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Development and Current Functioning in Adolescents with Asperger Syndrome: A Comparative Study

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Adolescents with Asperger syndrome (AS: without delay in speech development, diagnosed according to ICD-10 clinical criteria) were compared with a group with high-functioning autism (HFA: all with delayed speech development), and a group with conduct disorder (CD). Family and genetic studies suggest that Asperger syndrome and autism form part of the same spectrum, whereas the social impairments in conduct disorder are assumed to have different origins. The aims were to explore the relationships between early speech development and other aspects of functioning in autistic disorders, and to compare autistic and nonautistic social impairments. Early and current behaviour and IQ profiles were investigated.

The CD group were clearly different from both the AS and HFA groups. The AS group tended to have less severe early behavioural abnormalities than the HFA group, and were unlikely to have speech abnormalities, but other communicative, social, and restricted/stereotyped behavioural difficulties were largely of a similar pattern to the abnormalities in the HFA group. Eighty per cent of the AS group met criteria for autism on the diagnostic algorithm associated with the Autism Diagnostic Interview-Revised. By adolescence, the AS group were reported to be as abnormal as the HFA group but in structured 1:1 interaction their conversation was better. IQ profile in the AS group showed relative strength on verbal measures, unlike the HFA group, but relatively good performance on the Block Design subtest of the WISC/WAIS was a feature of both the AS and HFA groups. The results indicate closely similar behavioural manifestations may arise by adolescence despite differences in speech development. Follow-up studies and further family investigations will be required to clarify the origins of these and other patterns of autistic development.

Keywords: Adolescence, development, Asperger syndrome, autism.

Abbreviations: ADI: Autism Diagnostic Interview; ADOS: Autism Diagnostic Observation Schedule; AS: Asperger syndrome; CD: conduct disorder; HFA: high-functioning autism.

Introduction

Individuals in the normal range of intelligence with autistic disorders share core impairments in social communication and interaction. However, their language, cognitive profiles, and motor skills may show a number of different patterns. Those who do not show delay in speech development are a group of particular interest. First, the nature of social and communicative deficits may be explored without the complicating factors of low IQ or language delay (Tantam, 1988). Second, comparison of groups with normal or delayed speech development is potentially informative about the relationships between early speech development, other aspects of communicative and social behaviour, and later functioning in autistic disorders.

Asperger syndrome is now defined in ICD-10 (World Health Organisation, 1992) as an autistic disorder in which there are abnormalities in reciprocal social interaction and in patterns of behaviour and interests, without clinically significant delay in spoken or receptive language, or cognitive development. Asperger syndrome (AS) thus refers to a particular group of high-functioning children who did not have delayed speech development, and need not have had developmental difficulties before 3 years (in contrast to the onset criterion for childhood autism). In practice, children who meet criteria for AS may also meet the criteria for childhood autism; the approach to classification may then be hierarchical (as in DSM-IV; American Psychiatric Association, 1994) or

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these diagnoses may be viewed as alternatives. In this study, the aim was to focus on the links between early speech development and other aspects of functioning in autistic disorders, and to investigate whether individuals without early speech delay were different in other important respects. The diagnosis of AS was therefore applied to individuals who did not have early speech delay, without excluding any who also met criteria for childhood autism.

Before the introduction of ICD-10, a number of overlapping definitions of "Asperger syndrome" were in use—relatively good verbal ability and intelligence, together with social abnormality and unusual interest patterns, being the key elements. Wing (1981) conceptualised the syndrome as a variant of autism, recognising shared core social and behavioural deficits. Attempts to separate out an "Asperger" variant in studies of autistic disorders (Eaves, Ho, & Eaves, 1994; Prior et al., 1998; Siegel, Anders, Ciaranello, Bienenstock, & Kraemer, 1986) have, however, been only partially successful. Three comparative studies of AS and autism, controlled for overall intellectual level, have investigated behavioural and cognitive differences in "Asperger syndrome" and "high-functioning autism", with similarly inconclusive results. Szatmari, Bartolucci, and Bremner (1989) specified as inclusion criteria for AS: isolated behaviour; impaired social interaction; any one of: odd speech, impaired nonverbal communication, or bizarre preoccupations; and onset before age 6. Twenty-eight children aged 8–18 who met these criteria were identified from attenders at a child mental health facility, and compared with 20 individuals diagnosed according to DSM-III as autistic, who had an IQ above 70. The AS group were less behaviourally impaired early in life than this latter "high-functioning autistic" group, but Verbal and Performance IQs were similar in both groups, and other neurocognitive differences were not striking (Szatmari, Tuff, Finlayson, & Bartolucci, 1990). Ozonoff, Rogers, and Pennington (1991) identified a group of 23 high-functioning subjects, aged 8–20, who met DSM-III-R criteria for autistic disorder or pervasive developmental disorder. The group were then subdivided into 10 in whom "current language functioning was not impaired" ("Asperger syndrome"), and 13 where this was not the case ("high-functioning autistic"). Mean Verbal IQ was significantly higher in the Asperger group than the high-functioning autistic group. Within the AS group mean Verbal and Performance IQs were similar, whereas the HFA group showed a discrepancy with lower mean Verbal than Performance IQ. Better performance on theory of mind and verbal memory tasks by the AS group was not statistically significant once Verbal IQ was incorporated in the analysis. Ehlers et al. (1997) studied children, aged 5–15, referred to a neuropsychiatric diagnostic clinic. Forty individuals were recruited who were diagnosed as AS (according to the criteria of Gillberg and Gillberg, 1989, which include motor clumsiness), and had at least one IQ score over 70. Their WISC profiles were compared with profiles of two other diagnostic groups—40 children meeting DSM-III-R criteria for autistic disorder, and 40 who met criteria for attention/motor disorder (30 diagnosed as ADHD on DSM-III-R, and 10 as ADD on DSM-III, of whom a number were said to show autistic features). Among those of similar overall IQ, the AS group had higher Verbal IQ, and higher verbal subtest scores for vocabulary and comprehension than the autistic group, but were not significantly different on any subtest from the attention/motor group. Comparison and interpretation of the findings from these studies is difficult because of the differences in definition of AS and the use of current behavioural criteria for diagnosis (which means that diagnostic assignation might be altered if the clinical picture in an individual changed over time).

The ICD-10 criteria for Asperger syndrome now incorporate a specification about lack of delay in speech development (rather than "current" speech). Application of the criteria in the manner proposed above (i.e. not excluding individuals who also meet autism criteria) therefore allows the investigation of children without delayed speech development among those individuals of normal intelligence who have autistic disorders. It is now suggested that AS forms part of a spectrum of autistic disorders (Cox, 1991; Green, 1990; Tantam, 1988), and family and genetic studies have made it clear that the autistic phenotype extends beyond autism as traditionally diagnosed (Bailey et al., 1995; Bolton et al., 1994; Le Couteur et al., 1996). However, debate has continued about appropriate quantitative or qualitative distinctions between AS and HFA (see Happé, 1994a; Leekam, Libby, Wing, Gould, & Gillberg, 2000). The question of whether AS and HFA children are different in their pattern of early impairments or in their later functioning is of importance both clinically, since these children may not be recognised in early life, and theoretically, in understanding the links between language and social impairments in autistic disorders. Two recent comparative studies have produced apparently different results. Szatmari, Archer, Fisman, Streiner, and Wilson (1995) compared a group of young children (4–6 years) who met ICD-10 criteria for AS, applied as proposed above, with an autistic group (who had delayed or deviant speech development). The AS group were less severely impaired in socialisation, communication, daily living activities, and tests of language or verbal reasoning. However, they were *not* different on measures of nonverbal cognition. Klin, Volkmar, Sparrow, Cicchetti, and Rourke (1995) investigated an AS group, mainly adolescents, who met modified ICD-10 criteria (in that they also had to have an intense circumscribed interest, and motor clumsiness), and did not meet criteria for autism. This group was behaviourally similar but neuropsychologically distinct from an autistic group in that 18 of the 21 AS subjects had a predefined cognitive profile of "nonverbal learning disabilities syndrome". The apparently contrasting findings in these two studies may be related to differences in the diagnostic criteria or to the different ages at which the groups were compared. It is possible, for example, that AS and autistic groups might show different behavioural changes over time.

