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IQ in Children with Autism Spectrum Disorders: Data from the SNAP Project

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ABSTRACT

Background: Autism spectrum disorder (ASD) was once considered to be highly associated with intellectual disability and to show a characteristic IQ profile; with strengths in Performance over Verbal abilities and a distinctive pattern of 'peaks' and 'troughs' at the subtest level. However, there is little data from epidemiological studies.

Method: Comprehensive clinical assessments were conducted with 156 ten-to-fourteen-year-old children (mean (SD)=11.7 (0.9)) seen as part of an epidemiological study (81 childhood autism, 75 other ASD). A sample weighting procedure enabled us to estimate characteristics of the total ASD population.

Results: 55% of children with ASD had an intellectual disability (IQ<70) but only 16% had moderate to severe intellectual disability (IQ<50). 28% of children with ASD had average intelligence (115>IQ≥85) but only a minority (3%) were of above average intelligence (IQ≥115). There was some evidence for a clinically significant PIQ/VIQ discrepancy but discrepant verbal versus performance skills were not associated with a particular pattern of symptoms, as has been previously reported. There was mixed evidence of a characteristic subtest profile: Whilst some previously reported patterns were supported (e.g. poor Comprehension); others were not (e.g. no 'peak' in Block Design). Adaptive skills were significantly lower than IQ and were associated with severity of early social impairment as well as IQ.

Conclusions: In this epidemiological sample, ASD was less strongly associated with intellectual disability than traditionally held and there was only limited evidence of a distinctive IQ profile. Adaptive outcome was significantly impaired even for those children of average intelligence.

[Word count = 247]

INTRODUCTION

The long-established view of intellectual abilities in autism spectrum disorders (ASD) was that up to 75% of individuals had an intellectual disability (previously referred to as 'mental retardation'; Schalock et al., 2007); defined by an IQ<70, alongside accompanying impairment in everyday functioning (Volkmar et al., 2004; Tsatsanis et al., 2005). Furthermore, a widespread clinical view is that Performance IQ (PIQ) was commonly higher than Verbal IQ (VIQ) (e.g., Lincoln et al., 1995; Mayes & Calhoun, 2003). It has been reported that individuals who show a particularly discrepant PIQ-VIQ profile (those with a non-verbal advantage) have higher levels of social impairment, increased head circumference and enlarged brain volume (Joseph et al., 2002; Tager-Flusberg & Joseph, 2003; Black et al., 2009). Another widely accepted view is that at a subtest level (e.g., on Wechsler intelligence tests) a characteristic profile of strengths (or 'peaks') on subtests such as Block Design and weaknesses (or 'troughs') on subtests such as Comprehension is found (Happé, 1995; Lincoln et al., 1995; Mayes & Calhoun, 2003; de Bruin et al., 2006).

However, many of these widely held views about the intelligence of children with an ASD were first formed several decades ago when our conceptualisation of autism, in terms of to whom the diagnosis is applied and how prevalent the disorder is, was very different from today and historical data might not apply to children who currently receive an ASD diagnosis (Charman et al., 2009; Fombonne, 2009). Most studies have used clinically ascertained cohorts and there has been limited evidence presented within an epidemiological framework. The prevalence of ASD is now recognised to be between 60 and 116 per 10,000, depending on the strictness with which the diagnostic criteria are applied (Baird et al., 2000; Chakrabarti & Fombonne, 2005; Green et al., 2005; Baird et al., 2006; Rice et al., 2009).

There is evidence from recent epidemiological studies that only approximately 50% of children with ASD have intellectual disability (IQ <70) (Bertrand et al., 2001; Chakrabarti &

Fombonne, 2005), although this rose to approximately 60% and 70%, respectively, for the more narrowly defined autism group. However, both these studies had only moderate sample sizes (N=42 Bertrand et al., 2001; N=57 with cognitive data Chakrabarti & Fombonne, 2005). By contrast, in another recent prevalence study with a much larger sample (N=987, of whom N=880 had psychometric or developmental test data) 68% had intellectual disability (Yeargin-Allsopp et al., 2003).

