Journal of Child Psychology and Psychiatry 47:6 (2006), pp 621–628 doi:10.1111/j.1469-7610.2005.01584.x

The prevalence of autistic spectrum disorders in adolescents with a history of specific language impairment (SLI)

Gina Conti-Ramsden, Zoë Simkin, and Nicola Botting

School of Psychological Sciences, University of Manchester, UK

Background: Traditionally, autism and specific language impairment (SLI) have been regarded as distinct disorders but, more recently, evidence has been put forward for a closer link between them: a common set of language problems, in particular receptive language difficulties and the existence of intermediate cases including pragmatic language impairment. The present study aimed to examine the prevalence of autism spectrum disorders in a large sample of adolescents with a history of SLI. **Method:** The presence of autism spectrum disorders was examined in seventy-six 14-year-olds with a confirmed history of SLI. A variety of instruments were employed, including the Autism Diagnostic Interview-Revised (ADI-R), the Autism Diagnostic Observation Schedule (ADOS) and the Family History Interview (FHI). **Results:** The prevalence of autism spectrum disorders in young people with SLI was found to be 3.9%, about 10 times what would be expected from the general population. In addition, a much larger number of young people with a history of SLI showed only some autism spectrum symptoms or showed them in a mild form. **Conclusions:** Young people with SLI have an increased risk of autism. The magnitude of this risk is considerable. In addition, a larger proportion (a quarter of individuals) present with a number of behaviours consistent with autism spectrum disorders. **Keywords:** Specific language impairment (SLI), autism, prevalence, diagnosis. **Abbreviations:** ADI-R: Autism Diagnostic Interview-Revised; ADOS: Autism Diagnostic Observation Schedule; CCC: Children' Communication Checklist; FHI: Family History Interview; PDDNOS: pervasive developmental disorder not otherwise specified; PLI: pragmatic language impairment; SLI: specific language impairment.

Specific language impairment (SLI) is a developmental disorder that involves limitations in language learning and use in the absence of factors such as low nonverbal IQ, hearing impairment or neurological damage (Leonard, 1998). SLI is a common disorder: current research suggests that approximately 7% of children experience SLI (Tomblin et al., 1997). Autism is also a developmental disorder that involves limitations in language learning and use but additionally is characterised by concurrent social interaction difficulties and repetitive/limited behavioural repertoires (American Psychiatric Association, 1994; World Health Organization, 1993). Autism is a rare disorder: prevalence is thought to be between 20–40/10,000, i.e., between .2 and .4% of the general population (see Charman, 2002; Fombonne, 2003 for reviews).

A closer relationship between SLI and autism

For the past fifteen years or so, the traditional notion that SLI and autism are distinct disorders has been challenged. The roots of this challenge came as early as 1967 when Rutter hypothesised that language impairment was the key feature of autism and, as such, autism bore striking similarities to receptive language problems in SLI (Rutter, 1967). Since then, evidence of a closer relationship between SLI and autism has been accumulating.

Rapin and colleagues' classification of developmental language disorders included a subtype referred to as semantic-pragmatic deficit syndrome (Rapin, 1996; Rapin & Allen, 1998). This syndrome was characterised by difficulties in the social use of language. Rapin and her colleagues argued that this syndrome was evident in both children with language impairments (SLI) and children with autism, thus suggesting that both developmental disorders shared difficulties with this dimension of language, i.e., social use.

In addition, some children appear to have profiles of impairment intermediate between SLI and autism. In the speech and language literature, these children tend to be referred to as having semantic pragmatic disorder (without autism) or more recently pragmatic language impairment (PLI) (Bishop, 2000; Botting & Conti-Ramsden, 1999, 2003). In the psychiatric literature, a number of studies have reported groups with pervasive developmental disorder not otherwise specified (PDDNOS; e.g., Cox et al., 1999) or with atypical forms of ASD such as Lorna Wing's 'active but odd' subgroup (Wing, 1997). Children in all these

Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

groups are thought to have some of the characteristics of SLI and they make spontaneous social approaches, but also show particularly pronounced difficulties with the social use of language as would be expected of autism, for example difficulty using pragmatic cues in everyday conversation.