As well as the issue of distinguishing Asperger syndrome and autism, there is a question as to whether the impairment of social skills in Asperger syndrome is qualitatively distinct from the impairments in social understanding that occur in severe conduct disturbance. Children with conduct disorder show a repetitive and persistent pattern of behaviour which violates the rights of others or major age-appropriate societal norms and rules (ICD-10). Such behaviour has been attributed to abnormal processing of social information, a view supported by evidence from experimental and observational studies (Dodge, 1993; McKeough, Yates, & Marini, 1994). For example, deficits in interpersonal understanding in aggressive children include misattribution of hostile intentions to others (especially in situations where the

child is the likely target, or information is ambiguous or incomplete). These problems are usually understood as originating in deficient or abnormal social learning, in contrast to the intrinsic deficits in understanding others which occur in AS. However, there may be some surprising similarities. Happé and Frith (1996) found that, although children with conduct disorder could pass standard tests of theory of mind, their reported performance on behaviours requiring social insight was poorer than normal children. Detailed comparison of the pattern of early behavioural impairments would therefore be theoretically informative. Study of the boundary between these two groups is also potentially of practical value since comorbid antisocial behaviour may occur in Asperger syndrome (Everall & Le Couteur, 1990; Mawson, Grounds, & Tantam, 1985), and there may also be initial misdiagnosis of the syndrome as conduct disorder.

This study compared adolescents in the autistic spectrum without speech delay (Asperger syndrome, AS), with a group whose early speech was delayed (high-functioning autistic, HFA), and with a socially impaired nonautistic group (conduct disorder, CD). The first question was whether lack of delay in speech in the AS group was associated, during early development, with less severe or different communicative and social impairments from the HFA group, and with different impairments from the CD group. The second question was whether the absence of delayed speech development in the AS group was associated in later life with differences from the HFA group in communicative or social functioning, or in IQ profiles. This paper reports behavioural and IQ profiles in the AS group, compared with the HFA and CD groups.

Method

Study Design

All subjects were male adolescents or young adults within the normal range of intelligence. Early development (parent report) and current function (parent report, direct observation, and IQ profile) were compared in three diagnostic groups: Asperger syndrome (AS group); high-functioning autism (HFA group); conduct disorder (CD group).

Subjects

To recruit subjects with Asperger syndrome, clinicians in North West and Mersey regions were asked to refer any adolescent boys (11–19 years) who they considered to have AS, to the project team in Manchester. All referred cases were screened by the team to ascertain whether they met the ICD-10 clinical criteria for Asperger syndrome (qualitative deficiencies in reciprocal social interaction and restricted, repetitive stereotyped patterns of behaviour, interests and activities, but no clinically significant general delay in language or cognitive development). Reported *phrase speech* by age 3 (defined as two words including a verb, not echolalic, used meaningfully) was required in the AS group; single-word onset criteria had not been specified in the draft ICD-10 criteria available when the study began. However only one AS subject had onset of single words later than 24 months (at 28 months). Boys between 11 and 19 who met these criteria were then tested on the WISC-R (Psychological Corporation, 1974) or WAIS-R (Psychological Corporation, 1986), and those with a Full Scale IQ of 70 or higher were included in the study sample. This strict definition of Asperger syndrome meant that a large number (27) of clinically diagnosed cases referred to the project were excluded on the grounds of: delay in speech development (15); IQ (8); lack of early developmental information (2); not meeting ICD-10 criteria (2). A further 17 referred subjects were not included: 9 subjects or their families refused to participate and 8 could not be contacted. The final sample consisted of 20 male adolescents with Asperger syndrome (the AS group).

Twenty boys with conduct disorder (subsequently referred to as the CD group), aged between 11 and 19, were recruited from clinically diagnosed cases seen as outpatients or within special schools, and referred to the Manchester project team. All subjects had met ICD-10 criteria for conduct disorder *within* the last 2 years (repetitive and persistent pattern of behaviour, lasting at least 6 months, which violates the basic rights of others or major age-appropriate societal norms or rules) and had a Full Scale IQ of 70 or over on WISC/WAIS testing. Boys with concurrent mood disorder were not eligible. Clinically normal speech development was required, so that the group would be comparable in this respect to the AS group. Fourteen referred cases were excluded on the grounds of: delay in speech development (7); IQ (2); lack of early developmental information (4); not meeting ICD-10 criteria (1). A further 16 referred subjects were not included: 3 could not be contacted, 2 dropped out, and 11 subjects or families refused to participate. The CD group included in the study were significantly socially impaired—14 had been referred to specialist services because of emotional or behavioural difficulties; 10 of these, and the remaining 6 CD subjects, were in residential schools because of behavioural difficulties. Details of psychiatric comorbidity in the AS and CD groups are given in Green, Gilchrist, Burton, and Cox (2000). In brief, no subject had a concurrent clinical diagnosis of other disorder but one (5%) CD subject met modified ICD-10 criteria for hyperkinetic disorder, 25% had pervasive overactivity, 5% had pervasive inattention, and 30% had situational overactivity or inattention. Comparable data for the AS group were one (5%) hyperkinetic disorder, 5% pervasive overactivity, 10% pervasive inattention, and 40% situational overactivity or inattention.

Subjects with high-functioning autism (HFA group) were referrals to the Institute of Psychiatry (a tertiary referral centre) for clinical or research purposes. Forty-five male subjects were aged 11 or over. Fourteen of these were eligible for the study since they met the study criteria: met ICD-10 autism criteria (qualitative deviance in communicative, social, and behavioural development with an onset before 36 months), adolescent or young adult, performance IQ over 70, delayed development of speech. The crucial difference between the AS and HFA groups was, therefore, their early speech development: *phrase speech* was present by age 3 in the AS group and not present by age 3 in the HFA group. Data was missing for 1 subject so that the final HFA sample comprised 13 male subjects.

Procedures

Approval was obtained from the relevant local ethical committees. AS and CD subjects were seen by the project team in Manchester. Parents, and subjects over 16, gave informed verbal consent, with written consent for video taping of interviews. Assessments were conducted by trained research assistants at home or in an outpatient or educational setting, as convenient. Interviewers could not remain entirely blind to the AS or CD status of the subjects. In some cases the settings, for example a school for children with autistic disorders, suggested the diagnosis, and in other cases the research assistants reported that the clinical diagnosis rapidly became evident. Assessments of HFA subjects were carried out in similar settings by the child and adolescent psychiatry autism research team at the Institute of Psychiatry. These were conducted blind to the purposes of this study, and data on the HFA group was only made available after collection of data for the AS and CD groups was complete.

