distinct difference in expectations and academic instruction between mainstream and specialised settings.

Although the number of studies focusing on academic achievement may be

increasing, our understanding about factors that may be predictive of, or related to, educational outcomes is still limited. Increased knowledge in this area would facilitate the development of strategies to effectively target factors known to have a positive effect on academic outcomes. Research to date has found a strong correlation between IQ and outcomes such as achievement, academic progress and an individual's response to educational intervention for students with ASD (Mayes-Dickerson and Calhoun, 2007, 2008). It is also clear, however, that academic performance is influenced by factors other than IQ, whereby many individuals with ASD perform significantly above or below the level predicted by their IQ and/or outside age-norms in a range of academic domains (Jones et al., 2009). These factors may be related to specific child characteristics or to environmental factors, including educational programming. There has been some research in the past to suggest, for example, that improvement in academic performance of children with ASD over the past 15-20 years may be due to the availability of continuous, structured educational programs not previously available in the 1960s, 70s, and 80s (Venter et al., 1992).

With a growing research interest in academic outcomes for students with ASD, it is timely to examine the current state of knowledge in this area and consider research priorities for the future. The purpose of this paper was to review published research on factors that predict or are related to academic achievement in children and adolescents with ASD. Specifically, we aimed to identify factors that have been studied in relation to academic achievement to date, as well as the types of assessment tools and measures applied, to review key findings and consider future research directions.

Method

The ERIC®, PsycINFO®, CINAHL®, and PubMed® databases were searched

using a combination of the following descriptors: *autis*, asperger*, academic performance, academic achievement.* The search was limited to the title/abstracts of peer reviewed materials. There were no date limits applied. The initial search resulted in 107 papers after the removal of duplications.

Inclusion and exclusion criteria

Studies were included in this review if they included empirical data about the academic performance or achievement of children with ASD. They needed to utilise a specific measure of academic performance or achievement and include participants with a primary diagnosis of ASD aged 5 to 18 years. Studies were excluded if the primary focus was to measure the effectiveness of a specific intervention as a review of intervention outcomes was not the purpose of this paper.

Procedure

Using the inclusion and exclusion criteria, the titles and abstracts of 107 papers were examined resulting in the exclusion of 92 papers. Reasons for exclusion were participants outside the age range (6); participants not having an ASD diagnosis (29); study not employing a measure of academic achievement (9); no empirical data (e.g., a review paper) (18); and studies focusing primarily on intervention (30). Following an ancestry search of the remaining 15 papers, a further four papers were found that met the inclusion criteria, resulting in a total of 19 papers for review. The following information was extracted from each of the included studies: number of participants, participant data including diagnosis, mean age, and mean IQ, setting, purpose of study, measures of academic achievement, academic outcomes, additional variables measured as potential predictors or correlates, and key findings.

Results

Participants

The participant characteristics are provided in Table 1. The number of participants recruited for each study varied considerably (range = 15 to 164) with a mean of 65.3 participants across 19 studies (median = 58.5, SD = 39.5). Not all studies reported age ranges; some did not provide the mean age for the sample, while others provided ages for sub-samples but not the total sample. Overall, the mean age for participants across studies that reported these data was 10.8 years (median = 10.4, SD = 4.1), ranging from 5.8 years to 16.3 years. Studies varied in their reporting of participant diagnoses with some using the terms ASD or autism, and others differentiating subtypes such as Autistic Disorder (Mayes-Dickerson and Calhoun, 2003a, 2007), Asperger syndrome (Foley-Nicpon et al., 2012; Griswold et al., 2002) and high functioning autism (HFA) (Ashburner et al., 2008, 2010; Assouline et al., 2012; Estes et al., 2011; Foley-Nicpon et al., 2012; Goldstein et al., 1994; Mayes-Dickerson and Calhoun, 2007, 2008; Minshew et al., 1994; Troyb et al., 2014; Venter et al., 1992). Of the 19 studies, 12 involved children with HFA or Asperger syndrome defined in some studies as an IQ score ≥ 70 or 75, while other studies used an IQ score ≥ 120. Studies that reported IQ used Full Scale, Verbal, Non-Verbal and/or Index Scores ranging from a mean of 58 (VIQ) to 124.89. Only two studies had participants with a mean IQ score below 65 (Eaves and Ho, 1997; Kurth and Mastergeorge, 2010), although Mayes-Dickerson et al. (2003a, 2003b) analysed their data by separating participants into low (IQ<80) and high (IQ>80) IQ groups.

<Insert Table 1 about here>

Measures of academic achievement

Academic achievement was treated as the primary outcome measure with the

exception of Troyb et al. (2014), who examined academic achievement as a predictor of ASD 'optimal outcome'. A wide variety of assessment tools were used to measure academic achievement across the studies (see Table 1). The most commonly used tests were the Woodcock-Johnson Tests of Achievement (eight studies, four of which shared the same lead author) and the WIAT (five studies). The following measures were used in no more than two studies: a non-standardised teacher rating scale of academic skills; the Achenbach System of Empirically Based Assessment; the WRAT; the Differential Ability Scales (DAS) Achievement Tests; the Detroit Tests of Learning Aptitude; the Kaufman Test of Educational Achievement; the Wechsler Objective Reading and Numerical Dimensions; the Test of Word Reading Efficiency; the Central Institute of Test Development school attainment test; the Neale Analysis of Reading; Schonell Graded Spelling Test; and Enright Diagnostic Math Test. Assessments were usually administered by the researchers rather than the school or the students' teachers.

Setting

Of the 19 studies reviewed, eight did not provide any information on educational enrolment or placement of participants (Goldstein et al., 1994; Mayes-Dickerson and Calhoun, 2003a, 2003b, 2007, 2008; Minshew et al., 1994; Myles et al., 1994; Troyb et al., 2014). Educational enrolment for participants in the other 11 studies was mixed with participants enrolled in mainstream or regular education classrooms (Ashburner et al., 2008, 2010; Assouline et al., 2012; Eaves and Ho, 1997; Estes et al., 2011; Griswold et al., 2002; Jones et al., 2009; Kurth and Mastergeorge, 2010; Venter et al., 1992), part time mainstream class (Estes et al., 2011; Griswold et al., 2002), mixed special education/mainstream education class (Estes et al., 2011), self-contained classrooms (Eaves and Ho, 1997; Griswold et al., 2002; Kurth and

Mastergeorge, 2010; Venter et al., 1992), special schools (Jones et al., 2009; Manti et al., 2011; Venter et al., 1992), and gifted and talented programs (Assouline et al., 2012; Foley-Nicpon et al., 2012). In addition, some studies reported on whether the student received support from special education or through a teacher aid (Eaves and Ho, 1997).