Given the above evidence of a possible closer link between SLI and autism, it is interesting that very little data exists regarding the prevalence of autism in children and young people with SLI. Indeed, we are not aware of any study that has directly addressed this question using commonly used procedures, including gold standard diagnostic instruments for autism. This is perhaps due to the traditional model and diagnostic approach described above. Although research is beginning to question the overlap between these disorders, it is still the case that in practice a diagnosis of SLI disallows the diagnosis of autism in the same child, and this is influencing our research approaches in that we still view these disorders as aetiologically distinct.

Having said this, a recent study by Bishop and Norbury (2002) has taken the first step in this direction. These authors applied a number of standard instruments for the diagnosis of autism (including ADI-R and the ADOS) to a group of children with PLI and discovered two thought-provoking findings. First, children with PLI were spread across the autism spectrum: some did not present with any features of autism, some presented with mild features of the disorder, while others presented all the characteristics that warrant a diagnosis of autism. Second, and unexpectedly, in the group of children with SLI, some not thought to have pragmatic difficulties were reported (via ADI-R parental interview) as presenting with some or all the features typical of autism. This study was exploratory in nature and small in scale but despite these limitations the findings pointed to a clear need to examine more closely the prevalence of autism spectrum disorders within an SLI population.

Finally, the issue of diagnostic fluidity or stability over time has been much less addressed from an SLI perspective than in the ASD literature. In the latter, a number of studies have shown that there is a diagnostic interaction between age at diagnosis and the measure used (Cox et al., 1999; Charman & Baird, 2002); that while early diagnoses of ASD appear reasonably stable (Gillberg et al., 1990), the fluidity is much greater when PDD classifications are assigned (Cox et al., 1999); and that variability of scores increases with age (Charman et al., 2005). Charman and Baird (2002) discuss this instability as misdiagnosis, especially where the change in diagnosis is from language impairment to ASD. However, the study of long-term pathways and development of language impairment is only in its infancy and little is known about the prevalence and nature of late-onset autism in SLI.

Given the context described above, the first key aim of the present study was to examine the prevalence of autistic spectrum disorders in a large sample of adolescents with a history of SLI using a variety of instruments, including gold standard procedures for the diagnosis of autism. A second aim was to describe the characteristics of the autism spectrum disorders present in young people with SLI: What are the most common profiles of impairment within the triad?

Method

Participants

The participants in this study were originally part of a wider study, the Conti-Ramsden Manchester Language Study involving following children with SLI since they were 7,years of age (Conti-Ramsden & Botting 1999; Conti-Ramsden, Crutchley, & Botting, 1997). From the original cohort of 242 children, four families (2%) in which the child was adopted were not contacted at 14,years of age, no response could be obtained from 59 (24%) families, and 55 (23%) families refused consent. Of the 124 (51%) families who agreed to take part in the present phase of the study, 118 (95%) were assessed and 6 (5%) were not assessed due to alterations in family circumstances.

From this pool of 118 consenting, assessed families, 76 were selected for participation in the present study based on longitudinal data which showed that all participants in the current study met criteria for SLI at least at one time point (7, 8, 11 or 14 years). The criteria for SLI included:

1. performance IQ (PIQ) of 80 or more and a minimum of one concurrent standardised language test score which fell at least 1SD below the population mean at one of the longitudinal assessment stages;
2. no sensory-neural hearing loss;
3. English as a first language;
4. no record of a medical condition likely to affect language.

In addition to the SLI criteria above, participants in this stage of the study also had to have parental data (ADI-R) and observational data (ADOS) available. Participants had a mean age of 14; 6 years (range 13; 2–15;11). The majority was male (76.3% male/23.7% female).

In order to further describe the sample, current language status at the time of the study was used to categorise the young people (into currently SLI or not) using the same criteria that were used for inclusion in the study. Adolescents were classed as currently SLI if they had performance IQ (WISC-III PIQ) ≥ 80 and also an expressive or receptive language standard score (CELF-R ELS/RLS) <85. It was found that 35/76 adolescents (46.1%) fitted SLI criteria at the time of the study. Of the remainder, 28/76 (36.8%) showed both depressed nonverbal and verbal skills and 13/76 (17.1%) showed normal range nonverbal and verbal ability. These findings are consistent with our previous research which documents a substantial drop of PIQ

with time in young people with SLI (Botting, 2005). Thus in total, regardless of PIQ, 63/76 (82.9%) of this sample of adolescents exhibited a current language difficulty at a level of more than 1SD below the mean.