Measures

Autism Diagnostic Interview. The Autism Diagnostic Interview (ADI) (Le Couteur et al., 1989) is a semistructured

interview conducted with a parent or other informant. The interviewer enquires about general background, family, medical, and educational history, then obtains a detailed account of impairments in three domains: communication, reciprocal social interaction, and stereotyped behaviour. The behavioural descriptions obtained are coded as 0–no abnormality, 1–possible abnormality, 2–definite autistic type abnormality, or 3–severe autistic type abnormality. Items are coded for two time points: age 4–5 or "ever" (i.e. most severe ever), and "current". The ADI has an associated diagnostic algorithm, originally created by selecting groups of items within each of the three key areas (communication, reciprocal social interaction, and stereotyped behaviour) to correspond with symptoms in ICD-10. Codings for relevant items are added to produce a total for each algorithm area, which is compared with a prespecified threshold. If the threshold is met for each of the three areas and developmental problems of any sort were reported before 36 months, an algorithm diagnosis of autism is reached.

The original version of the ADI was used for autistic subjects; AS and CD subjects were assessed using the revised version (ADI-R; Lord, Rutter, & Le Couteur, 1994), with the addition of a few items from the original ADI to allow comparison with the HFA group. The group comparisons reported in this paper are for items that were equivalent in the original and revised versions of the ADI (total 79), items from the original ADI added to the ADI-R interviews (total 8), and a few further items, where some combination of items could be used as an equivalent (total 7). Details are given in the results tables, and fuller information is available from the authors on request. The aim was first to obtain standardised reports of subjects' early development and current functioning, which would allow group comparisons, and second to ascertain how the behavioural patterns of the AS group would be classified on the diagnostic algorithm.

Reliability of the ADI. Reliability of ADI-R ratings was checked by comparing codings made by the interviewer, and codings of the interview videotapes from eight subjects (four AS and four CD), made blind to diagnosis, by an independent project rater (DB). Transcripts of the interviews were then independently and separately rated, blind to diagnosis, by two members of the team who originally developed the instrument (MR and ALC).

For individual items the number of abnormal ratings was too low to compute kappa for most items. Percentage agreements were 80% or more for all early ADI items except *reduced conventional gestures*, *failure to point to express interest*, and *social disinhibition* (agreement 70% or more). For current ADI items agreement was 80% or higher for the majority of items, 70–79% for *reduced social chat*, *reduced reciprocal conversation*, *unusual intonation*, *reduced emotional gestures*, *curiousity*, and *engagement in appropriate activities*. Agreement was low (63%) for *reduced conventional gestures*, although all the disagreements were 1 point only.

To check reliability for total scores, mean scores for the pairs of raters (DB and the original rater) and MR and ALC were computed for the three algorithm areas (communication, reciprocal social interaction, and stereotyped behaviour). Intraclass correlation coefficients were calculated for the mean algorithm scores from each pair of raters (DB and the original rater versus MR and ALC). Agreement was good, the intraclass correlation coefficients being .84 for the social area, .79 for the communication area, and .81 for the stereotyped area.

Individuals were then categorised on the algorithm, using the mean algorithm area scores for each pair of raters. No subject from the CD group met any of the algorithm thresholds, according to either rater pair. For two AS subjects the two pairs of raters agreed on the classification for 3/3 algorithm areas. For one AS subject, there was agreement on 2/3 areas and for one AS subject there was agreement on 1/3 algorithm areas. In the two subjects where there was disagreement on whether an algorithm threshold was met, the actual differences in the mean algorithm area scores for the two rater pairs were small (maximum of two points).

Autism Diagnostic Observation Schedule. All subjects were assessed on the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 1989), an interactional interview with play and conversation sections lasting around 40 minutes. The ADOS was designed to be a measure of the quality and severity of social impairment in autistic disorders, sensitive to their manifestations in individuals with a range of intellectual abilities. Specifically, it provides standardised contexts in which to evoke and assess communication and social interaction, rather than simply being a measure of spontaneous behaviours. Ratings are made for specified aspects of language and communication, reciprocal social interaction, play, stereotyped behaviour and restricted interests, other abnormal behaviours, and mood, each item being rated from 0 (no autistic abnormality) to 3 (severe autistic abnormality). The relatively brief duration of the ADOS limits its sensitivity for infrequent behaviours, and for classifying repetitive or stereotyped behaviours, which may require a longer period of observation.

Reliability of ADOS. Interrater reliability was assessed by comparing interviewer codings for 10 subjects (7 AS and 3 CD) with codings made from the videotaped interviews by two other raters—one (JG) trained to reliability at the Institute of Psychiatry, and one a member of the original development team at the University of Chicago. Total scores for each section of the ADOS (communication, social behaviour, etc.) were compared using intraclass correlation coefficients which were as follows: language and communication .64; reciprocal social interaction .78; play .71; stereotyped behaviour and restricted interests .68; other abnormal behaviour .87; mood .42.

IQ profiles. The WISC-R was administered to subjects under 18, and the WAIS-R to subjects over 18, by trained psychology research assistants. Scaled scores were derived for all subtests and Verbal, Performance, and Full Scale IQ were calculated. The significance of any difference between Verbal and Performance IQ for individuals was assessed using the published tables in the WISC and WAIS manuals, which provide a threshold for each age group above which the difference is statistically significant at the 5% level of confidence.

Other assessments. Further assessments of everyday social and psychiatric functioning, and specific psychological deficits, were performed in the AS and CD groups, and will be reported separately. The measures applied included the Social and Emotional Functioning Interview, and a psychiatric interview (Rutter et al., 1988); Theory of Mind assessments (adapted from Bowler, 1992; and from Happé, 1994b), Facial Emotion Recognition Task (adapted from Hobson, Ouston, & Lee, 1988); Embedded Figures Test, and Wisconsin Card Sort Test.

Analysis

Data were analysed using SPSS for Windows (SPSS Inc., 1996). Groups were compared using one-way ANOVA with post hoc tests for total scores, if these were normally distributed, and the Kruskal-Wallis test with appropriate post hoc tests for individual item scores, or total scores that were not normally distributed. The Spearman rank correlation coefficient was used to measure the association between two continuous variables.

Results

Characteristics of the Comparison Groups

Table 1 shows the age and IQ of the subjects. The AS and CD groups were not significantly different in age or IQ. The HFA group were significantly older and their Full Scale IQ was significantly lower than both the AS and CD groups; where appropriate in later analyses, these differences were taken into account. As intended, age of onset of *phrase speech* (operationally defined as above) clearly separated the AS and HFA groups. All the AS group had

Table 1
Characteristics of Comparison Groups

	HFA ($N = 13$)		AS ($N = 20$)		CD ($N = 20$)	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Phrase speech onset (months)	67.3	(21.49)	23.7	(6.15)	24.7	(7.33)
Range	42–110		15–36		14–36	
Age (months)	20.92		13.75		14.47	
Range	16–26 [a]		11–19		11–18	
Verbal IQ	78.85	(7.51) [b]	97.10	(17.69)	87.90	(10.24)
Range	67–92		72–142		70–111	
Performance IQ	82.92	(10.78) [c]	87.35	(17.23)	96.50	(11.75)
Range	71–108		65–130		70–115	
Full Scale IQ	78.87	(5.83) [d]	92.15	(17.70)	91.15	(9.14)
Range	69–87		71–141		74–107	

[a] ANOVA $F(2) = 38.26$, $p = .0001$, post hoc Tukey tests AS and CD groups significantly different from HFA group.
[b] ANOVA $F(2) = 7.77$, $p = .0012$, post hoc Tukey tests HFA group significantly lower than AS group.
[c] ANOVA $F(2) = 4.22$, $p = .0202$, post hoc Tukey tests HFA group significantly lower than CD group.
[d] ANOVA $F(2) = 5.15$, $p = .0092$, post hoc Tukey tests HFA group significantly lower than AS and CD groups.