Only five studies (Ashburner et al., 2008, 2010; Jones et al., 2009; Kurth and Mastergeorge, 2010; Manti et al., 2011) included measures of academic achievement or other variables conducted at school and included input from school personnel such as the child's teacher or a school psychologist. For the remaining 14 studies, psychologists or other clinical personnel conducted measures in clinics or university centers without input from the participants' school. One study (Myles et al., 1994) collected data on academic achievement from school records, but accessed these at a central office and did not include school personnel or direct measurement with students in schools.

Study Purpose

Studies were grouped according to their stated purpose into one or more of the following three categories: identifying predictors of academic achievement (eight studies); identifying areas of relative academic strength/weakness (eight studies) and; exploring levels of academic achievement within ASD subtypes (two studies) or between ASD and other disorders or typically developing controls (four studies). A more detailed analysis of the findings from the included studies using these categories follows (see Tables 2, 3 and 4). Note that studies by Assouline et al. (2012), Estes et al., (2011) and Troyb et al., (2014) fell into several categories but appear in only one of the tables below to avoid duplication of information.

Predictors of academic achievement

In this section, findings related to predictors of academic achievement are reported (see Table 2). The predictor variables examined were usually associated with child characteristics, specifically autism symptomatology and IQ, although two studies also looked at environmental factors. In relation to autism symptomatology, Ashburner et al. (2008) found that sensory under-responsiveness and sensory seeking behaviours were associated with academic underachievement. Eaves and Ho (1997) observed that autism severity was related to academic achievement, while Manti et al. (2011) found that reduction in autism symptomatology did not predict academic growth. Social skills at age 6 were found to be predictive of academic achievement at age 9, but concurrent social skills at age 9 did not predict academic achievement at age 9 (Estes et al., 2011). Problem behaviours scores (irritability and hyperactivity) were not found to predict academic achievement (Estes et al., 2011).

<Insert Table 2 about here>

A number of studies looked at IQ as a predictor of academic achievement. Eaves and Ho (1997) found that for children with ASD and IQ>40, IQ predicted academic achievement as well as it did for typical children. In a study by Assouline et al. (2012), both working memory and processing speed scores were significant predictors of reading achievement, as well as math and written language achievement for gifted students (IQ ≥ 120) with ASD. Venter et al. (1992) followed high functioning children with autism over an eight-year period, providing the opportunity to look at early and current predictors of academic achievement at follow-up. They found early non-verbal IQ, the presence of functional speech before 5 years of age, severity of repetitive, restrictive behaviour and PPVT scores were significant predictors of academic achievement. At the eight-year follow-up, current verbal IQ,

deviance of social behaviour, and PPVT scores were significant predictors of current academic achievement. Finally, Mayes-Dickerson et al. (2008) found full scale IQ to be the best predictor of word reading, reading comprehension, math and writing achievement for students with ASD and IQ ≥ 70.

Two studies looked at environmental predictors of academic achievement. Kurth et al. (2010) compared students across educational settings and found that students with ASD in inclusive settings outperformed students matched on IQ and adaptive behaviour in self-contained classrooms on reading, writing and math. In a study by Assouline et al. (2012) involving gifted students with ASD, participation in gifted and talented programs was a significant predictor of academic achievement in math, reading, and oral language. Although Eaves and Ho (1997) considered a range of factors as predictors of placement in mainstream or specialised educational settings, they did not report the association between placement type and academic achievement.

Areas of relative academic strength/weakness

Studies described in this section focused on the academic skill areas of reading, mathematics, writing and oral language (see Table 3). As detailed below, few patterns were evident at the group mean level. At the individual level, however, discrepancies between achievement and general intellectual ability were reported in a number of studies. Most studies looked at a number of academic skills areas, particularly reading and mathematics. A smaller number of studies also investigated writing and two studies included a measure of oral language.

<Insert Table 3 about here>

Reading. Reading achievement was mostly found to be in the normal or average range and commensurate with IQ for groups of individuals with higher ability (IQ >80), but

varied widely at the individual level (Assouline et al., 2012; Estes et al., 2011; Jones et al., 2009; Griswold et al., 2002; Mayes-Dickerson and Calhoun, 2003a, 2003b; Myles et al., 1994; Troyb et al., 2014). Scores varied from well below average to the superior range, including for participants considered in the 'gifted' range (e.g., IQ ≥120). For lower ability groups (IQ <80), basic reading achievement appeared to be a relative strength with reading scores significantly exceeding mean IQ for the group (Mayes-Dickerson and Calhoun, 2003a, 2003b). Standard scores on tests of basic reading generally fell within the normal range.

At the subtest level, however, Mayes-Dickerson and Calhoun (2003a) found this group unable to complete the reading comprehension subtest. Jones et al. (2009) analysed academic profiles of 100 adolescents with ASD in both high and low ability ranges and identified subgroups where academic achievement was not commensurate with intellectual ability. In reading, the researchers identified a "reading peak" and a "reading dip" subgroup. The "peak" group demonstrated basic reading levels in the average range with below average full-scale IQ scores (FSIQ). The "dip" group scored below average in basic reading with low-average FSIQ. A large number (37) of adolescents displayed a dip in reading comprehension For 26 of these 37 individuals, reading comprehension was an isolated deficit. This deficit was associated with severity of social and communication difficulties. The finding that reading comprehension is a relative weakness was also consistent with the findings of Troyb et al. (2014) who found that children and adolescents with HFA scored much lower on reading comprehension measures than did peers matched for nonverbal IQ.