Autism diagnostic measures

Autism Diagnostic Interview – Revised. The Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994) is a modified version of the Autism Diagnostic Interview (ADI; Le Couteur et al., 1989). It is a standardised, semi-structured, investigator-based interview designed for caregivers of autistic individuals. The ADI-R consists of five sections: opening questions; questions on language and communication (both early and current); those on social development and play (again both early and current); enquiries about repetitive and restricted behaviours (all scored for both current and ever judgements); and a number of questions concerning general behaviour problems. This diagnosis of autism is made according to the algorithm specified by Lord et al. (1994).

Autism Diagnostic Observation Schedule. The Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) is a semi-structured, standardised assessment of communication, social interaction and play or imaginative use of materials. The ADOS consists of standard activities that allow the examiner to observe behaviours that have been identified as important to the diagnosis of autism spectrum disorders. Diagnostic classification of autism is made on the basis of exceeding the threshold on each of two domains – 'Social Interaction' and 'Communication' – and exceeding a threshold for a combined 'Communication–Social Interaction' total. If the thresholds for autism are not met, an ADOS classification of ASD/PDD instead of autism is appropriate, provided that all three thresholds for autism spectrum disorder are met or exceeded.

Family History Interview. The Family History Interview (FHI; Bolton et al., 1994, subsequently amended for use in language studies) is an investigator-based approach to eliciting information from caregivers for individuals with developmental disorders of cognition, social functioning and language. Items are coded for behaviour at different times in an individual's development, namely at 4–5,years old, currently or ever. The FHI examines the medical, developmental, social and educational history of individuals. Thus, the FHI is more general than the ADI-R and as such resembles an informal interview in a clinical setting. The FHI contains a summary question on the presence of autism (no autism, probable autism, definite autism), to be filled in after the interview has been completed. This coding relies on three summary codes, namely qualitative impairment in social interaction, qualitative impairment in communication and restricted, repetitive, stereotyped patterns of behaviour, interests or activities. Thus, it is important to note that the FHI is not a diagnostic instrument per se but a procedure that leads to an indication of the possible presence of autism.

Language, literacy and general cognitive measures

The adolescents in the study were administered the full WISC-III (Wechsler, 1992). This yielded an overall standardised performance IQ score (WISC-III PIQ) and verbal IQ score (WISC-III VIQ).

Language was assessed using the Clinical Evaluation of Language Fundamentals-Revised UK (CELF-R; Semel, Wiig, & Secord, 1987). This yielded a Receptive Language Score (RLS), an Expressive Language Score (ELS) and a Total Language Score (TLS).

Literacy was assessed using the Wechsler Objective Reading Dimensions (WORD; Rust, Golombok, & Trickey, 1993). This comprised Basic Reading, Spelling and Reading Comprehension subtests.

All standardised tests above provided standard scores with a mean of 100 (SD = 15).

Results

Diagnosis of autism in children with a history of SLI: data from different instruments

The majority of adolescents with a history of SLI did not present with characteristics necessary for a diagnosis of autism. The proportion of adolescents with features considered *not* to overlap with autism spectrum disorders was 85.5% on the ADI-R. The ADOS suggested no autism in 75% of the sample and a similar figure was obtained for the FHI (73.7%).

In terms of a positive diagnosis of autism and autism spectrum disorders (ASD) it was found that 14.5% of the adolescents in the present study were diagnosed as having autism according to the ADI-R and 14.5% according to the ADOS. A further 10.5% of the sample was diagnosed as having ASD according to the ADOS. In addition, 26.3% of adolescents were considered by the FHI to have characteristics of autism (comprising 17.1% probable and 9.2% definite).

Concurrence of different assessments in a sample with a history of SLI

It is of interest to examine concurrence, particularly between the ADI-R and the ADOS as these instruments are considered to be the 'gold standard' for the diagnosis of autism and designed to be used in conjunction with each other. Table 1 presents the

Table 1 Concurrence between ADI-R and ADOS diagnoses of autism

	ADOS diagnosis			
	No autism	ASD	Autism	
ADI-R diagnosis				
No autism	**53 (69.7%)**	4 (5.3%)	8 (10.5%)	65
Autism	4 (5.3%)	4 (5.4%)	**3 (3.9%)**	11
	57	8	11	76

diagnostic overlap expressed as a percentage of the total number of participants.