Table 2
Severity of Reported Impairment

	HFA	AS	CD	ANOVA			
ADI domain total	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	*F* ratio[a]	HFA > CD	HFA > AS	AS > CD
Early development							
Communication	20.8 (4.7)	11.2 (4.5)	1.8 (2.0)	98.58	+	+	+
Reciprocal social interaction	20.6 (6.7)	12.4 (6.1)	3.6 (2.8)	42.20	+	+	+
Stereotyped behaviour	12.2 (2.6)	6.8 (3.3)	0.4 (0.6)	97.98	+	+	+
Current							
Communication	13.7 (4.6)	12.0 (4.1)	2.3 (1.7)	53.92	+		+
Reciprocal social interaction	13.4 (4.3)	12.6 (4.0)	3.0 (2.4)	48.29	+		+
Stereotyped behaviour	8.5 (3.8)	6.8 (2.6)	0.7 (0.7)	47.17	+		+

[a] All *F* ratios $p < .0001$.

phrase speech by 36 months, and none of the HFA group had phrase speech before 42 months.

Early Development

ADI data allowed systematic comparison of parents' early concerns and the severity and pattern of early developmental abnormalities in the AS, HFA, and CD groups.

Early parental concerns. Parents of the HFA and AS groups were more likely to report having concerns about their child's development before age 3 than parents of the CD group (77%, 65%, and 30% respectively; $\chi^2 = 8.37$, $p = .015$). In the majority (69%) of the HFA group the first reason for concern was one or both of delayed speech or possible deafness; two (15%) had worried about lack of emotional responsiveness and two (15%) about behaviour difficulties. In contrast, the first reasons for concern in parents of the AS group were general behaviour, e.g. overactivity (35%), social difficulties, e.g. lack of interest in other children (30%), dislike of change (10%), and a medical problem (5%). Three (15%) parents said professionals had been the first to express concern. Only one parent (5%) mentioned speech (said to be "jumbled" initially, although no further details could be recalled by his mother and professionals had not been concerned). Parents of children in the CD group all reported their first concerns were behaviour, usually overactivity.

By the time their child was 3 years of age, 8 (62%) HFA parents had sought professional advice; only 4 (20%) AS, and 1 (5%) CD parents had done so. Only 4 (31%) of the HFA group had begun school in a normal primary class, compared with 19 (95%) of the AS group and all of the CD group. In most cases the diagnosis of Asperger syndrome was made relatively late (always after 5 years, in at least 40% at age 10 or later) and children had had multiple professional contacts and a variety of diagnoses prior to that of Asperger Syndrome.

Severity of early impairments. Data were grouped to test whether the AS group, without early speech delay, differed in the overall severity of reported early developmental abnormalities (those rated at 4–5 or "ever") from the HFA group. Total scores were calculated for the available items in the ADI domains of communication (15 items), reciprocal social interaction (11 items), and restricted/stereotyped behaviour (9 items).

As shown in the top section of Table 2, group mean scores in each of these three domains were highest (most abnormal) in the HFA group, with the AS group intermediate between the HFA and CD groups. Overall between-group differences were highly significant, and post hoc tests indicated each group was significantly different from each other. However, inspection of in-

dividual scores did indicate overlap between the AS and HFA groups, particularly in the social domain.

Separate one-way analyses of variance were then performed for the AS and HFA groups, to investigate any effect of the IQ differences between the groups. Using Full Scale IQ as a covariate, the AS group were still significantly less impaired than the HFA group in all three domains (main effect of diagnosis: communication $F = 25.75$, $p < .001$; social $F = 16.72$, $p < .001$; stereotyped $F = 22.18$, $p < .001$). Full Scale IQ and Verbal IQ as covariates each had a significant effect within the communication domain (Full Scale IQ covariate: $F = 7.56$, $p = .010$; Verbal IQ covariate: $F = 9.51$, $p = .004$) but not in the social or stereotyped domains. Thus the AS group, with no delay in early speech development, were also, as a group, less severely impaired in other areas of early functioning.

Pattern of early impairments. Possible differences in the pattern of early impairments in AS and HFA were then investigated. Reported early impairments (individual ADI items) in the three diagnostic groups were compared using the Kruskal-Wallis test and post hoc pairwise comparisons of all groups (Mann-Whitney U tests with Bonferroni correction).

Considering first early communication (see Appendix A), the AS group showed significantly less abnormality than the HFA group in *communicative use of speech by age 5*, *concerns about hearing*, *immediate echolalia*, and *pronominal reversal*. In contrast, early use of speech as reflected in *verbal rituals*, *stereotyped utterances*, and *inappropriate questions* was not significantly different in the AS and HFA groups, although use of *conventional gestures* was significantly less abnormal in the AS than the HFA group.

In early social and behavioural development (see Appendix B) the AS group were less abnormal in *imitative social play*, *not putting arms up to be lifted*, *failure to come for comfort*, *reduced sharing attention and seeking help*, and *reduced or abnormal greeting*. On other aspects of reciprocal social interaction as measured on individual ADI items, the AS and HFA groups were not significantly different. The social interaction domain was the one in which the CD group were most likely to show early abnormality, particularly in *affective reciprocity* and *social disinhibition*, but even so, they were significantly different from the AS and HFA groups on the majority of items.

Within the stereotyped behavioural domain, abnormalities were highly specific to AS and HFA. The AS group were significantly less likely than the HFA group to have ever shown *unusual attachment to objects*, *unusual sensory interests*, *idiosyncratic negative responses*, *rocking*, or *compulsions and rituals*. They were, however, not significantly less abnormal in other aspects of limited or stereotyped behaviour, nor in imaginative play (despite the play coding for the AS group being for age 4–5, and the HFA group coding being for age 3). Early *gross motor coordination* was reported as significantly worse in the AS group than the HFA or CD group. *Overactivity* was commonly reported in all the diagnostic groups—for the CD group it constituted the most frequently reported early problem.

Interrelationships between aspects of development. By definition, all the AS group had phrase speech by 3, whereas the HFA group's earliest reported onset of phrase speech was 42 months. The age of onset of phrase speech *within* each of these (AS and HFA) groups did not, however, correlate with other aspects of communicative development. For example, there was no relationship between the age of onset of phrase speech and the extent of early speech abnormalities (total score for *immediate echolalia*, *stereotyped language*, *pronominal reversal*, *neologisms*), or between either of these and *communicative use of speech by age 5*. Further data about social use of speech by 4–5 years was available only for the AS group (summed score for abnormalities in *social chat*, *report of things*, *reciprocal conversation*, and *talk expressing interest in others*). Abnormal social use of speech by age 4–5 in the AS group was, again, not related to any early speech indices, but was significantly correlated with the severity of early *social* abnormality (total score in the social domain) ($r = .725$, $p = .001$).

Early social abnormality in the CD group was significantly correlated with reported early *overactivity* ($r = .5240$, $p = .018$), but this was not true of the AS or HFA groups. Overactivity and the total score on the subset of items relating to social approaches (*greeting*, *sharing attention and seeking help*, *offering comfort*, *coming for comfort*, and *social disinhibition*) was even more significantly correlated ($r = .7297$, $p < .001$) in the CD group.

Algorithm classification. Categorical classification on the diagnostic algorithm for the ADI-R (Lord et al., 1994) depends mainly on the profile of behaviours during early development. With the exception of items for *social chat* and *conversation*, where the "current" coding is used, the algorithm incorporates ratings from age 4–5 or "ever" in the three key areas of reciprocal social interaction, communication, and restricted/stereotyped behaviour. Applying this algorithm, the impairments in 16 (80%) of the AS group met criteria for autism, i.e. scores reached the specified thresholds in all three areas, and developmental problems were reported before 36 months. Four (20%) AS subjects did not meet criteria for autism—case details are available from the authors. No CD subject had abnormalities that met algorithm criteria for autism in any area.

