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Autistic symptomatology and language ability in Autism Spectrum Disorder and Specific Language Impairment

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Abstract

Background: Autism spectrum disorders (ASD) and specific language impairment (SLI) are common developmental disorders characterised by deficits in language and communication. The nature of the relationship between them continues to be a matter of debate. This study investigates whether the co-occurrence of ASD and language impairment is associated with differences in severity or pattern of autistic symptomatology or language profile. **Methods**: Participants (N=97) were drawn from a total population cohort of 56,946 screened as part of study to ascertain the prevalence of ASD, aged 9 to 14 years. All children received an ICD-10 clinical diagnosis of ASD or No ASD. Children with nonverbal IQ ≥80 were divided into those with a language impairment (language score of 77 or less) and those without, creating three groups: children with ASD and a language impairment (ALI; N = 41), those with ASD and but no language impairment (ANL; N = 31) and those with language impairment but no ASD (SLI; N = 25). **Results**: Children with ALI did not show more current autistic symptoms than those with ANL. Children with SLI were well below the threshold for ASD. Their social adaptation was higher than the ASD groups, but still nearly 2 SD below average. In ALI the combination of ASD and language impairment was associated with weaker functional communication and more severe receptive language difficulties than those found in SLI. Receptive and expressive language were equally impaired in ALI, whereas in SLI receptive language was stronger than expressive. **Conclusions**: Co-occurrence of ASD and language impairment is not associated with increased current autistic symptomatology but appears to be associated with greater impairment in receptive language and functional communication. **Keywords**: Autistic disorder; specific language impairment, SNAP cohort.

Abbreviations: ASD: autism spectrum disorders; SLI: specific language impairment; ALI: ASD with language impairment; ANL: ASD without language impairment.

Introduction

Autism spectrum disorders (ASD) and specific language impairment (SLI) are common developmental disorders; ASD affects over 1% of children (Baird et al., 2006) and SLI up to 7% (Tomblin et al., 1997). Their shared language impairment has generated an ongoing debate about the association between them for over 30 years (e.g., Bartak et al, 1975; Bishop, 2003).

ASD is a strongly genetic neurodevelopmental disorder characterised by impairments in reciprocal social interaction, communication and repetitive and restricted behaviours and interests (ICD-10, WHO, 1993; DSM-IV, APA, 2000). A delay in the onset of language and an impaired ability to use language effectively in social contexts are core diagnostic features of ASD, with pragmatic deficits almost universal regardless of level of functioning (Tager-Flusberg, 2000). Impairments in the structural aspects of language (phonology, semantics and the lexicon, syntax and morphology) are also found to varying degrees. Segmental phonology is intact or at least relatively spared; lexical semantics may also be a relative strength; syntax and morphology are delayed (Tager-Flusberg, 2000). In contrast, comprehension of spoken language appears to be especially vulnerable in ASD. Preschool-aged children with ASD show a delay in receptive vocabulary relative to expressive vocabulary (Charman et al., 2003) and continuing significant delay in comprehension differentiates ASD from SLI (Rutter et al., 1992).

In ICD-10 (WHO, 1993) specific developmental disorders of speech and language are diagnosed if the child shows speech and or language skills which are delayed relative to nonverbal IQ, in the absence of hearing impairment, intellectual disability, and ASD. Children with SLI can show impairments at all the structural levels of language, but deficits in the production of grammatical morphology are greater than would be expected from their general delay in language acquisition (Leonard, 1998). Tense-marking in English SLI is

especially vulnerable and has been suggested as a reliable clinical marker of SLI (Rice, 2000). Another proposed marker is nonword repetition (Bishop, North, & Donlan, 1996).

Recently, Tager-Flusberg and colleagues have identified a subgroup of children with ASD who present with language impairments in the context of nonverbal skills within the average range (henceforth, Autistic Language Impairment (ALI)) – that is, a profile typical of children with SLI. Children with ALI show the difficulties with verb morphology (Roberts et al., 2004) and nonword word repetition (Kjelgaard & Tager-Flusberg, 2001) seen in SLI.