The majority of participants (69.7%) did not meet criteria for autism on either measure. Importantly, 3.9% of this sample was considered by both instruments to present with all the characteristics necessary for a diagnosis of autism. The picture is less clear for the remainder of the participants. For example, it can be seen that 5.3% met criteria for autism on the basis of parental report (ADI-R diagnosis) but were considered not to have autism or ASD by the researcher observation (ADOS diagnosis). In contrast, 15.8% of the sample was considered not to display autism based on parental response to ADI-R items but were given a diagnosis of autism (autism or ASD) by the researcher observation. A significant association was found between the diagnoses by the ADI-R and ADOS ($\chi^2(2) = 12.17$, $p = .002$). Cramer's V indicated the strength of association between the two instruments was .40. This can be described as moderate (Hollander & Wolfe, 1973).

The above findings suggest that there may be three subgroups of adolescents with a history of SLI: the no autism group, the autism group and an uneven autism profile group.

Relationship of gold standard diagnosis of autism to Family History Interview

It is interesting to examine the relationship between the gold standard diagnosis of presence/absence of autism (using the combined ADI-R and ADOS) and the indication of autism based on parental report instruments alone such as the FHI. The FHI concurs with an absence of autism against the gold standard in 84.9% of the 'no autism group' and the presence of autism in 66.7% of the autism group (although the latter group is very small, i.e., 2 out of 3 young people). A diagnosis of 'probable autism' is made in 15.1% of the no autism group, 20% if the uneven profile group and 33.3% of the autism group. A significant association was found between the ADI-R/ADOS gold standard diagnosis and the FHI ($\chi^2(4) = 25.797$, $p < .001$). Cramer's V indicated a moderate association of .41 between the aforementioned instruments.

Profiles of language and autism in subgroups

Table 2 presents information on the verbal and nonverbal abilities of the subgroup with no autism and the subgroup with an uneven autism profile. As the number of participants in the subgroup with concurred autism was small, test scores for this group are presented individually in Appendix 1.

T-tests revealed no significant differences between the groups. There were no differences in WISC-III performance IQ ($t(70) = 1.454$, $p = .150$), WISC-III verbal IQ ($t(71) = 8{\cdot}01$, $p = .426$), CELF-R expressive language ($t(71) = 1.59$, $p = .116$), CELF-R receptive language ($t(71) = .911$, $p = .366$), CELF-R total language score ($t(71) = 1.273$, $p = 207$), WORD basic reading ($t(71) = 1.453$, $p = .151$), WORD reading comprehension ($t(70) = .471$, $p = .639$) or WORD spelling ($t(71) = 1{,}611$, $p = .112$). Thus, it appears that the 'no autism' and the 'uneven autism profile' groups do not differ in their psycholinguistic profiles. However, it is noteworthy that the uneven autism group has approximately a 14-point difference between reading accuracy and reading comprehension scores versus a 5-point discrepancy in the no autism group. This difference between the groups in this discrepancy score was statistically significant ($t(70) = 2.753$, $p = .008$).

In terms of the proportion of adolescents in each subgroup meeting criteria for current SLI (see method section), it was found that 56.6% of the 'no autism' subgroup and 20% of the 'uneven profile' subgroup fitted SLI criteria. Of the remainder, 32.1% of the 'no autism' subgroup and 45% of the 'uneven profile' subgroup showed both depressed nonverbal and verbal skills; 11.3% of the 'no autism' and 35% of the 'uneven profile' subgroup showed normal range nonverbal and verbal ability. Of those three adolescents with a diagnosis of autism, one met current SLI criteria and two showed both depressed nonverbal and verbal skills.