Mathematics. Group means for general mathematics achievement for individuals with ASD and higher ability (IQ≥70) were either in the average (Mayes-Dickerson and Calhoun, 2003b; Troyb et al., 2014) or below average range (Estes et al., 2011;

Griswold et al., 2002; Myles et al., 1994). In general, mathematics achievement was also positively correlated with IQ for both low and high ability groups (Assouline et al., 2012; Mayes-Dickerson and Calhoun, 2003a, 2003b). However, as was the case for reading, mathematics performance was highly variable (Estes et al., 2011; Griswold et al., 2002; Jones et al., 2009; Myles et al., 1994) with large standard deviations from the mean on mathematic subtest standard scores for individual participants. Discrepancies between predicted achievement based on IQ and observed achievement were evident across groups (Estes et al., 2011; Jones et al., 2009). These discrepancies involved achievement scores on subtests that were either significantly lower or higher than predicted.

As in their analysis of reading achievement, Jones et al. (2009) also identified "peak" and "dip" subgroups in mathematics scores in their study of 100 adolescents with ASD. Both groups demonstrated a large discrepancy with Performance IQ (PIQ) scores greater than Verbal IQ (VIQ) scores. The peak group was identified as having an average FSIQ (although elevated when compared to the whole sample) and exhibited numerical operations scores in the superior range. The dip group also had a FSIQ in the average range, but exhibited numerical operations scores in the borderline range. In addition, the peak group demonstrated a mean score for mathematics reasoning that was significantly lower than numerical operations, a pattern not evident in the dip group.

Writing. Performance in written expression fell in the average range for children and adolescents with ASD and IQ ≥70 (Myles et al., 1994; Venter et al., 1992). Overall, significant discrepancies between IQ and writing or spelling at the group mean level were not identified in the included studies, although Estes et al. (2011) found much variability in their sample of children with high IQ where spelling scores were

significantly lower or higher than predicted on the basis of IQ for some participants. Mayes-Dickerson et al. (2008) found that written expression on the WIAT-II subtest was significantly lower than the norm and lower than scores on other subtests. In two previous studies, Mayes-Dickerson and Calhoun (2003a, 2003b) identified differences at a subgroup level between individuals with high or low IQ scores. Specifically, scores on written expression for the high IQ group were significantly lower than expected based on IQ. Furthermore, performance in written expression was below performance in other areas of academic achievement such as reading decoding and reading comprehension. In contrast, spelling achievement for the high IQ group was in the average range. Most of the low IQ group were unable to complete the written expression tests, but demonstrated mean spelling scores within expectations based on IQ with 50% scoring within the normal range despite scoring in the below average IQ range.

Oral language. Only two studies included measures of achievement in oral language. Assouline et al. (2012) found oral language was positively correlated with Perceptual Reasoning Index scores for children with ASD and IQ ≥70. In contrast, there was no link between oral language scores and other indices such as working memory, verbal comprehension or processing speed. Griswold et al. (2002) found that performance in oral expression was in the average range for children with Asperger syndrome and was an area of strength when compared with scores for listening comprehension.

Comparing levels of academic achievement

A number of studies specifically compared the academic performance of children and adolescents with ASD to other groups (typically developing or other disabilities) or to individuals diagnosed with different subtypes of ASD (see Table 4). Three studies compared the academic achievement of students with ASD and IQ ≥ 70

to the achievement of typically developing (TD) peers. Ashburner et al. (2010) reported high rates of academic under-achievement of students with ASD in their sample (54%) compared with TD students (8%). It is important to note, however, that under-achievement in this study was determined using a single teacher-rated item of academic performance on the Achenbach System of Empirically Based Assessment. Students with ASD in two other studies (Minshew et al., 1994; Goldstein et al., 1994) were also found to differ significantly from TD groups in their performance of comprehension and some interpretive tasks. Encouragingly, children with ASD under 13 years of age did as well or better than the TD group on procedural and mechanical tasks (e.g., word attack, spelling and computation) and on some interpretive tasks (e.g., reading comprehension), but less well on tasks involving complex linguistic instructions. In comparison, students with ASD who were over 13 years old, demonstrated below average scores on all subtests (except Word Attack). This older group also performed more poorly than the TD group on interpretive tasks such as reading comprehension, in contrast to the younger ASD group who performed as well as their TD peers in these areas.

<Insert Table 4 about here>

In a large study conducted by Mayes-Dickerson and Calhoun (2007), the academic achievement of children with ASD and IQ >80 was compared to that of children with ADHD, Anxiety/Depression, Oppositional Defiant Disorder and typically developing controls. Academic achievement was measured using Word Reading, Reading Comprehension, Numerical Operations, and Written Expression subtests from the WIAT or WIAT-II. Results showed that children with ASD performed less well than their typically developing peers on all subtests. Children with ASD and ADHD did not differ except that the ADHD group had significantly

more learning problems. Both the ASD and ADHD groups were found to exhibit weaknesses in graphomotor skills, attention, and processing speed, which are often predictors of academic achievement.

In comparing subtypes of ASD, Foley-Nicpon et al. (2012) tested the hypothesis that students with Asperger syndrome would perform better on verbally-based academic tests than students with HFA, but this hypothesis was not supported by their results. Mean scores for both groups on reading, math, writing and oral language were in the high average to superior range, but with significant variability across all domains. Troyb et al. (2014) compared the academic performance of three groups: individuals with HFA; optimal outcome (OO) individuals with a history of ASD but no longer meeting diagnostic criteria; and typically developing (TD) peers. The HFA group was distinguishable from the other groups by having significantly lower scores on reading comprehension, mathematical problem solving and verbal IQ. All three groups performed in the average range on all academic subtests and no significant differences were found between the OO and TD groups.

Discussion

The findings from this review indicate some patterns evident in the academic achievement of children and adolescence with ASD. The limited number of studies highlights the need for further research to address a number of gaps in our knowledge.

Participant bias

An analysis of the participants in the 19 studies reviewed suggests that the autism spectrum was generally not well represented, with a bias toward individuals younger in age (pre-adolescence) and of higher ability (IQ > 70). The bias towards individuals of higher ability may reflect difficulties in assessing academic achievement in individuals with lower IQs using standardised measures. Mayes-

Dickerson and Calhoun (2003a, 2003b), for example, found the participants of lower ability in their study were unable to complete the Written Expression and Reading Comprehension subtests on the WIAT. Where a child was unable to achieve basal scores on the WIAT, these researchers used the Woodcock Johnson Tests of Achievement that is suitable for children from 2 years of age. However, many of the studies in this review relied only on standardised assessments such as the WIAT that may not be appropriate for individuals with lower levels of cognitive ability. The inclusion of a greater variety of assessment types in future studies, including more individualised forms of assessment such as teacher questionnaires, may be necessary when investigating academic achievement among students with lower IQ scores.