Conversely, individuals with SLI who have receptive language impairments are reported to show autistic features. A group of children with receptive language impairments followed longitudinally were found to have increased difficulty in peer relationships between the ages of seven and nine, despite improvements in language functioning, and when followed up into adulthood, continued to show marked social impairments (Cantwell et al., 1989; Howlin et al., 2000). Recently, Conti-Ramsden, Simkin and Botting, (2006) reported the prevalence of ASD in a population of 14-year-olds with a history of SLI was higher (at 3.9%) than in the general population. Finally, Bishop (1998) reports a group of children with pragmatic language impairment (PLI) who show a history of SLI and severe pragmatic deficits, but not the restricted interests or difficulties with social relationships typical of ASD. While PLI combines features of both ASD and SLI, typically, both autistic and language impairments are less severely affected. Bishop and Norbury (2002) suggest the boundaries between SLI and ASD are fuzzy and that their association is best understood dimensionally. An alternative to modelling the association between SLI and ASD as a continuum is to see the disorders as distinct. In the case of ALI the pattern of impairments results from a "double hit" in which the presence of ASD leads to one set of deficits and SLI another. Under this model, children with ALI would present with ASD symptoms similar to those seen in children with ASD but without language impairment and similar language abilities to

children with SLI. A third possibility is that, while ASD and language impairment may be distinct disorders, when they co-occur they interact leading to more severe language impairments and ASD symptomatology. For example, an interaction of this sort has been reported for children with comorbid attention-deficit/hyperactivity disorder (ADHD) and SLI, such that where these disorders co-occur in children with a history of speech-sound production difficulties inattentive ADHD symptoms are more severe (McGrath et al., 2008).

The present study

We address the association between ASD and SLI with data from a stratified sample of children where ASD was established using standardised instruments and clinical diagnosis (Baird et al., 2006). The association between language impairment and behavioural presentation was investigated by comparing children with ALI to those with ASD but no language impairment (ANL) and by comparing children with ALI to those with SLI.

Method

Participants

Participants were drawn from a population cohort of 56,946 children born between July 1990 and December 1991 in South East Thames, UK, described by Baird et al. (2006). All those with a current clinical diagnosis of ASD (N=255) or considered "at risk" for being an undetected case by virtue of having a Statement of Special Educational needs (N=1,515) were screened using the Social Communication Questionnaire (SCQ; Rutter et al., 2003). A stratified sub-sample (N=255) received a comprehensive diagnostic assessment. At assessment the children were aged 9 to 14 years (Mean =12.0 years; SD = 1.1). This study was approved by the South East Multicentre Research Ethics Committee (00/01/50) and parents signed informed consent prior to participation.

Assessments

Autistic symptomatology was evaluated with using two criterion-referenced assessments, the Autism Diagnostic Interview – Revised (Lord, Rutter, & Le Couteur, 1994) and the Autism Diagnostic Observation Schedule – Generic (Lord et al., 2000). Both were scored following the published algorithms. The ADI-R is a semi-structured interview for parents and carers which focuses on ASD-typical behaviours and the descriptions elicited for communication, reciprocal social interaction and repetitive and stereotyped behaviours are rated for their autistic quality. An algorithm score can be generated based on behaviours reported for the child at 4-5 years of age for some it and of 'ever' for others. A child must reach cut-offs in reciprocal social interaction, communication, restricted and repetitive behaviour, and onset of symptoms to receive and autism diagnosis. The ADOS-G is semi-structured play and conversation based assessment consisting of 4 modules, each appropriate to different levels of language competence. It is designed to elicit communication and social behaviours with a number of 'presses' (e.g., the ability to participate in a to-and-fro conversation) which are rated for their autistic quality. An algorithm score is generated on the basis of ratings of current communication and social interaction and cut-offs are provided for autism and ASD for the communication and social domains and the combined communication and social score.

The Vineland Adaptive Behaviour Scales (Sparrow, Balla, & Cichetti, 1984) was used to measure everyday functioning in communication, daily living and social domains. IQ was measured using the Wechsler Intelligence Scale for Children-III (Wechsler, 1992).

Receptive vocabulary was assessed using the British Picture Vocabulary Scale 2nd Edition (Dunn et al., 1997) and the Clinical Evaluation of Language Fundamental 3rd Edition UK (CELF; Semel, Wiig, & Secord, 2000) provided a comprehensive measure of semantics, syntax and morphology in the receptive and expressive domains. Pragmatic skills were measured using the parent-completed Children's Communication Checklist (CCC; Bishop,

1998), which asks about inappropriate initiation, discourse coherence, stereotyped conversation, use of context in understanding conversation, and rapport (use of conversational cues) to generate a composite pragmatic impairment score. A pragmatic composite score of 132 or below indicates a pragmatic impairment.