Table 3 presents the proportion of the subgroups with no autism and an uneven autism profile

Table 2 Psycholinguistic characteristics (standard scores) for the 'no autism' and 'uneven autism profile' subgroups

	'No autism' subgroup ($n = 53$) M (SD)	'Uneven autism profile' subgroup ($n = 20$) M (SD)	CI_{95} of the difference
WISC-III PIQ	86.9 (19.2)	79.4 (20.4)	−2.77, 17.75
WISC-III VIQ	80.8 (16.1)	77.1 (21.5)	−5.55, 13.01
CELF-R Expressive Language	68.8 (10.3)	73.8 (16.0)	−11.37, 1.28
CELF-R Receptive Language	79.5 (15.9)	84.1 (25.9)	−14.54, 5.42
CELF-R Total Language	72.4 (12.3)	77.5 (21.3)	−13.05, 2.88
WORD Basic Reading	84.0 (15.1)	90.4 (20.1)	−15.02, 2.36
WORD Reading Comprehension	78.8 (13.1)	76.9 (18.4)	−5.97, 9.66
WORD Spelling	80.2 (15.1)	87.1 (18.3)	−15.27, 1.62

Table 3 Percentage of adolescents with ADI-R/ADOS no autism and uneven autism profile showing impairment in each triad area

	ADOS											
	Social interaction				Communication				Stereotyped behaviours			
	No autism subgroup		Uneven profile subgroup		No autism subgroup		Uneven profile subgroup		No autism subgroup		Uneven profile subgroup	
	normal	>cut-off*	normal	>cut-off*	normal	>cut-off*	normal	>cut-off*	normal	>cut-off†	normal	>cut-off†
ADI-R												
Social interaction												
normal	79%	13%	0%	40%								
> cut-off	2%	6%	20%	40%								
Communication												
normal					81%	8%	0%	45%				
> cut-off					9%	2%	15%	45%				
Repetitive behaviours												
normal									75%	8%	35%	5%
>cut-off									11%	6%	35%	25%

*Cut-off defined as above threshold for ASD.
†Cut-off defined as a score of one or more on at least one of the four items.

exceeding the instrument thresholds for impairment in each area of the autism triad.

The majority of the 'no autism' group has normal functioning in the areas of social interaction (79%), communication (81%) and repetitive and stereotyped behaviour (75%). However, despite this group being defined as not autistic across the triad, there are examples of isolated impaired behaviour in each of the domains. It is evident that those adolescents with an uneven autism profile are all characterised by difficulties with social interaction and communication. However, impairment in the domain of stereotyped and repetitive behaviours was not a feature of the profiles of all of these adolescents.

Discussion

The results of the present study suggest that the prevalence of autistic spectrum disorders in young people with a history of SLI is around 3.9%, about 10 times what would be expected in the general population (Fombonne, 2003). Consistent with recent research on the autism phenotype (Pickles et al., 2000), in addition to those few individuals that appear to show full autism, a much larger number of young people with a history of SLI show fewer symptoms or show them in a mild form.

The use of different instruments

It is evident that using the current methodology involving a number of instruments, the prevalence of autism spectrum disorders in young people with a history of SLI presents a relatively consistent picture: the majority of young people with a history of SLI in the present study (around three-quarters) do not display behaviours indicative of autism spectrum disorders. The other approximate 25% of young people with a history of SLI appear to present with a number of behaviours consistent with autism spectrum disorders as defined by either parental interview instruments or direct researcher observation.

In recent years, the combination of interview and observational measures (in particular the ADI-R and the ADOS) has been considered to be the gold standard for the diagnosis of autism (Lord et al., 1994, 2000). In the present study we found a significant (moderate) association between the ADI-R and the ADOS diagnosis of autism in adolescents with a history of SLI. These findings are not unexpected. These instruments have been developed to diagnose autism, albeit from different, complementary sources of information, i.e., parental interview versus direct assessment via observation. In addition, both sets of instruments look specifically at social interaction and communication as part of their algorithm for the diagnosis of autism. On the other hand, some differences between the instruments are to be expected. For example, the ADI-R focuses on how the child was (most items relate to the 4–5-year range or 'ever'), while the ADOS is based on how the young person is now. Thus, it is to be expected that some children may have looked more autistic in the past but less now and the other way around – some children may have looked less autistic in the past but more so now. Ideally, one would want to have both parent report and direct observation at both early age and currently, but these were not available for the present study.

Cases of autism in SLI adolescents: aetiological continuity or misdiagnosis?

The present investigation has established a tenfold risk factor for autism in SLI. Are these true cases of autism in young people with SLI or simply misdiagnosed cases of autism?