It is also troubling how few studies collected data from school personnel, relying instead on standardised assessments such as the WIAT and Woodcock-Johnson. The use of these assessments is often restricted to professionals such as psychologists as they require specialised training in test administration, scoring and interpretation. Results from these assessments are valuable when researching academic achievement, but the inclusion of school-administered assessments could complement these data and yield additional information about academic achievement of relevance to schools and families. It is also important to investigate ways schools can participate in the assessment of academic achievement and use the results to inform educational programming. Given the dissatisfaction of parents (Starr and Foy, 2012) and educators (Fleury et al., 2014) regarding education outcomes for individuals with ASD, it would seem paramount that future research employs measures that are conducted in school settings and with school involvement.

The bias toward measuring academic achievement of students with ASD and higher IQ scores may also reflect the differing priorities placed on academic

achievement in specialised versus inclusive educational settings. Children with ASD who are higher functioning are more likely to attend mainstream education programs where they access mainstream academic curricula and participate in standardised measures of academic achievement, particularly in the areas of literacy and numeracy. In contrast students with lower IQ scores are more likely to be participating in education programs conducted in specialised settings, and are more likely to be exempt or excluded from standardised measures of academic achievement (Cumming and Dickson, 2013; Witmer and Ferreri, 2014). Furthermore, the educational programs offered to students in specialised settings may place less emphasis on academics. Kurth and Mastergeorge (2010) found that individual education plans for students in special settings focused more on life skills and developmental areas, whereas individual education plans in mainstream settings focused on academic progress. Thus students with lower IQ scores may have fewer opportunities to engage with and demonstrate skills in academic areas than those with higher IQ scores. In light of these factors, the inclusion of students with lower IQ scores in studies of academic achievement is urgently needed to address the current gap in our knowledge and improve academic opportunities and outcomes for these students.

The lack of studies involving participants in the adolescent years was disturbing, although it is consistent with a more general trend that has identified a lack of research relating to outcomes, strengths and needs of people with ASD in adolescence and adulthood (Jang et al., 2014; Magiati et al., 2014). This trend is especially concerning given the increased emphasis on academic knowledge and outcomes for students in secondary schools (Cumming, 2012). An important focus for future research is to include participants in the adolescent years and to explore how academic outcomes can be measured across the entire spectrum, inclusive of students

with low ability and across primary and secondary schooling years.

Overall trends

In general, individuals with higher IQ scores tended to do better on measures of academic achievement (e.g. Eaves and Ho, 1997) and individuals with more behaviour issues and less social skills tended to do worse (Manti et al., 2011). In addition, individuals with ASD, even those with HFA, tended to perform lower than their typically developing peers in some areas, particularly those involving reading comprehension and problem solving (e.g. Troyb et al., 2014), and some studies found that individuals with ASD often underperformed in many areas (e.g. Ashburner et al., 2008). With the onset of adolescence, the gap between children with ASD and their typically developing peers appeared to widen (Goldstein et al., 1994), even in areas such as mechanical and procedural skills that were a relative strength prior to adolescence. An important task ahead is to consider ways of building on areas of relative strength evident in the pre-teenage years as children transition into high school.

Uneven patterns of achievement

This review clearly highlighted the significant variability in academic achievement across the autism spectrum and across different academic skill areas. Aggregating data for all participants in a study tended to mask this variability. Thus, at the individual level, child-related factors varied in the degree to which they predicted academic achievement. Some students did better than their IQ would predict (Mayes-Dickerson and Calhoun, 2003b) while others exhibited academic achievement at lower levels than would be expected given their autism symptomology (e.g. Manti et al., 2011) or IQ scores (e.g. Mayes-Dickerson and Calhoun, 2007). In addition, an uneven pattern of achievement was often evident within different academic skill

areas. For example, Mayes-Dickerson and Calhoun (2003a) found that students with both high and low levels of ability often performed much better on spelling than written tasks. The variability across academic skill areas was further supported by the identification of academic 'peaks' and 'dips' in reading and arithmetic for some individuals (Jones et al., 2009).

This finding is significant and underscores the need for educators to identify individual strengths and weaknesses across all academic skill areas. Individualised assessment that leads to profiling the relative strengths and weaknesses of individuals with ASD, irrespective of age and IQ, can inform educational programming and provide a baseline for measuring achievement over time.

Environmental factors

Only two of the included studies considered the relationship between academic achievement and factors external to the child. Specifically, Kurth et al. (2010) considered educational programs and Assouline et al., (2012) investigated educational settings. Both the type of educational program students accessed and the educational setting (inclusive versus self-contained) predicted academic achievement for students with ASD. The lack of research investigating environmental predictors of academic achievement was surprising given the amount of time children spend in educational settings and the growing body of evidence demonstrating the effects of a range of intervention practices on developmental outcomes (Wong et al., 2013). A systematic review of intervention studies that have targeted academic achievement could help to identify some environmental factors that may enhance academic outcomes for some children. However intervention studies may focus on a specific intervention practice and participant numbers are often small and usually include individuals who share similar characteristics. Furthermore, changes in academic performance can be

difficult to determine when educational interventions are of relatively short duration. These issues limit the information that can be gained from intervention studies about factors external to the child that may significantly impact academic performance. It is important that researchers and educators work together to determine environmental and programming factors that facilitate academic achievement for students with ASD. Fleury et al. (2014) stress that the data on poor postsecondary outcomes for individuals with ASD indicate that re-evaluation of educational programs needs to occur if achievement for these individuals is to improve.

Large scale studies, involving individuals with ASD of varying ability and age, that examine academic achievement using a range of measures, and include common environmental variables found across educational settings could contribute a great deal to our understanding of factors that influence academic achievement. This is particularly important, as factors that are external to the child are an obvious target for future interventions aimed at enhancing academic outcomes. These external factors may include but are not limited to various pedagogical practices, teacher/student ratios, inclusive and self-contained settings, physical features of the classroom, curriculum type, design and focus, use of technology, school attendance, assessment practices, and parental involvement.