As part of a prevalence study of ASD we assessed a group of 158 nine-to-fourteen-year-old children with an ASD drawn from a geographically-defined population (Special Needs and Autism Project (SNAP); see Baird et al., 2006; for details). A sample weighting procedure enabled us to estimate characteristics of the total population of children with an ASD. This provided us with the opportunity to examine the following questions regarding the profile of cognitive abilities adaptive behaviour of children with ASD within an epidemiological framework:

1. What proportion of children with an ASD have severe/profound, moderate and mild intellectual disability?
2. What proportion of children with an ASD have average or above-average intellectual ability?
3. Does intellectual ability differ in girls and boys with an ASD?
4. Is there a characteristic PIQ-VIQ profile and are there peaks (e.g., in Block Design) and troughs (e.g., in Comprehension) on the Wechsler subtests?
5. What is the level of adaptive behaviour in children with ASD and what characteristics are associated with adaptive behaviour?

METHOD

The study was approved by the South East Multicentre Research Ethics Committee (REC) (00/01/50).

SNAP cohort

The SNAP sample was drawn from a total population cohort of 56,946 children. Due to the impossibility of efficiently screening all children for ASD we adopted a screening, stratification and weighted epidemiological design to target the subgroup most at risk for ASD (see Baird et al., 2006; for details). All those with a current local clinical diagnosis of ASD (N=255) or considered 'at risk' for being an undetected case by virtue of having a statement of Special Educational Needs (SEN; N=1,515) but not a local clinical diagnosis were surveyed (mean age=10.3, SD=1.1) using the Social Communication Questionnaire (SCQ; Berument et al., 1999). A Statement of SEN is a legal document issued by UK local education authorities when children require significant additional support in school due to any learning and/or behavioural problems. Note that this will likely skew captured cases to the lower IQ cases but it does allow an epidemiological design to be adopted using a statistical weighting procedure based on all those approached to be screened. A stratified subsample (coincidently also N=255; 223 boys, 32 girls) drawn from across the range of SCQ scores received a comprehensive diagnostic assessment including standardized clinical observation (Autism Diagnostic Observation Schedule - Generic (ADOS-G); Lord et al., 2000) and parent interview assessments of autistic symptoms (Autism Diagnostic Interview-Revised (ADI-R); Lord et al., 1994), language and IQ, psychiatric comorbidities and a medical examination.

The age at which participants were assessed ranged from 9.8 to 14.5 years (mean (SD)=11.5 (0.9)). On the basis of all available information, the team used ICD-10 (WHO, 1993) research criteria to derive a clinical consensus diagnosis of childhood autism (N=81; 77 boys, 4 girls) and 'other ASDs' (N=77; 65 boys, 12 girls). Of the 77 cases with consensus diagnosis of 'other ASDs'; 6 met ICD-10 criteria for 'atypical autism' due to late onset; 61 met ICD-10 criteria for 'atypical autism' due to sub-threshold symptomatology; 7 met ICD-10 criteria for 'pervasive developmental disorder unspecified' due to lack of information

(incomplete assessment, adopted children for whom early history was not available) and 3 met ICD-10 criteria for 'overactive disorder associated with mental retardation and stereotyped movements' (see Baird et al., 2006; for details). 97 children did not meet clinical consensus diagnosis for childhood autism or other ASD, although with one exception they met criteria for another ICD-10 neurodevelopmental condition. The present paper does not report further on these non-ASD cases.

Measures

Adaptive behaviour was assessed using the Vineland Adaptive Behavior Scales – Expanded Edition (VABS; Sparrow et al, 1984; n=140). IQ was measured using the Wechsler Intelligence Scale for Children (WISC-III-UK; Wechsler, 1992; n=127), Raven's Standard Progressive Matrices (SPM) or Coloured Progressive Matrices (CPM; Raven, 1990a,b), depending on the child's ability. For the 21 cases where SPM (n=2) or CPM (n=19) but not WISC full scale IQs were available, imputed full-scale IQs were obtained using the regression relationship of full scale IQ to SPM/CPM IQ within each diagnostic group. For the 10 cases where no direct cognitive testing was possible 8 cases had Adaptive Behaviour Composite on the VABS below 20 and these cases were assigned an IQ score of 19 to reflect their profound level of intellectual disability; 2 cases had no IQ test data and no VABS data and were excluded from the current analysis leaving a final sample of N=156 (81 childhood autism, 75 other ASD; 16 girls, 140 boys).