There are a number of arguments that support the notion that the cases identified in the present study are cases of SLI with autism. In the present study all the participants had been identified as having primary language difficulties, were attending special education provision for children with language difficulties and had all met objective criteria for a diagnosis of SLI during their development. Importantly, the three young people who met parental interview and observational criteria for autism at 14 years, all had met the aforementioned SLI criteria prior to or at 14 years.Furthermore, current profiles of impairment were widely different in these three young people. One adolescent had normal nonverbal IQ and very poor oral language skills and problems with reading comprehension and spelling (and still met objective criteria for SLI at 14 years). Two young people had poor nonverbal IQ, one with problems across language and literacy while the other presented with problems more specific to receptive language and reading comprehension. Thus, no one profile seemed to determine the presence or absence of autism.

In addition, it is important to note that in the present study those young people with SLI and uneven autism profiles did not differ significantly from young people with SLI without autism in terms of their language profiles. This finding underlines the notion that the young people in these varying autism spectrum groups had similar heterogeneous profiles of impairment, as would be expected of SLI. In general, one would have expected to find autistic features more common among children with receptive language difficulties, but the data in Table 3 show that, if anything, receptive scores tend to be slightly lower in the no autism subgroup. Out of interest, we further examined performance for each of the receptive language subtests of the CELF across the two subgroups and found the same pattern of no significant differences between the uneven autism profile subgroup and the no autism subgroup.

Interestingly though, the young people with uneven autism profiles were less likely to meet criteria of SLI at 14,years than the no autism group were. The main difference that was found between the two subgroups was the increased percentage of children in the uneven autism profile subgroup who showed normal range nonverbal and verbal ability (35% versus 11.3%). This finding suggests that the types of tests usually used in clinical practice (mainly focused on structural aspects of language) are unlikely to pick up the communication difficulties that young people with uneven autism profiles may experience. It was also revealing to find through analysis of discrepancy scores that the uneven autism profiles subgroup appeared to have relatively good reading accuracy with poor reading comprehension: a profile which is relatively unusual in SLI, but would seem to fit well with what we know about autism.

Finally, it is worth noting that unlike studies of ASD diagnostic stability reported earlier (Cox et al., 1999), the difference in diagnosis has not occurred at very young ages (when it is even difficult to separate an SLI population from those who are 'late talkers'; see Leonard, 1998). Instead this sample were all definite cases of SLI as late as 7 years of age, when the stereotypical behaviours and atypical social skills characteristic of autism would have been visible if they had been present, especially as assessed by speech and language professionals who see a large number of children with autism as well as those with SLI. Instead the findings are suggestive of the *development* of increasingly autistic-like behaviours over time.

The key finding of this investigation is that a proportion of the young people with SLI also met criteria for a diagnosis of autism (3.9%) and a considerable proportion met criteria for autism in at least one of the two instruments used in the gold standard diagnosis of autism (the uneven autism profile group, 26.4%). Noterdaeme, Mildenberger, Sitter, and Amorosa (2002) also found that 1 out 11 children with receptive language disorders met criteria for autism using the ADI-R (but not the ADOS, suggesting that this child would have fallen in what we describe as the uneven autism profile group). Interestingly, these authors interpreted these findings as a case of misdiagnosis or false classification. It is important to keep in mind the possibility of false positives based on the use of a single instrument and measurement error more generally and to be particularly aware of the imperfect nature of the operational cut-offs being used by different instruments/approaches to classification. Having said this, we would like to argue that there is a meaningful group of young people, beyond the unavoidable artefacts of classification error or noise in the data. These young people form approximately a quarter of our participants with SLI, who present with uneven autism profiles. This evidence points to a clear overlap between SLI and autism. Consistent with the work of Bishop (2003), we suggest that there is aetiological continuity between these two disorders, most likely due to sharing of common risk factors.

Having said this, it is important to note that the nature of our SLI sample may have increased the heterogeneity observed in adolescence. Although all the young people participating in the study had met SLI criteria prior to or at 14 years, they had not all presented with a documented SLI profile at age of recruitment (7 years of age from language units). In addition, the present study did not obtain a general psychopathological profile for the participating adolescents, particularly possible coexisting symptoms such as ADHD, dyslexia or emotional disorders, to mention a few. Such factors are likely to have increased the heterogeneity of our sample and may have played a role in the results obtained in this investigation. It would be of interest for future

research to replicate our findings with different samples of young people with SLI.