Diagnostic process

The ADI-R and ADOS-G were each conducted by different researchers. The research team scored the assessments and made an initial clinical diagnosis. The principal clinical investigators (GB, ES, TC) reviewed every case, scoring the presence or absence of each ICD-10 symptom for autism as definitely or probably present. A consensus clinical diagnosis of childhood autism or other ASD was made on the basis of all sources of information: our assessments, earlier locally-based assessment, school information, and age of onset of impairments.

For 36 randomly selected cases project consensus diagnoses were compared to those of 8 internationally recognised experts using ICD-10 criteria (usually 2 experts independently rated ADI, ADOS, psychometric findings and a clinical vignette for each case). Quadratic weighted agreement between project consensus and expert autism/ASD/no-ASD diagnostic categories was 93% with kappa 0.77 (see Baird et al. 2006 for details).

Children included in analyses

The analyses included only those children with a WISC-III Performance IQ (PIQ) or Perceptual Organisation Index (POI) score of 80 or above (N= 97). This sub-sample of children was classified according to their ASD diagnosis (ASD and No ASD) and language status. Language impairment was defined as a CELF-3 Receptive Language, Expressive Language or Total Language score of 77 (-1.5SD) or below. This led to three groups of children: SLI (language impairment and no ASD) (N = 25; boys = 23); ALI (ASD and language impairment) (N = 41; boys = 39); ANL (ASD but no language impairment; N = 31;

boys = 30). The majority of language impaired children had impairments in both receptive and expressive language (SLI = 16; ALI = 23). Three children categorised as ALI were unable to complete the CELF-3, but each showed a significant discrepancy between VIQ and PIQ. All of the children were able to participate in Module 3 ADOS assessments, except three children with ALI who completed Module 2. The SLI group was older (M = 12.7 years; SD = 1.1) than the ALI groups (M = 11.4 years; SD = .8) ($t(62) = 5.59$, $p < .001$) and the ANL (M = 11.7 years; SD = .7) ($t(54) = 4.16$, $p = .001$). The ALI and ANL groups did not differ in age ($p > .1$).

Statistical Analysis

Stratification of the SNAP sample was based on whether or not a child had a locally recorded ASD diagnosis (yes/no) and 4 levels of SCQ score (low score (<8), moderately low score (8-14), moderately high score (15-21), high score (≥22). Analyses were conducted using the svy procedures in Stata 9.2 (StataCorp, 2006) with weights to account for the stratified sampling design (see Baird et al., 2006 for details). All statistics are target population estimates calculated using two-steps of inverse probability weighting to take account not only of the differences in sampling proportions and participation in in-depth assessment across the eight SCQ by prior local ASD diagnosis strata, but also the differential response to the SCQ associated with a prior local ASD diagnosis, district and child's sex. Data for diagnostic and psychometric measures were analysed using weighted linear regressions followed by Wald tests for pairwise comparisons.

Results

There was a significant difference in PIQ between the three groups (Wald $F(2, 95) = 12.96$, $p < .001$). The ANL group had a higher PIQ (M = 100.1, SE = 1.9) than the SLI group (M = 88.4, SE = 1.7) (Wald $F(1, 96) = 20.65$, $p < .001$); other pairwise differences were not significant (p-values > .1). PIQ was included as a covariate in all the following analyses to

account for between group differences in nonverbal abilities. Reported means are weighted and adjusted for PIQ. The SLI (M = 82.9, SE = 3.8) and ALI (M = 76.2, SE = 2.4) children did not differ in their overall Verbal IQ (p-value > .1). But both language impaired groups showed lower VIQ scores than the ANL children (M = 101.2, SE = 3.6) (SLI compared to ANL: $F(1,96) = 12.80$, $p < .001$; ALI compared ANL: $F(1,96) = 36.56$, $p < .001$). The SLI (M = 86.6, SE = 2.4) and ALI (M = 82.0, SE = 1.4) children did not differ in their Full Scale IQs (p-value > .1). Again, both language impaired groups showed lower FSIQs than the ANL children (M = 96.9, SE = 2.2) (SLI compared to ANL: $F(1,96) = 10.46$, $p = .002$; ALI compared ANL: $F(1,96) = 34.85$, $p < .001$).

Does language impairment affect the severity of autistic symptoms and adaptive behaviour?