Statistical analysis

Stratification of the screened ASD/SEN sample was based on whether or not a child had a locally recorded ASD diagnosis (yes/no) and 4 levels of SCQ score (low score (<8), moderately low score (8-14), moderately high score (15-21), high score ($\geq$22); see Baird et al., 2006; Figure 1 for details). Use of weights allowed all statistics such as proportions, means and group differences to be presented as target population estimates, taking account

not only of the differences in sampling proportions according to SCQ score and local ASD diagnosis, but also the differential response to the SCQ associated with a prior local ASD diagnosis, health district and child's sex. All reported frequencies are unweighted. Standard deviations, Wald test statistics (adjusted t and F-tests) and p-values were calculated using the linearisation version of the robust parameter covariance matrix as implemented by the svy procedures of Stata 9 (Stata, 2005).

RESULTS

The (weighted) mean (SD) IQ for the total ASD sample was 69.4 (24.1). IQ was similar for the childhood autism (67.9 (24.0)) and other ASD (70.1 (24.2)) groups (t=0.43, p=.67). Table 1 shows the mean weighted proportion (with 95% confidence intervals (CI)) of the sample falling into each of the ICD-10 categories of 'intellectual disability' ('mental retardation'), as well as those falling into the below average (70-84), average (85-99; 100-114) and above average (≥115) IQ ranges.

55.2% (95% CI 42.1% - 67.7%) of the total ASD sample were in the intellectual disability range (IQ<70), 39.4% in the mild (50-69), 8.4% in the moderate (35-49) and 7.4% in the severe (20-34; 1.9%) or profound (<20; 5.5%) intellectual disability ranges. These proportions were similar for the childhood autism and other ASD subgroups who did not differ from one another (childhood autism: 53.2% (<70), 35.2% (50-69), 10.1% (35-49), 7.9% (<35) vs. other ASD: 56.2% (<70), 41.5% (50-69), 7.5% (35-49), 7.2% (<35); weighted χ^2=0.13, p=.94). Of the children outside the intellectual disability range, 16.6% of the total ASD sample were in the below average IQ range (70-84), 25.4% in average (85-114) and 2.7% in the above average (≥115). These proportions were similar for the childhood autism and other ASD subgroups who did not differ from one another (childhood autism: 18.4% (70-84), 26.5% (85-114), 1.9% (≥115) vs. other ASD: 15.7% (70-84), 24.9% (85-114), 3.1% (≥115); weighted χ^2=0.11, p=.93).

The mean (SD) imputed IQ was 61.8 (16.3) for girls (actual N=16, weighed N=37) was marginally lower than that for boys (71.7 (25.6); actual N=140; weighted N=119) (t=1.97, p=.05). 78.4% (95% CI 43.7% - 94.5%) of girls had an intellectual disability (IQ<70) compared to 48.0% (95% CI 35.9% - 60.5%) of boys, a proportion that just missed significance (weighted χ^2=3.64, p=.06).

------- Table 1 about here ------

127 of the total ASD sample (61 childhood autism, 66 other ASD; 116 boys, 11 girls) were able to complete 10 subtests (5 Performance, 5 Verbal) of the WISC-III. Full Scale IQ, PIQ and VIQ for the total ASD sample and the childhood autism and other ASD subgroups, and for the groups with and without intellectual disability, are shown in Table 2. Using weighted paired t-tests; PIQ was marginally higher than VIQ (t=1.85, p=.07) for the total ASD sample but not for the childhood autism or other ASD subgroups (both p>.10). For the subgroup with WISC FSIQ <70 PIQ and VIQ were not different and for the subgroup with WISC FSIQ≥70 PIQ was marginally higher than VIQ (t=1.75, p=.09).