All 13 HFA individuals had early behavioural impairments that met criteria for autism on the algorithm for the original ADI.

Current Functioning

Current reported impairments (ADI), observed impairments (ADOS), and IQ profiles were compared across the diagnostic groups.

Reported Impairments (ADI)

Severity of current impairments. To compare the severity of impairments in current functioning, total scores were computed for the available items in the ADI domains of communication (17 items), reciprocal social interaction (10 items), and stereotyped behaviour (11 items). These domains are similar but not identical to the ADI domains for early development (because additional or different "current" ADI items were available, details available from the authors). The data are shown for comparison in the lower section of Table 2; the AS and HFA groups were not significantly different on any of the major domains, in contrast to the difference in reported early impairments. There were no significant correlations between ADI domain totals and age for any diagnostic group.

Pattern of current impairments. Differences in the

Table 3
Current Observed Impairments (ADOS)

	HFA	AS	CD	Kruskal-Wallis				
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	χ^2	*p* value	HFA > CD	HFA > AS	AS > CD
Language/ communication (max score = 32)	5.85 (2.38)	4.20 (3.11)	0.6 (1.10)	29.75	< .0001	+		+
Reciprocal social interaction (max score = 26)	12.46 (5.06)	7.90 (5.03)	2.2 (2.63)	27.87	< .0001	+		+
Play (max score = 3)	1.08 (0.95)	0.95 (0.89)	0.25 (0.55)	10.02	< .01			
Stereotyped behaviour/ restricted interests (max score = 17)	1.23 (1.09)	2.25 (1.83)	0.15 (0.49)	20.10	< .001			+
Other abnormal behaviour (max score = 13)	0.23 (0.60)	1.60 (1.79)	0.35 (0.93)	14.25	< .01		AS > HFA	+
Mood (max score = 8)	0.15 (0.38)	0.85 (0.99)	0.55 (0.60)	5.60	.06			
Total	21.00 (7.44)	17.65 (9.46)	4.10 (4.05)	30.96	< .0001	+		+

pattern of current impairments were investigated using individual "current" ADI items (see Appendix C). There were very few items on which the AS and HFA groups were significantly different. In the communication domain, all subjects were reported to have "phrase speech" (defined in the ADI as functional use of speech on a daily basis involving phrases of three words or more), and abnormalities in current speech were definitely present only in two of the HFA group, of whom one had *immediate echolalia* and one had *neologisms*. Use of stereotyped, repetitive, or idiosyncratic speech, failures in aspects of conversational interchange, and abnormal use of intonation and gesture discriminated both the AS and HFA groups from the CD group. The AS group were less likely to have reduced social talk (*social "chat"*), but in other aspects of communication did not differ significantly from the HFA group.

In the social domain, there were no significant differences between the AS and HFA groups. Items relating to verbal and nonverbal behaviour signalling social intentionality (*seeking help* and *facial expression*, i.e. use of facial expression to communicate) were highly specific to AS or HFA, occurring in 10% or fewer of the CD group. However, some social abnormalities were evident in the CD group—in 30% or more some degree of impairment was reported in *sharing others' pleasure*, *coming for comfort*, *affective reciprocity*, *inappropriate facial expression*, *social disinhibition*, and *friendships*.

In the stereotyped domain the AS and HFA groups were still significantly different from each other in *rocking*, but not on any other item (in contrast to the early picture). Abnormalities of *gait* and *posture* were significantly more common in both the AS and HFA groups than the CD group, and the AS group had significantly more *abnormal gross motor coordination* than the HFA or CD groups.

Early development and current function. Change over time in reported impairments was investigated in the AS and HFA groups, using percentage change (early ADI domain score − current ADI domain score / early ADI domain score × 100) to allow comparison. For the HFA group, mean changes in ADI scores in each domain were positive, i.e. there was less reported abnormality currently than during early development. The AS group were significantly different, with more reported abnormality in all domains currently than during early development (Mann-Whitney U tests all $p < .01$). Considering individuals, the total "current" ADI score was 10% or more lower (less abnormal) than the "early" ADI score in 12 (92%) of the HFA group, but in only 2 (10%) of the AS group.

Within the AS group the severity of early abnormality was related to adolescent functioning with significant correlations between the severity of early and current abnormality in each ADI domain (communication $r = .63$, $p = .003$; social $r = .71$, $p = .001$; stereotyped $r = .46$, $p = .04$ respectively). These correlations between early and later functioning were not significant for the HFA group. For the CD group early and current social abnormality, only, were significantly correlated ($r = .50$, $p = .025$).

Early language measures (age of onset of phrase speech, communicative use of speech by age 5, degree of early language abnormalities) were not related to reported current communicative or social functioning in either the AS or HFA groups. In the AS group, early social abnormality was significantly correlated with later communicative abnormality ($r = .53$, $p = .015$). For the HFA group early stereotyped abnormality was correlated with later social abnormality ($r = .56$, $p = .045$).

Observed Impairments (ADOS)

To investigate the severity of observed impairments, subtotals for each section of the ADOS, and an overall total score were derived by summing scores for individual ADOS items. HFA, AS, and CD groups were compared using Kruskal-Wallis tests and post hoc pairwise comparisons of all groups (Mann-Whitney U tests with Bonferroni correction) (Table 3). Both the HFA and AS groups showed significantly more abnormality (higher total scores) than the CD group, and their total scores on the ADOS were not significantly different from each other.

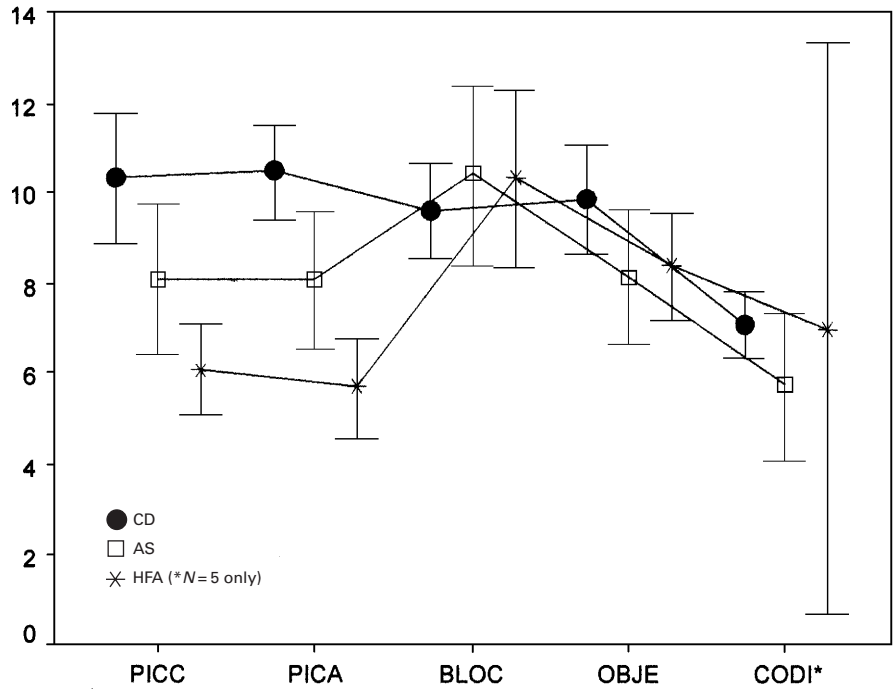

Figure 1. Performance IQ subtests (group mean scores).