The ALI and ANL groups were compared on the different measures of autistic symptomatology (see Table 1). The groups did not differ on SCQ scores, ICD-10 total symptom scores or ADI-R and ADOS-G algorithm scores (all p-values > .1). The ADI-R and ADOS-G provide separate scores for communication impairments, impairments in reciprocal social interaction and repetitive and restricted behaviours. These were considered separately to investigate the possibility that differences between the language impaired and non-impaired ASD children was restricted to one of these domains. The ALI group showed significantly more social impairment on the ADI-R than the ANL group (Wald $F(1, 96) = 5.45$, $p = .022$) but were not significantly different in communication or repetitive and restricted behaviours (all p-values > .1). For the ADOS-G neither the social nor the communication scores differed between the ALI and ANL groups (both p-values > .1).

--- Table 1 about here ---

The impact of language impairment on adaptive behaviour in children with ASD was investigated using the VABS. In contrast to the ADI-R and ADOS-G, which focus on atypical behaviours, the VABS is a norm-referenced measure of typical social and

communication development. Both ASD groups showed extremely low Adaptive Behaviour Composite scores (see Table 2), with the ALI group showing a significantly lower score than the ANL group (Wald $F(1, 85) = 5.34$, $p = .023$). The ALI group showed lower Communication scores than the ANL group (Wald $F(1,86) = 42.24$, $p < .001$), who scored just below the average range of the normative population sample. The ALI children also scored lower than the ANL group in the Daily Living (Wald $F(1,86) = 6.63$, $p = .012$). The ASD groups did not differ in their Social scores (p-value > .1).

--- Table 2 about here ---

The association between language impairment and pragmatic abilities in ASD was addressed using the CCC. The ALI children's pragmatic composite score ($M = 120.1$, $SE = 3.0$) did not differ from that of the ANL group ($M = 119.0$, $SE = 2.4$) (p-value > .1). Both groups scored well below the pragmatic impairment cut-off of 132 and below 122 (i.e., 2 SD below the mean for Bishop's (1998) SLI sample).

The SLI group had less impaired scores than the ASD groups on all of the ASD diagnostic instruments (see Table 1). This was reflected in significant differences when the groups were compared on the SCQ (Wald $F(2,95) = 10.05$, $p < .001$), ICD-10 (Wald $F(2,95) = 21.22$, $p < .001$), ADI-R (Wald $F(2,95) = 35.80$, $p < .001$), and ADOS-G (Wald $F(2,94) = 5.69$, $p = .005$). The SLI group's pragmatic composite score ($M = 137.5$, $SE = 3.0$) was above the impairment cut-off but still below a score of 140, which was the lowest score of the typically developing group reported by Bishop and Baird (2001). The strongest evidence for social impairments in SLI came from the VABS, where the SLI group's Social score was nearly 2 SD below the normative population average (see Table 2).

Does ASD affect the onset, severity or profile of language?

Early language milestones were evaluated using the ADI-R. The ANL group acquired first words at 15.4 ($SE = 2.1$) months, the SLI group at 22.0 ($SE = 3.8$) months and ALI group at

22.2 (SE = 2.0) months. The ALI group acquired words significantly later than the ANL group (Wald F(1,76) = 4.43, p = .039). The other differences were not significant (p-values > .1). The ANL children acquired phrases at 28.4 (SE = 4.6) months, the SLI children at 35.4 (SE = 4.7) months and ALI children at 45.2 (SE = 5.4) months. Again ALI group reached this language milestone significantly later than the ANL group (Wald F(1,76) = 5.86, p = .018). Other group comparisons for the phrase speech milestone were not significant (p-values > .1). The ALI group was significantly more pragmatically impaired than the SLI group, whose pragmatic composite score was above the impairment cut-off (Wald F(1,80) = 17.39, p < .001). The difference between the ALI groups and the SLI group was not significant for one pragmatic composite subscale, inappropriate initiation (SLI: M = 23.8 (1.0); ALI: M = 22.4 (.49); p>.1), and just missed significance for another, stereotyped language (SLI: M = 24.6 (1.1); ALI: M = 21.8 (1.0); Wald F = (1,76) = 3.48, p = .066). The ALI group also showed poorer functional communication than the SLI group, as measured by the Communication Domain of the VABS, (Wald F(1,86) = 4.72, p = .033).