------- Table 2 about here ------

However, the above analyses speak to group mean differences only. In order to examine PIQ-VIQ discrepancy profiles at the level of the individual child, the proportion of children with a *clinically significant* PIQ-VIQ discrepancy from the standardisation of the test of >=12 points (Wechsler, 1992) was examined to create 3 groups: PIQ>VIQ, PIQ=VIQ and PIQ<VIQ. The (weighted) proportions of the respective 3 groups were: total ASD sample (28.3%, 58.8% and 12.9%), childhood autism subgroup (26.9%, 52.7% and 20.4%) and other ASD subgroup (28.9%, 61.3% and 9.8%). In each case the most common subgroup was the PIQ=VIQ subgroup. However, when the proportions of children with clinically discrepant profiles (that is PIQ>VIQ vs. PIQ<VIQ excluding children with PIQ=VIQ) are compared using weighted logistic regression there was a significantly higher proportion of children with

PIQ>VIQ than PIQ<VIQ in the total ASD sample (t=2.10, p=.04) and a non-significant trend to such a difference in the other ASD group (t=1.92, p=.07). Weighted regressions showed that the PIQ-VIQ profile groups did not differ on either their past symptom severity (ADI-R 4-to-5/ever algorithm scores) or their current symptom severity (ADOS-G algorithm scores) (all p>.18); see Table 3.

------- Table 3 about here ------

The individual WISC subtest scores and the mean subtest score are shown in Table 4 for the total ASD sample and the childhood autism and high IQ (>70) subgroups, with the latter two subgroups being selected as most likely to show the characteristic subtest profile for parsimony. In order to examine the subtest profile a series of weighted paired tests were conducted to determine if each subtest score was significant different from the subtest mean score across 10 subtests. In order to take account of multiple comparisons a Bonferroni correction was applied so that significance was set at p<.05/30 = p<.001. Table 4 shows which subtests were above (+) and below (-) the mean. For the total ASD sample and the high IQ subsample Picture arrangement was above the subtest mean and Vocabulary and Comprehension were below the subtest mean. For the total ASD sample only Picture completion was also above the subtest mean. For the childhood autism subgroup no subtests were above the subtest mean and only Comprehension was below.

------- Table 4 about here ------

124 participants completed the SPM and the WISC-III. Following Dawson et al. (2007) and Bölte et al. (2009), we compared the IQ scores across the different instruments. SPM IQ (88.3 (18.1)) was significantly higher (weighted paired t-test) than both the WISC FSIQ (75.6 (20.4) and WISC PIQ (79.9 (21.9)) scores (t=7.78 and t=4.37, both p<.001). 14.5% (95% CI 7.3% - 26.8%) of children who completed the SPM had a SPM IQ<70.

Adaptive behaviour

Adaptive behaviour scores as measured by the VABS are shown in Table 5 that also shows the imputed IQ for the participants with VABS data (excluding the 8 cases who had no WISC, SPM or CPM test score who were assigned an imputed IQ score of 19 on the basis of their VABS standard score <20). ABC was lower than IQ for the total ASD sample (t=7.73, p<.001; weighted paired t-test) and for the childhood autism and other ASD subgroups (t=15.3 and t=5.1, both p<.001) and high and low IQ subgroups (t=16.5 and t=4.3, both p<.001). Analysing the between-domain differences for the total ASD only (for reasons of parsimony as the pattern was similar across all 4 subgroups) showed that Communication domain scores were higher than Social and Daily Living Skills domain scores (t=2.64, p<.01 and t=8.24, p<.001, respectively) and Daily Living Skills domain scores were lower than Social domain scores (t=224, p<.03). A weighted multivariate linear regression was run to identify the unique associations to adaptive behaviour (VABS Adaptive Behaviour Composite Score) with imputed IQ, previous symptom severity (ADI-R 4-to-5 years Social, Communication and Repetitive domain scores) and current symptom severity (ADOS-G Social, Communication and Repetitive domain scores) entered as predictors. Only IQ (β=.33, t=4.97, p<.001) and ADI-R 4-to-5 years Social domain score (β=-.99, t=3.73, p<.001) were associated with adaptive functioning.