Conclusion

This review was conducted in order to ascertain what research has been conducted on factors that either predict or are related to the academic achievement of children and adolescents with ASD. Nineteen studies were found, that examined predictors of academic achievement, areas of relative academic strength and weakness, and comparisons of levels of academic achievement between groups of individuals. A participant bias was noted in that few studies included participants with

IQ scores below 70 or in the adolescent/young adulthood age range. Significantly, measures used to assess academic achievement were often conducted in clinical settings and did not gather data from education professionals or in education settings responsible for delivering the primary programs designed to address the academic knowledge and skills of children with ASD. Additionally, the majority of the studies that examined predictors of academic achievement, focused on child characteristics such as intelligence or language ability. Although these findings may highlight some aspects of the needs of these individuals, they reveal little about the programs or strategies that most directly influence academic achievement, and that have direct relevance for practice. Future research is needed to evaluate the environments and programs that teachers, parents and professionals can implement to build on the strengths of individuals with ASD and enable them to achieve the academic knowledge they need to be successful as they move through adolescence and into adulthood.

The results of this review also point to the heterogeneity of individuals with ASD and the need for educators to undertake individualized, comprehensive assessments of academic strengths and weaknesses to inform educational programming. Studies identified that individuals with ASD have a diverse profile of academic achievement, with some individuals performing below and others above expected levels. This variability highlights the need for psychologists and educators to undertake specific assessments across the range of academic skill areas to ensure educational programs are responsive to individual strengths, peaks and dips in academic learning. Furthermore, this review has highlighted the need for researchers to include measures and procedures that link clinical understanding of academic profiles of individuals with ASD with educational practices that will impact the

academic achievement for these individuals. Raising the awareness of teachers about individual variability in academic performance will be critical to improving academic outcomes for individuals with ASD. The findings from this study confirm that there is no single learning profile that characterizes students with ASD. Educational programs and practices must account for diverse learning profiles through individualized assessment and planning.

In summary, there are significant gaps in current knowledge about predictors and correlates of academic achievement, and addressing these gaps may help to address the reported academic under-achievement of students with ASD. In particular, research is needed in relation to adolescents, individuals with lower IQ scores, and the impact of a range of environmental factors on academic achievement. Additionally there is a need for research to focus on bridging the gap between understanding the nature of academic achievement for individuals with ASD, and working with educators to investigate and create environments and practices that support individuals with ASD to achieve academic success.

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Table 1. Participant characteristics, setting, purpose, measures and variables studied for included studies

Author (year)	N	Diagnosis	Mean Age (yrs)	Mean IQ (SD)	Setting	Purpose	Measure of Academic Achievement	Variables Studied (in addition to academic achievement)
Ashburner et al. (2008)	28 ASD and 51 TDC	ASD IQ ≥ 80	6 - 10	N/A	Enrolled in mainstream class – evaluated at school	To explore the associations between sensory processing and classroom emotional, behavioural, and educational outcomes of children with ASD	Achenbach System of Empirically Based Assessment Teacher rating scale	• Sensory processing • IQ • Symptoms of ASD • Sensory aspects of environment
Ashburner et al. (2010)	28 ASD and 51 TDC	ASD IQ ≥ 80	6 - 10	N/A	Enrolled in regular education class – evaluated in school	To compare teachers' perceptions of academic performance, behavioural and emotional regulation of students with ASD compared to TDC	Achenbach System of Empirically Based Assessment	• IQ • ASD characteristics Emotional and behaviour regulation
Assouline et al. (2012)	59	ASD IQ Index Score ≥ 120	10.7	N/A (Index scores only)	Enrolled in mainstream class and gifted and talented program – evaluated in clinic	To examine the predictability of achievement among high ability youth with ASD (twice-exceptional) related to: diagnosis, measures of ability and educational interventions, and acceleration	Woodcock-Johnson III	• IQ • Eye-hand and fine motor coordination • Educational program
Eaves and Ho (1997)	76	ASD, PDD, range of severity	11.6	VIQ 58 PIQ 62	Enrolled special classes (36%); mainstream class with aid (38%); mainstream class without aid (16%) – evaluated in clinic	Investigated school placement and variables related to the philosophy of least restrictiveness, achievement, and teachers' perceptions of a group of children with autistic spectrum disorders who had been exposed to "best Practices" for past decade including early identification, preschool, typical peers, IEPs, communication training, behaviour support.	WRAT-R; Teacher's rating of academic skills	• Autism symptomatology • Behaviour • IQ • Class placement
Estes et al. (2011)	30	ASD IQ ≥ 70	6	89.57 (15.75)	Enrolled in mainstream (22) special ed/mainstream(5), mixed class (3) – evaluated at University autism centre	To investigate academic achievement patterns and their relationships with intellectual ability, social abilities and problem behaviour in a sample of children with ASD	DAS Achievement Tests	• IQ • Social skills • Problem behaviour
Foley-Nicpon et al. (2012)	39	HFA AS ≥ 120 in at least one domain	6 - 16.6	HFA: 120.29 (9.18) AS:	Enrolment had been accelerated 1 grade (4); participated in gifted and talented program (11) received special ed	To examine the cognitive and academic profiles among high ability students with ASD and identify possible profile differences between those with HFA and AS	Woodcock-Johnson III	• IQ • ASD subtype