The children with ALI and SLI were compared on the verbal IQ subtests of the WISC-III to investigate whether ASD affected the severity and pattern of impairment in verbal abilities (see Table 3). An examination of the individual VIQ subtests showed that the ALI group had significantly a lower Comprehension score than the SLI group (Wald F(1,96) = 12.21, p < .001). The SLI group's Comprehension score was not different to that of the ANL group (p-value > .1). However, the ANL group did show a greater discrepancy between Comprehension and mean subtest score than the SLI group (ANL: M = -3.1, SE = 0.6; SLI: M = -0.4, SE = 0.47; F(1, 96) = 14.63, p < .001) as did the ALI group (M = -2.1, SE = 0.5; F(1, 96) = 4.98, p = .028). The ASD groups did not differ in this discrepancy (F(1, 96) = 1.08, p > .1). The ALI and SLI groups did not differ on the Information, Similarities, Arithmetic or Vocabulary subtests (all p-values > .1).

--- Table 3 about here ---

The impact of ASD on the severity and pattern of impairment in structural language abilities was examined using the BPVS and CELF-3 (see Table 4). The ALI group showed lower CELF-3 Receptive Language scores than the SLI group (Wald $F(1, 90) = 10.42$, $p = .002$). The groups did not differ on BPVS or CELF-3 Expressive Language or Total Language (p-values > .1). Furthermore, discrepancy between receptive and expressive language was greater in the SLI children than the ALI children (Wald $F(1,90) = 8.51$, $p = .004$). ALI children not only showed lower absolute receptive language than the SLI children, they also showed a different association between receptive language and expressive language. Where the SLI children showed a discrepancy in favour of receptive language the ALI children showed a flat profile. The BPVS and CELF Receptive Language provided two different measures of verbal comprehension. The discrepancy between BPVS and CELF-RL was significantly greater for the ALI group than the SLI group (Wald $F(1,90) = 8.64$, $p = .004$). Hence, compared to the SLI children, the ALI children showed a relative strength in receptive vocabulary vs. the broader measure of receptive language provided by the CELF.

--- Table 4 about here ---

Performance on the individual subtests of the CELF-3 is shown in Figure 1. The only receptive language subtest that differentiated between the ALI and SLI groups was Concepts and Directions with the ALI group scoring lower than the SLI group (Wald $F(1,90) = 14.08$, $p < .001$). The groups did not differ on Word Classes or Semantic Relationships (p-values > .1). In the expressive domain the ALI group achieved a higher score on Sentence Assembly (Wald $F(1,90) = 4.09$, $p = .046$). The groups did not differ on Formulated Sentences or Recalling Sentences (p-values > .1).

--- Figure 1 about here ---

Discussion

Autism severity in the ALI and ANL groups

The ALI and ANL groups did not differ in severity of current autistic symptoms or pragmatic impairment. For autistic symptoms at 4-to-5 years, the ALI group were reported to show more impaired reciprocal social interaction, but no more impairment in communication or in repetitive and restricted behaviours, than the ANL group. This may suggest a slightly different profile of impairment developmentally but not currently. Another possibility is parental recall bias on this retrospective report measure may have led to parents of children with ASD and LI remembering their children as having been more socially impaired, although this was not evident in their report of communication impairment and repetitive and restricted behaviour. The ALI group showed weaker functional communication measured on the Vineland than the ANL group, an expected finding because of the marked language impairments of the ALI children, but also poorer daily living skills, which may be less expected. However, Liss et al. 2001 found that in high-functioning individuals with ASD Vineland performance, including daily living skills, was associated with language and verbal abilities rather than overall IQ. Thus, the poorer scores in the ALI group may reflect the impact of language impairment on some aspects of daily living. The ALI and ANL groups showed equally low social adaptive behaviour scores. Hence, when looking at the association between language impairment and ASD in late childhood, there was little evidence that their co-occurrence was associated with an increase in autistic symptoms or greater pragmatic impairment. However, the ALI group were more delayed in everyday adaptive communication and daily living skills but notably not in social adaptive abilities.

Social impairment in the SLI group

Our data do not suggest any overlap between the SLI and ASD groups in autistic symptomatology. There was some evidence of social impairments in the SLI children on the ASD diagnostic measures, but they scored well below the diagnostic cut-offs. Pragmatic

impairments characteristic of children with ASD were not found in the children with SLI . The CCC, which measures appropriate pragmatic behaviour, suggested the SLI group were only slightly below the average range suggested by Bishop and Baird (2001) and well above the cut-off for pragmatic impairment. Finally, social adaptive functioning was significantly stronger in SLI than in ASD, although the mean was nearly 2 SD below the average range. This pattern of results suggests that while the language impairment in SLI is not associated with an autistic social impairment, it is nevertheless associated with impaired social functioning.