------- Table 5 about here ------

DISCUSSION

This study adds to our understanding of the level and profile of intelligence of children with an ASD in a number of ways. First, it confirms findings from other recent epidemiological studies that only approximately half of individuals with ASD have intellectual disability (Bertrand et al., 2001; Chakrabarti & Fombonne, 2005) and fewer than 1-in-5 have moderate to severe disability (IQ<50). The present sample is considerably larger than in both these previous studies and the coverage of modern, well standardised IQ

assessments is more complete. The childhood autism and other ASD groups did not differ from one another, either in terms of the group mean IQ (~70 in both groups) or in the proportion of children who met criteria for intellectual disability (IQ<70). Second, we also report for the first time within an epidemiological study the proportion of children with an ASD with average intelligence (85-114) – approximately one quarter – as well as the proportion with above average (<115) – a few percent. Marginally more girls than boys had an intellectual disability; but the low number of girls assessed (N=14) mean that the confidence intervals for these analysis are wide and overlapping and this finding requires confirmation in future studies.

These findings need to be understood in the context of the particular sampling framework that we adopted in the prevalence study (see Method and Baird et al., 2006). We only screened children with a statement of special educational needs or a local clinical diagnosis of ASD – this was to avoid screening all 57,000 children which would have been both impractical and inefficient. Although there are a wide number of reasons why children in the area in the late 1990s would have received statements, problems in development and learning, as well as behaviour and/or a known medical condition that might require recognition and/or support at school would be the most common reasons. Thus, we will have not have ascertained some cases of ASD who had not been recognised by local teams by the age of 10 years and who had not been deemed in need of support in school. These are likely to have been cases of average or above average intelligence. That is, our sampling frame was biased in the direction of lower intelligence individuals, making it likely our finding that half of children with an ASD have an IQ of 70 or above should be considered a minimum estimate.

In terms of IQ profiles, we found weak support for a distinctive PIQ-VIQ profile. Whilst at a group mean level PIQ was higher than VIQ (but only by a few points), when

examined at the level of clinically meaningful PIQ-VIQ discrepancies the most common profile was for PIQ to be similar to VIQ. When the frequency of PIQ>VIQ was compared to the opposite pattern (VIQ>PIQ) it was found to be slightly more common. These findings are a contrast to some previous studies that have found larger PIQ advantages compared to VIQ (e.g., Lincoln et al., 1995; Mayes & Calhoun, 2003). We found no support for the idea that individuals with a non-verbal advantage have higher levels of social impairment, casting doubt on this as a putative meaningful subgroup (Joseph et al., 2002; Tager-Flusberg & Joseph, 2003; Black et al., 2009).

There was some support for a distinctive profile at the WISC subtest level but it was only partly consistent with much of the previous literature. In line with other studies we found that performance on the Vocabulary and Comprehension subtests was poor compared to other abilities. However, neither Block Design nor Object Assembly were significant strengths as has been reported previously (Happé, 1995; Lincoln et al., 1995; Mayes & Calhoun, 2003; Caron et al., 2006). Instead, Picture completion and Picture arrangement, that both heavily reply on visual materials, were areas of strength ('peaks') in the total ASD sample and in the subgroup with IQ>70, although somewhat counter-intuitively the latter also taps some level of social understanding (order events in time, many with drawn human characters).

The fact that some widely-held clinical views about the relative strengths and weakness of the intelligence in individuals with ASD were not supported in this epidemiological study might have reflected the fact in clinical samples language delay and weaker verbal than non-verbal skills are part-and-parcel of the reason for referral for many children with ASD. We were able to test this out in the current study by looking at the profiles for children who had received a local clinical diagnosis as opposed to a research ICD-10 consensus diagnosis as part of the research study using a sampling design to estimate prevalence (weighted estimates were 58% of children with childhood autism and 23% of

children with other ASD had a local clinical diagnosis; see Baird et al., 2006; for details). The children with a local diagnosis seen as part of the present study (N=87) had a higher IQ (80.0 (20.3)) that the cases with an ICD-10 research diagnosis, most likely explained by the fact that many children who within the study design following independent and thorough assessment met our research ASD criteria had low IQ and a local clinical diagnosis of developmental delay/intellectual disability. However, there was little evidence of a PIQ (80.9 (19.4)) vs. VIQ (82.7 (21.9)) discrepancy and at the level of WISC subtests their pattern was very similar to that reported in Table 4 with the 2 lowest subtest being Coding and Comprehension and the 2 highest being Picture completion and Picture arrangement (data not shown, available on request from the corresponding author).