Clinical implications

The present study has established the risk of autism in young people with a history of SLI to be 10 times more than would be expected from the general population. This finding suggests a need for a change in the diagnostic criteria used for SLI where autism is currently disallowed. Instead, clinician-researchers need to be aware of the possible increased risk of autism in this population and take steps to include in their diagnostic battery assessments specifically designed to evaluate autism spectrum disorders.

The fact that some children with a clear profile of SLI in middle childhood might later develop symptoms more characteristic of autism also indicates that researchers and clinicians should be taking a developmental approach to childhood difficulties, rather than necessarily assuming that changes in profile are 'misdiagnoses' due to instrument insensitivity.

Acknowledgments

The authors gratefully acknowledge the support of the Wellcome Trust (Grant 060774), the Nuffield Foundation (Grants AT251[OD] and DIR/28), and an ESRC postdoctoral fellowship to Dr Nicola Botting (RES-000–270–003). Thanks also go to Helen Betteridge, Emma Knox and Catherine Pratt for their help with data collection. The authors would also like to thank the schools and families who helped us with this research and Tony Charman and Andrew Pickles for their comments on an earlier draft of the paper.

Correspondence to

Gina Conti-Ramsden, Human Communication and Deafness, School of Psychological Sciences, Humanities Devas Street Building, The University of Manchester, Oxford Road, Manchester M13 9PL, UK; Tel/Fax: 0161 275 3514/3965; Email: gina.conti-ramsden@manchester.ac.uk

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders IV*. Washington, DC: American Psychiatric Association.

Bishop, D.V.M. (2000). Pragmatic language impairment: A correlate of SLI, a distinct subgroup or part of the autistic continuum? In D.V.M. Bishop & L.B. Leonard (Eds), *Speech and language impairments in children: Causes, characteristics, intervention and outcome*. Hove: Psychology Press.

Bishop, D.V.M. (2003). Autism and specific language impairment: Categorical distinction or continuum? In G. Bock & J. Goode (Eds), *Autism: Neural basis and treatment possibilities, Novartis Foundation Symposium* (pp. 213–226). Chichester: John Wiley.

Bishop, D.V.M., & Norbury, C.F. (2002). Exploring the borderlands of autistic disorder and specific language impairment: A study using standardised diagnostic instruments. *Journal of Child Psychology and Psychiatry*, *43*, 917–929.

Bolton, P., MacDonald, H., Pickles, A., Rios, P., Goode, S., Crowson, M., Bailey, A., & Rutter, M. (1994). A case–control family history study of autism. *Journal of Child Psychology and Psychiatry*, *35*, 877–900.

Botting, N. (2005). Non-verbal cognitive development and language impairment. *Journal of Child Psychology and Psychiatry*, *46*, 317–326.

Botting, N., & Conti-Ramsden, G. (1999). Pragmatic language impairment without autism. *Autism*, *3*, 371–396.

Botting, N., & Conti-Ramsden, G. (2003). Autism, primary pragmatic difficulties and specific language impairment: Can we distinguish them using psycholinguistic markers? *Developmental Medicine and Child Neurology*, *45*, 515–524.

Charman, T. (2002). The prevalence of autism spectrum disorders. *European Child and Adolescent Psychiatry*, *11*, 249–256.

Charman, T., & Baird, G. (2002). Practitioner review: Diagnosis of autism spectrum disorder in 2- and 3-year-old children. *Journal of Child Psychology and Psychiatry*, *43*, 289–305.

Charman, T., Taylor, E., Drew, A., Cockerill, H., Brown, J., & Baird, G. (2005). Outcome at 7 years of children diagnosed with autism at age 2: Predictive validity of assessments conducted at 2 and 3 years of age and pattern of symptom change over time. *Journal of Child Psychology and Psychiatry*, *46*, 500–513.

Conti-Ramsden, G., & Botting, N. (1999). Characteristics of children attending language units in England: A national study of 7-year olds. *International Journal of Language and Communication Disorders*, *34*, 359–366.

Conti-Ramsden, G., Crutchley, A., & Botting, N. (1997). The extent to which psychometric tests differentiate subgroups of children with specific language impairment. *Journal of Speech, Language and Hearing Research*, *40*, 765–777.