Language profiles in the ALI and SLI groups

The ALI and SLI groups did not differ on several of the language measures used; including, notably, Recalling Sentences, which is a good psycholinguistic marker for language impairment (Conti-Ramsden, Botting & Faragher, 2001). However, receptive language was weaker in ALI than SLI. As well as the absolute level of receptive language being lower in ALI, a different relationship between receptive language and expressive language is apparent. Where children with SLI were characterised by stronger receptive than expressive language, the ALI children showed a flat language profile suggesting a general lowering of language ability. The ALI children also showed a greater discrepancy between receptive vocabulary (BPVS) and overall receptive language (CELF-RL) than the SLI children, which may indicate different aspects of receptive language are differentially impaired. The weaker CELF-RL score in ALI was largely due to a poor score on the Concepts and Directions. This subtest involves retaining and following a sequence of spoken instructions and makes heavy demands on attention and auditory short-term memory as well as those associated with the purely linguistic aspects of the materials. It is therefore difficult to identify the locus of the impairment that leads to the difference between the groups, especially, because both children with SLI and ASD have difficulties with attention (e.g.,

Corbett & Constantine, 2006; Stevens, Sanders & Neville, 2006) and auditory memory (Botting & Conti-Ramsden., 2003; Kjelgaard & Tager-Flusberg, 2001). While the ALI and SLI groups did not differ on overall CELF Expressive Language, the ALI children showed better performance on the Sentence Assembly subtest. The visual support provided by the written sentences used in the task may explain the result, as individuals with ASD show an advantage for pictures over words in access to semantics compared to typical controls (Kamio & Toichi, 2000) and access to semantic long-term memory is correlated with nonverbal IQ (Toichi & Kamio, 2002).

When the association between ASD and language impairment is considered in terms of language rather than autistic symptoms, there may be evidence of an interaction between the weak receptive language and pragmatic and social impairments which could account for the clinical impression that ALI children have a level of difficulty with functional understanding that is not always captured in language test results. In ALI there was poorer performance on the Comprehension subtest of the WISC-III than in SLI. A number of studies have shown poor performance on this subtest in ASD (e.g., de Bruin et al., 2006; Siegel et al., 1996) and both the ALI and ANL groups show a similar degree of discrepancy between Comprehension and other WISC VIQ substests. In ALI a structural difficulty understanding question forms may combine with an ASD-based difficulty with the content of questions, which focus on social rules and concepts, to explain the poor performance of children with ALI on this subtest. Evidence for an interaction between ASD and language impairment may be provided by the VABS Communication Domain scores, which were lower in ALI than SLI. Again this may be the result of a specific ALI language profile, in which comprehension is poor, and pragmatic and social impairments typical of ASD. Indeed in ANL, where language is unimpaired, functional communication is poor, with VABS Communication scores 1.5 SD below average and not significantly better than in SLI. In addition both ASD

groups showed very low CCC scores, which in part reflects poor understanding of the pragmatic aspects of language.

Strengths and Limitations

Strengths of the present study include: the comprehensive diagnostic assessment and use of a clinical consensus decision-making process corroborated by independent expert rating and the generalisability of the findings due to the population weighting procedure. The use of a range of autism diagnostic tools allowed both past and current symptomatology to be measured, although retrospective reporting of past behaviour may be considered a limitation. The age difference between the SLI and ASD groups may be seen as a limitation, but the language measures used were norm-referenced and small differences in age do not influence the ADI-R or ADOS-G. In addition, age was secondary to study design where more controls were seen toward the end. Another possible limitation was the nonverbal IQ of the SLI group, which may be considered low for children who were defined as having nonverbal abilities in the average range. However, the SLI group reported here are comparable with children of the same age in the Nuffield longitudinal study who had PIQs of 86.2 at 11 years and 83.0 at 14 years (Botting, 2005). The use of standardised instruments to measure language function was another potential limitation. The reasons for failure on a test may not necessarily be the result of the behaviour being assessed. For example, the low scores of the ALI group on CELF-3 Concepts and Directions may have been the result of attentional difficulties, poor short term memory or problems scanning the array of pictures rather than impaired verbal comprehension. More psycholinguistically informed approaches to language processing are required to follow up the findings presented here. In addition, a group of children without SEN were not included and so it was not possible to address the question of whether children with SLI show more "autistic behaviours" than typically developing children. Finally, these findings may be considered limited because they only relate to

children with ASD who have nonverbal IQs at least within the average range. The relationship between language abilities and autistic symptomatology may well differ in children with lower IQ.