IQ measured by the SPM was 20 points higher than WISC FSIQ as has been previously reported by Dawson et al. (2007) and Bölte et al. (2009) and only 14.5% scored <70. There has been discussion as to whether this represents an isolated skill for individuals with ASD or whether it is indicative of intact cognitive processing abilities that are not represented in the higher-order cognitive processing abilities tapped by broader intelligence tests such as the WISC that in part test social learning as well as intelligence (see Bölte et al., 2009; Dawson et al., 2007).

Overall adaptive outcome was significantly lower than IQ and the discrepancy was most notable in the high IQ subgroup, where adaptive behaviour scores lagged ~35 points behind IQ. This demonstrates that the picture seen in clinical cohorts (Carpentieri & Morgan, 1996; Liss et al., 2001; Klin et al., 2007; Saulnier & Klin, 2007) is true more generally of the whole population of children with ASD and is not an artefact of referral bias of the more adaptively impaired children to clinical services. Also notable was the fact that it was in the domain of Daily Living Skills that children with ASD lagged furthest behind their age peers. Higher IQ and less severe social ASD symptoms at 4-to-5 years were associated with better

overall adaptive outcome at age 11 years. Whilst in a cross-sectional study we are unable to securely answer the question as to how social impairments lead to poorer development of adaptive competencies, autism significantly impairs everyday functioning. One important clinical conclusion is that because a child scores well on an IQ test, notwithstanding the promise this suggests in terms of academic progress, this should not be mistaken for their ability to cope in the everyday world that can be considerably impaired even for the most 'high functioning' individual.

Strengths and limitations of the present study

The strengths of the present study include: the epidemiological framework of the study using a stratification design and population weighting procedure; the comprehensive diagnostic assessment and use of a clinical consensus decision-making process that was corroborated by independent expert rating (see Baird et al., 2006). However, whilst the epidemiological stratification design allows us to derive population estimates using sampling weights the decision to only screen cases with a local clinical diagnosis and/or children with a statement of special education needs means that we will not have captured all higher IQ children with an ASD. Another limitation of the present study is that the study is cross-sectional and included children of one age only drawn from an 18 month birth cohort. Consequently, we are unable to comment on how the profile of IQ and adaptive behaviour might vary at a group or an individual level across childhood. The age of the sample is also a strength, both in that diagnosis by this age is relatively secure as shown by high inter-rater reliability in our study and in that direct cognitive testing is possible at this age with all but the most profoundly intellectually disabled children.

Conclusions

Some long-held clinical views were not supported at a population level: only half of children with ASD have an intellectual disability; children with ASD did not show the

commonly understood characteristic profile on the WISC either in terms of PIQ-VIQ discrepancy or in terms of peak skills on particular WISC subtests. Adaptive behaviour was significantly poorer than other skills, reflecting how maladapative it is to grow up as a child with autism in a world where social interaction and communication are central to so much of everyday life. One further feature that is notable in the present epidemiological sample that has been previously described in clinical and research cohorts (Charman et al., 2005; Lord et al., 2006) is the variability of outcome by middle children in terms of IQ, and to a lesser extent adaptive behaviour. An important task for future work, including in both prospective studies of population cohorts and in intervention trials, is determining endogenous and exogenous factors that explain this great variability in outcome.

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Table 1 IQ for the total ASD sample (weighted %; 95% CIs; actual N)

	IQ*		
	%	*95% CIs*	*N*
Level of intellectual disability/ability			
Severe/profound (IQ<35)	7.4%	3.0% – 17.1%	11
Moderate (IQ 35-49)	8.4%	3.6% – 18.4%	12
Mild (IQ 50-69)	39.4%	26.0% – 54.7%	49
Below average (70-84)	16.6%	9.9% – 26.6%	33
Average (85-114)	25.4%	16.6% – 36.9%	44
Above average (≥115)	2.7%	1.2% – 5.9%	7
Total sample	*100%*		*156*

* Imputed IQ; see text for details of imputation

Table 2 WISC-III FSIQ, PIQ and VIQ for the total ASD sample and the diagnostic and IQ subgroups