Considering the language/communication section, there was no overall significant difference between the AS and HFA groups, although individual item analyses showed that the AS group were significantly less abnormal than the HFA group for *conversation*. In the reciprocal social interaction section the AS and HFA groups were not significantly different. In abnormal behaviour (*appearance*, *overactivity*, *attention*, *tantrums or aggression*, *disruptive behaviour*, and *negativism*) the AS group were significantly more abnormal than the HFA group; impaired attention was rated as present to some degree in 45% of the AS group. (Further details of individual items are available from the authors.)

IQ Profiles (*WISC or WAIS*)

All AS and CD subjects completed all the subtests, but nine of the HFA group had not completed either the information or coding subtests (in seven cases neither had been completed). As previously shown in Table 1, mean Verbal IQ was significantly lower in the HFA group than the AS group but mean Performance IQs were not significantly different. Mean Performance IQ was significantly lower in the HFA than the CD group but mean Verbal IQs were not significantly different.

Ten (50%) of the AS group had a significantly higher Verbal than Performance IQ, compared with only one (5%) of the CD group, and 1 (8%) of the HFA group. None of the AS group had a significantly lower Verbal than Performance IQ, compared with 7 (35%) of the CD group and 2 (15%) of the HFA group, $\chi^2(4) = 18.83$, $p < .001$.

We next wished to investigate IQ Verbal and Performance subtest profiles within and between diagnostic groups. As shown in Figures 1 and 2, the profile of subtest results within each diagnostic group appeared to show some interesting differences, which would not be evident if a simple comparison of group mean scores for each subtest was performed. For example, the group mean scores for the block design IQ subtest (Fig. 1) are similar, but these occur on a background of lower overall Performance IQ in the HFA group. To statistically compare these profiles it was necessary to take account of the overall differences in IQ. A "relative subtest score" was therefore calculated for each subtest using the following formulae: for verbal subtests, relative subtest score = subtest score/ total of verbal scores (excluding information) $\times$ 100%; for performance subtests, relative subtest score = subtest score/ total of performance scores (excluding coding) $\times$ 100%. The information and coding subtests were excluded since so few of the HFA group had completed them. Thus each subtest score was expressed as a percentage contribution to the relevant total.

ANOVA and post hoc tests were then performed on these relative subtest scores. The AS and HFA groups were not significantly different for any of the performance subtests; both were stronger on block design relative to their overall performance scores than the CD group (ANOVA F ratio = 9.74, $p = .001$, post hoc tests HFA > CD, AS > CD). Twelve (60%) of the AS group, 8 (62%) of the HFA group, and 4 (20%) of the CD group had block design as the highest of their performance subtest scores.

Applying the same approach to the verbal subtest scores, both the HFA and AS groups were poorer on comprehension, relative to their overall verbal scores, than the CD group, but the AS group were significantly better than the HFA group (ANOVA F ratio = 20.49, $p = .001$, post hoc tests HFA < CD, HFA < AS, AS < CD). Four (20%) of the AS group, 8 (62%) of the HFA group, and 2 (10%) of the CD group had comprehension as their lowest verbal subtest. The HFA group were also better on digit span relative to their overall verbal scores than either the AS or CD groups (ANOVA F ratio = 9.74, HFA > CD, HFA > AS).

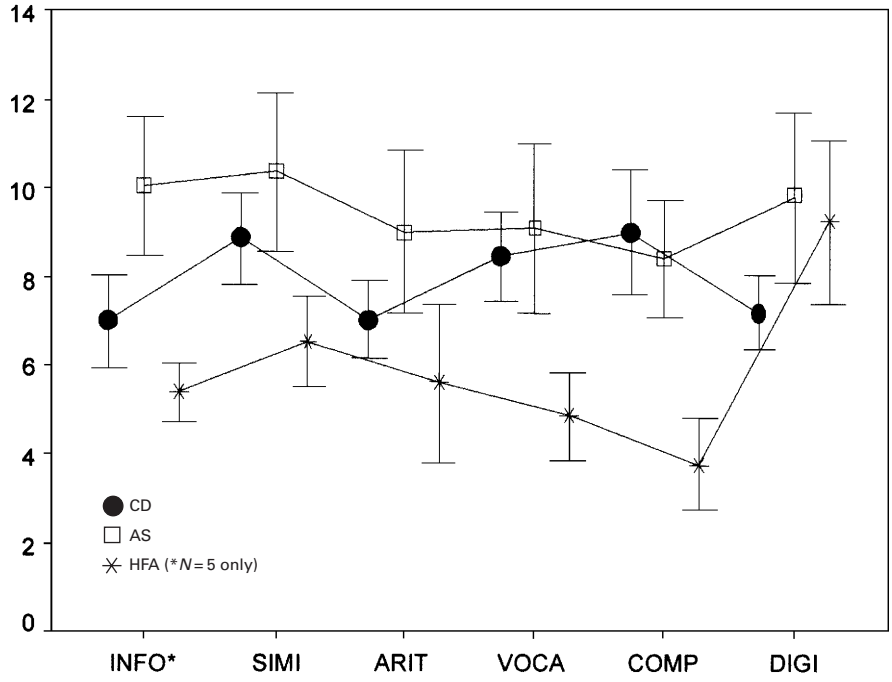

Figure 2. Verbal IQ subtests (group mean scores).

Discussion

The CD group were strikingly different from the AS and HFA groups on the assessment measures (ADI, ADOS, and IQ profile) reported in this paper. Despite their social impairments (including family and school relationship problems, and poor ability to share emotion and respond affectively to others) they did not show the pattern of difficulties in reciprocal communication and social behaviour (particularly features of social interaction related to shared attention, or the integrated use of verbal and nonverbal communication) that were evident in the AS and HFA groups. Early social abnormality in the CD group was linked with overactivity in a way that was not true of either the AS or HFA groups, and the IQ profile of the CD group was different. (Further reports from this study will consider wider aspects of emotional and social functioning, see Green et al., 2000), and neuropsychological deficits in the AS and CD groups).

The AS group in this study had, by definition, no early speech delay. Compared with the HFA group, whose speech was, by definition, delayed, they presented clinically at a later age. Their behavioural abnormalities during early development were largely of a similar nature to those of the HFA group, although they tended to be less severe. However, abnormalities in the form of speech, or qualitatively abnormal stereotyped behaviours (unusual attachment to objects, unusual sensory interests, idiosyncratic negative responses) were rare in the AS group. By adolescence, impairments in the AS and HFA groups were similar, although the AS group showed better conversational ability in a 1:1 assessment of communication and social interaction (ADOS).

In this study subjects recruited from clinically diagnosed groups were compared to investigate the implications of clinically normal or delayed early development of speech in individuals of normal IQ with autistic disorders. Although it cannot be assumed that language development in the AS group was entirely normal, they all had phrase speech (as defined for the purposes of this study) by 36 months, whereas the HFA group did not. Behavioural and IQ profiles not involved in defining the diagnostic groups could then be meaningfully compared, using standardised assessment instruments. As the figures on recruitment indicate, it proved relatively difficult to identify a "pure" AS group who met the ICD-10 criteria of no early speech delay and normal IQ, even from clinically diagnosed cases. Since the study was clinically recruited rather than population based, other groups of children with pervasive developmental disorders, including those who do not meet criteria for AS or autism, might well overlap in different ways with those we studied if the same behavioural and IQ assessment measures were applied.