				124.89 (13.59)	services (5) – evaluated in clinic			
Goldstein et al. (1994)	64	HFA IQ ≥ 70	16.11	95.88 (14.04)	Enrolment unspecified – evaluated in clinic	To investigate age differences in the academic profile of high-functioning autistic individuals as compared with normal controls	Detroit Tests of Learning Aptitude Woodcock Reading Mastery Tests Kaufman Test of Educational Achievement	ASD symptomatology
Griswold et al. (2002)	21	AS	10	100.14 (26.06)	Enrolled in various educational settings – evaluation in clinic	To develop a profile of the academic strengths, deficits, problem-solving and critical thinking abilities of children and youth with AS and to compare profile with academic performance of normed population.	WIAT	• Problem solving • Language-based critical thinking
Jones et al. (2009)	100	ASD Childhood autism	15.6	84.3 (18)	Enrolled in mainstream (57) and special school (43) – evaluated at school	To (i) establish an estimate of the frequency of specific attainment dips and peaks within the ASD population, and (ii) report the profile of intellectual ability of individuals with specific peaks or dips in their attainment profile.	Wechsler Objective Reading Dimensions Test of Word Reading Efficiency Wechsler Objective Numerical Dimensions	IQ
Kurth et al. (2010)	15	Autism	12.3 – 15.9	64.9 (inclusive) 60 (self-contained)	Enrolled in general education (7) or self-contained school settings (8) – evaluated at school	To describe the academic skill development of adolescents with autism who have been educated in inclusive and self-contained settings using three measures: cognitive assessments, adaptive behaviour, and academic achievement to describe strengths and concerns and to examine the effects of setting on academic skill acquisition.	Woodcock-Johnson III	• Education setting
Manti et al. (2011)	89	49.5% ASD 50.5% other	5.8	N/A	Enrolled in special school – evaluated at school	To explore the developmental course of children with autism attending special needs school, in particular the development of disorder symptoms and academic growth based on parent and teacher perceptions	Central Institute of Test Development (CITO) school attainment test	Autism symptomatology
Mayes-Dickerson and Calhoun (2003a)	116	Autistic Disorder Young group Older group	4.8 8.5	Low IQ group: 66 (11) High IQ: 99 (13)	Enrolment unspecified – evaluated in clinic	To analyze intelligence, cognitive, and academic profiles in a large sample of children with autism using current measures of ability to delineate strengths and weaknesses and to determine whether differences exist as a function of age and IQ	WIAT, Woodcock-Johnson	• IQ • Graphomotor skills
Mayes-	164	Autism	5.9	75	Enrolment unspecified	To identify and understand differences in ability	WIAT,	• IQ

Dickerson and Calhoun (2003b)					– evaluated in clinic	test scores as a function of age and IQ and to generate implications for educational programming and intervention	Woodcock-Johnson	• Graphomotor skills • Visual reasoning
Mayes-Dickerson and Calhoun (2007)	118	AD IQ ≥ 80	9	N/A	Enrolment unspecified – evaluated in clinic	To analyze learning, attention, graphomotor, and processing speed scores in typical children and children with ADHD, autism, anxiety, depression or ODD to determine differences between groups and to investigate interrelationships between and the coexistence of learning, attention, graphomotor and processing speed weaknesses.	WIAT or WIAT II	• Diagnosis - disability • Attention • Graphomotor ability • Processing speed
Mayes-Dickerson et al. (2008)	54	HFA IQ ≥ 70	8.2	101 (19)	Enrolment unspecified – evaluated in clinic	To analyze WISC-IV and WIAT-II scores in 54 children with HFA to determine if specific neuropsychological and learning profiles emerge and to compare findings with previous research on the WISC-III and WIAT.	WIAT II	IQ
Minshew et al. (1994)	54	HFA IQ ≥ 70	16.3	95.5 (15.54)	Enrolment unspecified – evaluated in clinic	To investigate differences between academic profiles of high functioning autistic individuals and age, gender, and IQ matched normal controls, particularly between procedural tasks and those involving comprehension, problem solving, comprehension and encoding.	Detroit Tests of Learning Aptitude (DTLA-2); Woodcock Reading Mastery Tests (WRMT-R); Kaufman Test of Educational Achievement (K-TEA)	ASD symptomatology
Myles et al. (1994)	41	HFA, PDD, PDD-NOS IQ ≥ 70	N/A 3-18yrs	N/A	Enrolment unspecified – records pulled from US metropolitan school district	To identify characteristics of students from a school district who had been identified as having HFA in order to understand the unique educational features of the disorder.	Woodcock-Johnson	• IQ • Speech/language • Social/adaptive behaviour
Troyb et al. (2014)	41 21	HFA OO*	13.81 12.91	HFA: VIQ 104.93 (14.55)	Enrolment unspecified – evaluation in university setting	To examine the reading, writing, and arithmetic problem solving of a group of children and adolescents who were diagnosed with ASDs in early childhood, but who no longer meet diagnostic criteria for these disorders	WASI Woodcock-Johnson III Test of Written Language	• IQ • Adaptive functioning • ASD symptomatology
Venter et al. (1992)	58	HFA Early IQ ≥ 60	14.69	80.24 (19.28)	Enrolled in special ed class (28), mainstream class (13), special school/sheltered-supervised employment (13); unemployed/not in school (3) – evaluated in clinic	To evaluate the role of various cognitive and behavioural measures in childhood in predicting social-adaptive and academic attainment in high-functioning autistic adolescents and adults	Neale Analysis of Reading Schonell Graded Spelling Test Enright Diagnostic Math Test	• Language • Autistic symptomatology • IQ • Adaptive behaviour •

Table 2. Purpose and key findings for included studies in the Predictors of Academic Achievement category

Author (year)	Purpose	Key findings
Ashburner et al. (2008)	• To explore the associations between sensory processing and classroom emotional, behavioural, and educational outcomes of children with ASD	• Auditory filtering difficulties, sensory under responsiveness, and sensory seeking - with academic underachievement in the children with ASD. • Under-responsive/seeks sensation and auditory filtering difficulties - 47% of variance in academic performance • IQ not significant predictor of academic performance • Auditory filtering, negative correlation with inattention to cognitive tasks; hyperactivity, tactile hypersensitivity positive correlation with inattention.
Assouline et al. (2012)[1]	• To examine the predictability of achievement among high ability youth with ASD (twice-exceptional) related to: diagnosis, measures of ability and educational interventions, and acceleration	• Working Memory and Processing Speed significantly correlated with reading, mathematics, and written language scores and significant predictors in reading achievement, and predictive of math and written language achievement. • Perceptual Reasoning Index scores positively correlated with oral language. • Involvement in talented and gifted programming predicted academic achievement in math, reading, and oral language
Eaves and Ho (1997)	• Investigated school placement and variables related to the philosophy of least restrictiveness, achievement, and teachers' perceptions of a group of children with autistic spectrum disorders who had been exposed to "best Practices" for past decade including early identification, preschool, typical peers, IEPs, communication training, behaviour support.	• Age, IQ, and severity of autism were related to class placement and school achievement. • Older, less able, more autistic pupils were more likely to be in special classes. • Teachers reported 25% were average compared to their peers in academic subjects, about 10% were average in behavioural areas such as working independently, completing tasks, and paying attention. • Teachers rated participants as having difficulties in abstract reasoning, language expression and comprehension, following instructions and problem solving. • IQ predicted school achievement. • None of the children with IQs below 40 had literacy skills; for those above 40, achievement was correlated with IQ. • Teachers rating of academic skills correlated with achievement results. • Teacher reported high levels of class behaviour that interfered with achievement.
Estes et al. (2011) [1]	• To investigate academic achievement patterns and their relationships with intellectual ability, social abilities and problem behaviour in a sample of children with ASD	• Significant discrepancies between actual academic achievement and the level of academic achievement predicted from overall intellectual ability. • 27/30 demonstrated at least one discrepancy in Spelling, Word Reading, or Basic Number Skills. • Lower than predicted achievement was observed in at least one domain in 18 children and 18 children demonstrated at least one area of higher than predicted achievement. • Word Reading and Basic Number Skills were related to IQ, whereas Spelling was not. • After controlling for IQ, level of social skills at age 6 was predictive of level of academic achievement at age 9. • Most strongly, social skills at age 6 were related to Word Reading scores at age 9. Concurrent measures of social skills at age 9 were not associated with academic achievement at age 9, over and above Nonverbal IQ. • Furthermore, level of problem behaviours assessed at either age 6 or 9 years of age, was not significantly correlated with level of academic achievement at age 9.
Kurth et al. (2010)	• To describe the academic skill development of adolescents with autism who have been educated in inclusive and self-contained settings	• No significant difference between groups (students in inclusive or self-contained settings) on intelligence or adaptive behaviour measures. • Statistically significant differences between groups on achievement. • Included group outperformed self-contained group on all subtests (reading, writing, math) although matched for