		FSIQ	**PIQ**	**VIQ**
	N	Mean (SD)	Mean (SD)	Mean (SD)
All ASDs	127	75.5 (20.7)[a]	79.7 (22.1)[b]	75.9 (20.0)
Diagnostic subgrouping				
Childhood autism	61	76.2 (20.4)	79.8 (19.7)	76.9 (23.1)
Other ASD	66	75.2 (20.9)[a]	79.7 (23.2)[b]	75.4 (18.8)
WISC FSIQ subgrouping				
IQ ≥ 70	77	92.1 (13.5)	96.1 (16.1)	91.0 (15.2)
IQ < *70*	50	57.6 (8.5)	62.0 (11.6)	59.6 (8.5)

Values in row with different superscripts are significantly different from each other

Table 3 Mean (SD) ADI-R and ADOS-G scores for the PIQ-VIQ discrepancy subgroups

	PIQ>VIQ N=32	**PIQ=VIQ** N=70	**PIQ<VIQ** N=25
ADI-R[a]			
ADI Social domain	19.7 (5.0)	17.5 (7.3)	19.3 (5.5)
ADI Communication domain	13.5 (4.8)	13.3 (6.4)	14.5 (4.2)
ADI Repetitive domain	5.0 (2.8)	5.0 (2.9)	5.7 (3.3)
ADOS-G			
ADOS Social domain	6.9 (3.7)	6.1 (3.3)	6.0 (3.1)
ADOS Communication domain	3.1 (2.6)	2.2 (1.7)	2.1 (1.2)
ADOS Repetitive domain	1.5 (1.7)	2.1 (1.7)	2.1 (1.9)

a ADI-R 4-to-5-years or ever domain scores as per manual algorithm

Table 4 Weighted mean (SD) subtest scores on the WISC-III

	Total ASD sample N=127	Childhood autism subsample N=60	IQ≥70 subsample N=81
Subtest mean	*6.3 (3.2)*	*6.5 (3.1)*	*8.8 (1.9)*
Picture completion	7.6 (3.9)+	7.1 (4.1)	10.1 (2.8)
Information	6.5 (4.5)	7.1 (4.8)	9.3 (4.1)
Coding	6.0 (3.3)	5.3 (3.3)	7.6 (3.2)
Similarities	6.6 (4.0)	6.7 (4.9)	9.3 (3.2)
Picture arrangement	8.4 (5.2)+	7.3 (4.3)	11.4 (4.1)+
Arithmetic	6.1 (4.0)	5.9 (4.5)	8.7 (3.5)
Block design	6.0 (4.6)	7.8 (4.7)	9.1 (3.6)
Vocabulary	5.4 (3.3)-	5.9 (4.1)	7.5 (2.7)-
Object assembly	6.0 (4.1)	6.8 (3.7)	8.8 (3.1)
Comprehension	4.7 (3.6)-	4.3 (3.5)-	6.7 (3.3)-

+ Subtest significantly above subtest mean ($p<.001$)

- Subtest significantly below subtest mean ($p<.001$)

Table 5 VABS standard scores for the total ASD sample and the diagnostic and IQ subgroups

		IQ*	**VABS-ABC[a]**	**Social[b]**	**Comm[c]**	**DLS[d]**
	N	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
All ASDs	140	69.2 (24.3)	45.8 (15.9)	49.6 (14.9)	56.8 (22.2)	44.8 (20.2)
Diagnostic subgrouping						
Childhood autism	73	67.1 (23.7)	39.3 (15.7)	44.6 (15.4)	49.7 (22.4)	36.8 (19.0)
Other ASD	67	70.2 (24.6)	49.1 (15.0)	52.1 (14.1)	60.3 (21.3)	48.7 (19.7)
WISC FSIQ subgrouping						
IQ ≥ 70	73	91.1 (13.6)	54.3 (12.3)	57.1 (10.2)	67.2 (17.5)	55.4 (17.6)
IQ < *70*	67	51.4 (14.4)	39.0 (15.2)	43.6 (15.4)	48.4 (22.1)	36.2 (18.1)

a Vineland Adaptive Behavior Composite Score; b Vineland Socialisation domain score; c Vineland Communication domain score; d Vineland Daily Lining Skills domain score

* Imputed IQ; see text for details of imputation

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