It was not possible to completely match the diagnostic groups within the study on IQ and age. Although the AS and HFA groups had similar Performance IQs, the AS group had significantly higher Verbal and Full Scale IQ than the HFA group, and higher IQ might be invoked to explain their overall pattern of less severe early developmental abnormality. However, it seems unlikely to be having a major effect since all subjects were in the clinically normal range of IQ, differences were still significant after covarying for IQ, and in some aspects the AS group were as severly impaired as the HFA group. Similarly, it could be argued that age differences account for the surprising similarity in current severity of impairment in the AS and HFA groups. The HFA group were older, and the usual expectation in autistic disorders, especially among high-functioning subjects, is of improvement with age. However, this assumption may not always be warranted; within the AS group in this study, severity of impairment was not significantly correlated with age, and many of the AS group were reported to be showing more difficulties in adolescence than early life. Recent follow-up twin data (Le Couteur et al., 1996) suggest that a pattern of more overt difficulties in adolescence and young adult life may also occur in

nonautistic co-twins affected by the broader phenotype of autism.

The findings from this study regarding the early behavioural impairments in AS are similar to those of Szatmari et al. (1989, 1995). Szatmari et al. (1989) originally reported that an "AS" group were behaviourally intermediate between an autistic group and a socially impaired psychiatric outpatient comparison group, but less likely than the autistic group to have had early "lack of imaginative play". In the study reported here, impairment of early imaginative play was universal in both the AS and the HFA groups. This difference is probably explicable by differences in selection of the samples and the use of a relatively stringent definition of imaginative play within the ADI in our study. More recent work (Szatmari et al., 1995) using ICD-10 criteria for AS as they were employed in this study, and the ADI, produced data on early impairments in AS consistent with those reported here.

The AS group in this study had a significantly higher mean Verbal than Performance IQ, and half the individual AS subjects had significantly higher Verbal than Performance IQ, a pattern that did not occur in the HFA group. Klin et al. (1995) describe similar evidence of verbal-performance discrepancies with higher Verbal IQ, in an AS group, in subjects who met diagnostic criteria based on ICD-10 *and* had motor clumsiness. However, the AS group in this study and that of Ehlers et al. (1997) also had a relative strength in performance on block design, like that of autistic individuals (Happé, 1994c), supporting the view that there may be some common core features that are relatively independent of speech development.

The findings from this study suggest that individuals with autistic disorders may show similar communicative and social abnormalities despite differences in speech or other aspects of development. Early in life, speech in the AS group appeared grossly normal and abnormalities in the form of language were rare, while motor clumsiness was common. Many of the AS group in this study had been diagnosed relatively late or after much difficulty, despite the fact that problems in social interaction and stereotyped behaviour in individuals in the AS group could be as severe as those found in the HFA group. It is possible that when speech development was not delayed, deviant communicative and social development was not recognised. Consistent with this idea, parents of AS children were less likely than parents of HFA children to have sought specific help before their child was aged 3, and even in retrospect, were not necessarily aware that behaviour was unusual. For example, parents were often unable to recall instances of their children showing integrated use of verbal and nonverbal behaviours in social approaches, shared attention, or imaginative play, and nearly all the AS group were reported to have had impaired early interest in other children. On the other hand, parents of HFA children had recognised that their child's late speech was abnormal.

By adolescence, behavioural impairments in AS were similar to those of the HFA group and parent reports suggested that the difficulties of many of the AS group were viewed as more severe than in early life. Their reports might reflect developmental change with clearer expression of underlying difficulties, increased awareness of difficulties as children's range of behaviour increased, or adverse interactions between relatively subtle developmental impairments and increasing social demands. It could be argued that late recognition of difficulties in the AS group was associated with inappropriately high expectations or lack of appropriate management. Within this sample, only 5% of the AS group but 69% of the HFA group had been in special education from starting school. The current emphasis on earlier detection of autistic spectrum disorders should allow assessment of whether early appropriate intervention influences outcome in adolescence and young adult life in young people with AS.

In summary, a group meeting ICD-10 criteria for AS (by definition with no delay in speech development) were less impaired in early life than an HFA group and clearly different from a CD group. In adolescence, the AS group was reported to be behaviourally more similar than dissimilar to an HFA group. On IQ testing, the AS group, compared with the HFA group, showed relative strength on Verbal IQ and no difference in Performance IQ profile. Further neuropsychological data should clarify whether IQ profile in the AS group is linked with other aspects of psychological functioning, and what the relationships are between these and behavioural difficulties. Normal age of onset of speech does not necessarily predict better functioning in adolescence in individuals with autistic spectrum disorders. Further research is needed to identify potential factors in the child or aspects of their environment that might influence early recognition and later outcome.

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Appendix A

Early Communication

ADI items	HFA ($N = 13$) %1	HFA ($N = 13$) %⩾2	AS ($N = 20$) %1	AS ($N = 20$) %⩾2	CD ($N = 20$) %1	CD ($N = 20$) %⩾2	Kruskal-Wallis χ^2	p value	Post hoc pairwise comparisons: HFA > CD	HFA > AS	AS > CD
Speech and response to sound/speech											
Reduced communicative use of speech (age 5)[a]	23	69	45	10	5	0	28.18	.0001	+	+	+
Concerns about hearing (ever)	0	92	40	20	10	25	15.99	.0003	+	+	
Reduced attention to voice (4–5)	31	62	35	25	10	5	19.81	.0001	+		+
Unduly sensitive to noise (ever)	46	54	15	40	5	0	25.86	.0001	+		+
Abnormal articulation/pronunciation (age 5)	8	23	0	10	5	0	4.90	.0865			

Appendix A (cont.)

ADI items	HFA ($N = 13$) %1	HFA ($N = 13$) %⩾2	AS ($N = 20$) %1	AS ($N = 20$) %⩾2	CD ($N = 20$) %1	CD ($N = 20$) %⩾2	Kruskal-Wallis χ^2	p value	Post hoc pairwise comparisons: HFA > CD	HFA > AS	AS > CD
Form of speech											
Immediate echolalia (ever)	8	69	25	5	0	0	26.00	.0001	+	+	
Pronominal reversal (ever)	31	54	5	10	0	0	30.80	.0001	+	+	
Neologisms/idiosyncratic language (ever)	15	15	35	0	5	0	5.96	.0509			
Stereotyped, repetitive or idiosyncratic speech											
Verbal rituals (ever)	46	23	20	15	0	0	16.87	.0002	+		
Stereotyped utterances (ever)	39	39	65	10	10	0	23.11	.0001	+		+
Inappropriate questions or statements (ever)	39	39	45	40	15	10	15.29	.0005	+		+
Use of gesture											
Reduced conventional gestures (4–5)	0	92	15	60	20	0	37.05	.0001	+	+	+
Reduced nodding (4–5)	8	54	20	30	5	0	16.53	.0003	+		+
Reduced head shaking (4–5)	15	54	20	20	0	0	19.98	.0001	+		
Failure to point to express interest (4–5)	23	54	35	30	10	0	17.67	.0001	+		+

[a] One HFA subject had insufficient speech to be coded.