	using three measures: cognitive assessments, adaptive behaviour, and academic achievement to describe strengths and concerns and to examine the effects of setting on academic skill acquisition.	intelligence and adaptive behaviour. • Academic achievement scores were generally one to four standard deviations below the mean expected based on student grade level. • Areas of strength in concrete, procedural academic tasks. • Relative weaknesses in performing abstract and inferential tasks, including passage comprehension, writing passages, and solving applied math problems (e.g. word problems).
Manti et al. (2011)	• To explore the developmental course of children with autism attending special needs school, in particular the development of disorder symptoms and academic growth based on parent and teacher perceptions	• Teachers and parents perceptions of children's symptomology differed significantly with teachers but not parents, reporting a significant reduction after two years. • Both groups had gains in different aspects of school-based academic skills but no association between symptom reduction and academic growth.
Mayes-Dickerson et al. (2008)	• To analyze WISC-IV and WIAT-II scores in 54 children with HFA to determine if specific neuropsychological and learning profiles emerge and to compare findings with previous research on the WISC-III and WIAT.	• Written Expression was significantly lower than the other achievement scores and the norm. • Word Reading, Reading Comprehension, and Numerical Operations did not differ significantly from each other or the norm. • Correlations between FSIQ and achievement were all significant. The best overall single predictor of reading, math, and writing achievement was FSIQ. • FSIQ was the most powerful predictor of achievement in word reading, reading comprehension, math, and written expression.
Venter et al. (1992)	• To evaluate the role of various cognitive and behavioural measures in childhood in predicting social-adaptive and academic attainment in high-functioning autistic adolescents and adults	• Predictors from T1 measures: Early non-verbal IQ and speech before 5 years were significant predictors of achievement scores in all areas: reading accuracy and reading comprehension, spelling, and computations. • Early language deviance was associated with reading accuracy and comprehension above an 8-year-old level at follow-up. • There was also an association between early PPVT scores and decoding and spelling above an 8-year-old level. • Predictors from T2 measures: Verbal IQ, current deviance of social behaviour, and the PPVT were all significant predictors of academic achievement. • Verbal IQ and comprehension of oral language were significant predictors of all achievement scores except mathematic computations. • Performance IQ and current language deviance were associated with reading accuracy, comprehension, and spelling at above an 8-yearold level. • The PPVT was also associated with reading accuracy and comprehension above an 8-year-old level at follow-up.

[1]These papers were also included in the category 'Areas of Relative Academic Strengths and Weakness'

Table 3. Purpose and key findings for included studies in the Areas of Relative Academic Strengths and Weakness category

Author (year)	Purpose	Key findings
Griswold et al. (2002)	• To develop a profile of the academic strengths, deficits, problem-solving and critical thinking abilities of children and youth with AS and to compare profile with academic performance of normed population.	• Participant scores for academic achievement varied considerably from significantly above to far below what might be predicted from their grade level. • Aggregate mean Language Composite scores on the WIAT fell within the average range while scores on the TOPS-R/TOPS-A were on average 2 standard deviations below the mean. • Lowest achievement scores (but within the average range) were shown for Numerical Operations, Listening Comprehension and Written Expression. • Relative strengths on the WIAT in oral expression and basic reading.
Jones et al. (2009)	• To (i) establish an estimate of the frequency of specific attainment dips and peaks within the ASD population, and (ii) report the profile of intellectual ability of individuals with specific peaks or dips in their attainment profile.	• 72% of participants had at least 1 area of literacy or mathematical achievement that was highly discrepant from their general intellectual ability. • No significant differences were found at the group mean level, across the spectrum of IQ, between intellectual skill and either arithmetical ability, basic word reading or spelling. • However, 42.4% of individuals had a significant discrepancy between full scale IQ and word reading (Reading Peak and Dip subgroups) or arithmetic (Arithmetic Peak and Dip subgroups).
Mayes-Dickerson and Calhoun (2003a)	• To analyze intelligence, cognitive, and academic profiles in a large sample of children with autism using current measures of ability to delineate strengths and weaknesses and to determine whether differences exist as a function of age and IQ	• For children 3–7 yrs in both low and high IQ groups, nonverbal IQs were significantly greater than verbal IQs. • There was a nonsignificant difference between nonverbal and verbal IQs for children 6- 15yrs. • Generally, children performed well academically relative to IQ. • For young children in the high IQ group, mean academic achievement test scores in reading decoding, math, and writing were in the average range and were commensurate with IQ. • For older children in the low IQ group, mean math and spelling scores were within expectancy based on IQ, and reading decoding was significantly higher. • Approximately half of these children earned reading decoding and spelling standard scores that were within normal limits, in spite of below normal intelligence. This is consistent with their relative strength in rote learning and previous reports of hyperlexia in some children with autism. • However, most of the older children in the low IQ group were not able to complete the reading comprehension and written expression subtests, suggesting weaknesses in these areas. • Older children in the high IQ group also performed well in reading decoding, math, and spelling, as well as in reading comprehension. Mean scores were in the average range and were consistent with IQ. • Specific learning disabilities in reading decoding or reading comprehension were uncommon and found in only 7% of the children. • A specific learning disability in math was also not prevalent (22%). • However, 63% of the children had a specific learning disability in written expression, and mean performance on the WIAT Written Expression subtest was significantly lower than IQ and other academic scores.
Mayes-Dickerson and Calhoun (2003b)	• To identify and understand differences in ability test scores as a function of age and IQ and to generate implications for educational programming and intervention	• Significant and positive relationships between increasing IQ and increasing age until age 8, when verbal and nonverbal IQs for the total group stabilized. • Visual reasoning test scores significantly exceeded graphomotor scores in all four of the IQ/age groups, and visual reasoning was superior to overall IQ in all groups except school-age children with high IQs. • Academically, school-age children in the low-IQ group performed at or above expectancy based on IQ. Math, spelling, and written expression scores were not significantly different than IQ, and reading scores significantly