Cox, A., Klein, K., Charman, T., Baird, G., Baron-Cohen, S., Swettenham, J., et al. (1999). Autism spectrum disorders at 20 and 42 months of age: Stability of clinical and ADI-R diagnosis. *Journal of Child Psychology and Psychiatry*, *40*, 719–732.

Fombonne, E. (2003). Epidemiological surveys of autism and other pervasive developmental disorders: An update. *Journal of Autism and Developmental Disorders*, *33*, 365–382.

Gillberg, C., Ehlers, S., Schaumann, H., Jakobsson, G., Dahlgren, S.O., & Lindblom, R. (1990). Autism under age 3 years: A clinical study of 28 cases referred for autistic symptoms in infancy. *Journal of Child Psychology and Psychiatry*, *31*, 921–934.

Hollander, M. & Wolfe, D. (1973). *Nonparametric statistical methods*. New York: Wiley.

Le Couteur, A., Rutter, M., Lord, C., Rios, P., Robertson, S., & Holdgrafer, M. (1989). Autism Diagnostic Interview: A standardized investigator-based instrument. *Journal of Autism and Developmental Disorders*, *19*, 363–387.

Leonard, L.B. (1998). *Children with specific language impairment*. Cambridge, Massachusetts: The MIT Press.

Lord, C., Risi, S., Lambrecht, L., Cook, E.H., Leventhal, B.L., DiLavore, P.C., et al. (2000). The Autism Diagnostic Observation Schedule – Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders*, *30*, 205–223.

Lord, C., Rutter, M., DiLavore, P.C., & Risi, S. (1999). *Autism Diagnostic Observation Schedule (WPS edition)*. Los Angeles: Western Psychological Services.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autistic Diagnostic Interview – Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorder. *Journal of Autism and Developmental Disorders*, *24*, 659–685.

Noterdaeme, M., Mildenberger, K., Sitter, S., & Amorosa, H. (2002). Parent information and direct observation in the diagnosis of pervasive and specific developmental disorders. *Autism*, *6*, 159–168.

Pickles, A., Starr, E., Kazak, S., Bolton, P., Papanikolaou, K., Bailey, A., et al. (2000). Variable expression of the autism broader phenotype: Findings from extended pedigrees. *Journal of Child Psychology and Psychiatry*, *41*, 491–502.

Rapin, I. (1996). Practitioner review: Developmental language disorders: A clinical update. *Journal of Child Psychology and Psychiatry*, *37*, 643–655.

Rapin, I., & Allen, D.A. (1998). The semantic-pragmatic deficit disorder: Classification issues. *International Journal of Language and Communication Disorders*, *33*, 82–87.

Rust, J., Golombok, S., & Trickey, G. (1993). *Wechsler Objective Reading Dimensions*. Sidcup, Kent: The Psychological Corporation.

Rutter, M. (1967). Concepts of autism: A review of research. *Journal of Child Psychology and Psychiatry*, *9*, 1–25.

Semel, E., Wiig, E.H. & Secord, W. (1987). *Clinical evaluation of language fundamentals – revised UK*. Sidcup, Kent: The Psychological Corporation.

Tomblin, J.B., Records, N.L., Buckwalter, P.R., Zhang, X., Smith, E., & O'Brien, M. (1997). Prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language and Hearing Research*, *40*, 1245–1260.

Wechsler (1992). *Wechsler Intelligence Scale for Children – Third Edition – Revised, UK*. Sidcup, Kent: The Psychological Corporation.

Wing, L. (1997). The autistic spectrum. *Lancet*, *350*, 1761–1766.

World Health Organization. (1993). *The ICD-10 classification for mental and behavioural disorders: Diagnostic criteria for research*. Geneva: World Health Organization.

Manuscript accepted 16 August 2005

Appendix

Appendix 1 Psycholinguistic characteristics (standard scores) of the three adolescents classified as 'autistic' by the gold-standard

	Adolescent 1	Adolescent 2	Adolescent 3
WISC-III PIQ	85	57	62
WISC-III VIQ	72	57	60
CELF-R Expressive Language	64	88	72
CELF-R Receptive Language	54	83	63
CELF-R Total Language	56	84	65
WORD Basic Reading	97	97	75
WORD Reading Comprehension	71	65	69
WORD Spelling	56	80	65