Appendix B

Early Social Interaction and Behaviour

ADI items	HFA ($N = 13$) %1	HFA ($N = 13$) %⩾2	AS ($N = 20$) %1	AS ($N = 20$) %⩾2	CD ($N = 20$) %1	CD ($N = 20$) %⩾2	Kruskal-Wallis χ^2	p value	Post hoc pairwise comparisons: HFA > CD	HFA > AS	AS > CD
Early social behaviours											
Lack of imitative social play (4–5)	15	85	45	40	30	0	33.12	.0001	+	+	+
Not putting arms up to be lifted (4–5)	15	54	15	5	0	5	17.65	.0001	+	+	
Lack of social responses (4–5)	23	46	35	35	30	5	8.07	.0177			
Absence of separation anxiety (by 4–5)	15	54	15	30	30	25	2.58	.2748			
Lack of cuddliness	15	39	15	15	20	0	5.94	.0513			
Reciprocal social interaction											
Failure to come for comfort (4–5)	15	77	20	25	15	0	23.24	.0001	+	+	
Reduced sharing attention and seeking help (4–5)	23	77	45	30	0	0	35.16	.0001	+	+	+
Reduced affective reciprocity (4–5)	23	77	5	75	25	25	15.04	.001	+		+
Failure to offer comfort (4–5)	15	85	15	65	15	0	33.38	.0001	+		+
Social disinhibition (> 10)	31	69	30	55	20	15	16.84	.0002	+		+
Reduced or abnormal greeting (4–5)	8	77	35	25	5	0	25.19	.0001	+	+	+

Appendix B (cont.)

Early Social Interaction and Behaviour

ADI items	HFA ($N = 13$) %1	HFA ($N = 13$) %⩾2	AS ($N = 20$) %1	AS ($N = 20$) %⩾2	CD ($N = 20$) %1	CD ($N = 20$) %⩾2	Kruskal-Wallis χ^2	p value	Post hoc pairwise comparisons: HFA > CD	HFA > AS	AS > CD
Qualitatively abnormal behaviours[a]											
Unusual sensory interests	62	23	15	5	5	0	24.76	.0001	+	+	
Unusual attachment to objects	31	39	20	0	0	0	24.33	.0001	+	+	
Idiosyncratic negative responses	46	15	10	0	0	0	25.66	.0001	+	+	
Rocking	23	39	0	5	10	0	24.87	.0001	+	+	
Hand and finger mannerisms	15	54	20	30	5	0	16.44	.0003	+		+
Other complex mannerisms	23	31	5	20	10	0	8.00	.0184			
Restricted/stereotyped behaviours											
Unusual preoccupation or circumscribed interest[b]	23	77	25	75	5	0	39.29	.0001	+		+
Circumscribed interest			30	70	10	0					+
Unusual preoccupation			15	25	5	0					+
Resistance to change in own routines or environment[b]	31	62	20	65	0	0	32.36	.0001	+		+
Compulsions/rituals	15	85	35	35	5	0	33.10	.0001	+	+	+
Lack of imaginative play[c]	15	85	40	60	35	0	29.08	.0001	+		+
Motor											
Abnormal gait and posture[d]	46	31	15	30	0	0	19.03	.0001	+		
Abnormal gross motor co-ordination[d]	31	8	25	50	15	5	15.84	.0004		+[e]	+
Overactivity at home (ever)	39	31	35	45	20	50	1.12	.5712			

[a] Codings for "ever" unless otherwise noted.
[b] Coded as one item for HFA group, but separately for AS and CD groups. Higher coding used in comparison.
[c] HFA group coded for age 3, AS and CD groups coded for age 4–5.
[d] HFA group coded for "ever", AS and CD groups coded for 4–5.
[e] AS worse than HFA.

Appendix C

Current Reported Impairments (ADI)

	HFA ($N = 13$) %1	HFA ($N = 13$) %⩾2	AS ($N = 20$) %1	AS ($N = 20$) %⩾2	CD ($N = 20$) %1	CD ($N = 20$) %⩾2	Kruskal-Wallis χ^2	p value	Post hoc pairwise comparisons: HFA > CD	HFA > AS	AS > CD
Communication											
Speech											
Overall level of language (phrase speech present)	0	0	0	0	0	0	0.00	1.000			
Reduced complexity of non-echoed utterances	23	0	20	0	5	0	2.56	.2777			
Abnormal articulation/ pronunciation	0	0	5	5	0	0	3.36	.1861			
Form of speech											
Immediate echolalia	8	8	5	0	0	0	3.52	.1719			
Pronominal reversal	15	0	5	0	0	0	3.71	.1565			
Neologisms/idiosyncratic language	15	8	20	0	0	0	4.89	.0866			
Stereotyped, repetitive or idiosyncratic speech											
Verbal rituals	46	8	25	5	0	0	12.44	.0020	+		
Stereotyped utterances	39	15	60	5	5	0	15.68	.0004	+		+
Inappropriate questions or statements	54	8	60	20	20	0	15.56	.0004			+

Appendix C (cont.)

	HFA ($N = 13$)		AS ($N = 20$)		CD ($N = 20$)		Kruskal-Wallis		Post hoc pairwise comparisons		
	%1	%⩾2	%1	%⩾2	%1	%⩾2	χ^2	p value	HFA > CD	HFA > AS	AS > CD
Relative failure in conversational interchange											
Reduced social "chat"	46	46	45	10	5	0	26.42	.0001	+	+	+
Reduced reciprocal conversation	39	54	40	55	30	0	26.46	.0001	+		+
Reduced report of things	39	31	35	40	15	5	13.81	.0010	+		+
Difficulty understanding plots	39	31	60	5	10	0	17.81	.0001	+		+
Intonation											
Unusual intonation	54	39	30	45	40	0	14.58	.0001	+		+
Reduced vocal expression of feelings	31	54	60	20	10	0	25.00	.0001	+		+
Use of gesture											
Reduced conventional gestures	15	46	25	55	15	5	15.34	.0001	+		+
Reduced emotional gestures	31	46	45	40	25	10	9.12	.0105			+
Reciprocal Social Interaction											
Failure to come for comfort	23	62	40	25	35	5	11.97	.0025	+		
Reduced seeking help	77	15	40	15	0	0	26.63	.0001	+		+
Reduced affective reciprocity	46	54	45	50	25	5	24.86	.0001	+		+
Reduced sharing of others' pleasure	31	54	60	30	15	15	13.65	.0011	+		+
Social disinhibition	39	54	40	45	30	5	17.82	.0001	+		+
Lack of appropriate social responses	69	15	40	25	20	0	14.72	.0006	+		+
Lack of friendships	23	77	40	60	20	20	23.32	.0001	+		+
Reduced or abnormal greeting	39	23	50	25	15	0	15.44	.0004	+		+
Limited facial expression	54	15	40	40	5	0	24.17	.0001	+		+
Inappropriate facial expression	69	8	55	30	25	5	13.99	.0009			+
Interests/Behaviour											
Qualitatively abnormal behaviours											
Unusual sensory interests	62	0	10	5	5	0	14.34	.0008	+		
Unusual attachment to objects	8	23	10	0	0	0	5.55	.0623			
Idiosyncratic negative responses	23	0	10	0	0	0	5.85	.0536			
Rocking	31	39	5	0	0	0	21.99	.0001	+	+	
Hand and finger mannerisms	39	8	35	15	0	0	13.39	.0012			+
Other complex mannerisms	23	8	10	10	10	0	2.29	.3184			
Restricted/stereotyped behaviours											
Unusual preoccupation or circumscribed interest[a]	69	31	20	65	5	0	32.31	.0001	+		+
Resistance to change in own routines or in environment[a]	46	15	55	25	0	0	25.25	.0001	+		+
Compulsions/rituals	39	46	45	25	5	0	24.41	.0001	+		+
Reduced curiosity	8	54	45	20	15	0	13.47	.0012	+		+
Reduced engagement in appropriate activities	62	8	45	20	30	0	7.68	.0215			
Motor											
Abnormal gait and posture	62	8	50	32	0	5	21.80	.0001	+		+
Abnormal gross motor coordination	31	8	50	35	10	10	17.01	.0002		+	+

[a] These items were coded separately for AS and CD but as one item for HFA subjects. The higher coding for AS and CD subjects was included for the analysis.