		exceeded IQ. • For both of the high-IQ groups, mean IQ, reading, math, and spelling scores were in the average range. • For school-age children with high IQs, though, written expression was significantly lower than IQ.
Myles-Dickerson et al. (1994)	• To identify characteristics of students from a school district who had been identified as having HFA in order to understand the unique educational features of the disorder.	• Students tended to have academic achievement scores writing, reading and mathematics within one standard deviation of the mean, but at the lower end of the average continuum. • Students received the highest mean standard score on the Reading subtest (M = 92.00) and the lowest mean score on the Mathematics subtest (M = 80.00).
Troyb et al. (2014) [2]	• To examine the reading, writing, and arithmetic problem solving of a group of children and adolescents who were diagnosed with ASDs in early childhood, but who no longer meet diagnostic criteria for these disorders	• Groups were matched on age, sex, and nonverbal IQ; however, the HFA group scored significantly lower than the optimal outcome (OO) and typically developing (TD) groups on verbal IQ. • All three groups performed in the average range on all subtests measured, and no significant differences were found in performance of the OO and TD groups. • The HFA group scored significantly lower on subtests of reading comprehension and mathematical problem solving than the OO group.

[2]This paper was also included in the category 'Levels of Academic Achievement'

Table 4. Purpose and key findings for included studies in the Levels of Academic Achievement category

Author (year)	Purpose	Key findings
Foley-Nicpon et al. (2012)	• To examine the cognitive and academic profiles among high ability students with ASD and identify possible profile differences between those with HFA and AS	• Verbal and nonverbal skills were higher than working memory and processing speed skills for HFA and AS groups. • The size of the discrepancy, particularly when comparing Verbal Reasoning and Processing Speed or Perceptual Reasoning and Processing Speed, is larger than what is typical for the gifted student population, but not uncommon for high ability students with disabilities or students with ASD. • The AS group had significantly higher verbal comprehension scores than the HFA group. • Processing speed scores were higher for students with HFA than for students with AS. • Vocabulary skills of the AS group were higher than among those with HFA. Group differences were not apparent on tests measuring verbal abstract reasoning and social judgment. • Students with HFA performed better on a task of visual scanning and cognitive processing than those with AS. • Both groups demonstrated clinically lower scores on Coding than on other subtests (Matrix Reasoning for both groups and Vocabulary and Similarities for the AS group). • Academic domain scores did not differ amongst the AS and HFA groups, but there was a notably large score distribution.
Ashburner et al. (2010)	• To compare teachers' perceptions of academic performance, behavioural and emotional regulation of students with ASD compared to TDC	• Students with ASD exhibit significantly higher levels of behavioural and emotional difficulties than their typically developing peers. • 43% had clinically significant issues with perfectionism. • A high proportion of students with ASD had attention difficulties including hyperactive symptoms (36% clinically significant and 36% borderline) and inattentive symptoms (32% clinically significant and 43% borderline). • High rates of academic under-achievement of the students with ASD (54% of students with ASD as compared to 8% of typically developing students) • Poor attention and emotional regulation in classroom
Goldstein et al. (1994)	• To investigate age differences in the academic profile of high-functioning autistic individuals as compared with normal controls	• Younger (<13 years) participants with ASD performed as well or better than younger controls on psychoeducational measures of mechanical and procedural skills, and on some complex, interpretive tasks. • However, participants with ASD performed more poorly than controls on tasks that involve following complex linguistic instructions. • Younger participants with ASD and controls did not differ significantly from each other on interpretive tasks, while the older participants with ASD did significantly more poorly than the older controls on such tasks.
Mayes-Dickerson and Calhoun (2007)	• To analyze learning, attention, graphomotor, and processing speed scores in typical children and children with ADHD, autism, anxiety, depression or ODD to determine differences between groups and to investigate interrelationships between and the coexistence of learning, attention, graphomotor and processing speed weaknesses.	• Control children performed better than children with autism and ADHD in all areas. • Children with ADHD and autism did not differ, except that children with ADHD had greater learning problems. • Attention, graphomotor and speed weaknesses were likely to coexist, the majority of children with autism and ADHD had weaknesses in all three areas, and these scores contributed to prediction of academic achievement.

Minshew et al. (1994)	• To investigate differences between academic profiles of high functioning autistic individuals and age-, gender, and IQ matched normal controls, particularly between procedural tasks and those involving comprehension, problem solving, comprehension and encoding.	• Significant differences between ASD and controls were found for all subtests of the DTLA-2, Visual-Auditory Learning and Passage Comprehension, and Reading Comprehension. • There was a consistent pattern of significant differences on the comprehension tasks in the absence of such differences on encoding and procedural tasks. • ASD subjects did not differ from controls with regard to overall reading and mathematical scores, nor did they differ with regard to basic procedural skills related to reading. • Significant differences were found for those composites that contrasted procedural and mechanical skills on the one hand with comprehension skills on the other. • This dichotomy was also reflected in the finding that the autistic group was better at Word Attack relative to Word Identification, while the opposite was true for the control group.