Clinical and Theoretical Implications

The results presented here suggest that when ASD and language impairment co-occur in children with nonverbal abilities within the average range autistic symptoms are no more or less severe in late childhood than in children with ASD but no language impairment. Furthermore, on global measures of language ability children with ALI show similar levels of deficit as those with SLI. This may indicate that these two areas of deficit combine as a "double hit": ASD leads to one set of impairments and language impairment to another. However, when the detail of language presentation is considered there is some evidence that ALI is associated with differences in the severity and profile of language deficits compared to children with SLI, which may indicate that the two are interacting leading to more severe language impairments in ALI, in particular affecting verbal comprehension and functional communication.

Clinically, these findings underline the importance of a thorough assessment of language abilities once an ASD diagnosis has been made. ASD children with normal range nonverbal IQs may present with only mild delays in verbal IQ and relatively strong receptive vocabulary skills but have marked structural language difficulties, which need to be fully explored. Whilst structural language impairment may not affect autistic symptomatology, it has implications for functional communication and so needs to be specifically managed separately from the management of the presenting ASD. Conversely, children with SLI whilst not presenting with social impairments of the quality or severity found in ASD, can show significant social impairments and these also need to be assessed and managed separately.

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Table 1. Diagnostic instruments: Weighted, PIQ adjusted, mean (SE) total and domain scores for SCQ, ICD-10 symptom counts, ADI-R, and ADOS-G. (*RRBI = Repetitive and Restricted Behaviours and Interests)

	SLI	ALI	ANL	Group differences ($p < .05$)
SCQ	11.9 (1.9)	21.6 (1.5)	21.5 (1.6)	ALI=ANL>SLI
ICD-10 Total	2.0 (0.6)	6.6 (0.5)	7.0 (0.5)	ALI=ANL>SLI
ICD-10 Social	0.7 (0.3)	2.2 (0.3)	2.5 (0.2)	ALI=ANL>SLI
ICD-10 Communication	0.6 (0.1)	2.4 (0.2)	2.2 (0.2)	ALI=ANL>SLI
ICD-10 RRBI*	0.4 (0.2)	1.9 (0.2)	2.3 (0.2)	ALI=ANL>SLI
ADI-R Total	12.0 (2.6)	39.7 (1.9)	32.9 (3.6)	ALI=ANL>SLI
ADI-R Social	5.4 (0.9)	20.0 (1.0)	15.9 (1.6)	ALI>ANL>SLI
ADI-R Communication	5.5 (1.6)	14.5 (0.8)	12.3 (1.6)	ALI=ANL>SLI
ADI-R RRBI	1.1 (0.3)	5.3 (0.5)	4.8 (0.7)	ALI=ANL>SLI
ADOS-G Total	3.9 (1.1)	8.3 (0.9)	8.7 (1.6)	ALI=ANL>SLI
ADOS-G Social	3.0 (0.8)	6.1 (0.6)	6.4 (1.1)	ALI=ANL>SLI
ADOS-G Communication	0.9 (0.3)	2.2 (0.4)	2.2 (0.6)	ALI=ANL>SLI

Table 2. Weighted, PIQ adjusted, mean (SE) Vineland Adaptive Behaviour Scales scores.

	SLI	ALI	ANL	Group differences (p<.05)
Adaptive Behaviour	66.5 (3.4)	50.4 (1.2)	59.2 (3.7)	SLI=ANL>ALI
Composite				
Communication	68.9 (4.5)	58.1 (2.0)	80.1 (2.8)	ANL>ALI>ALI
Daily Living	72.1 (2.7)	50.8 (2.2)	63.3 (4.3)	SLI=ANL>ALI
Social	73.0 (4.1)	56.9 (2.4)	55.9 (2.4)	SLI >ALI=ANL

Table 3. Weighted, PIQ adjusted, mean (SE) WISC-III Verbal subtest scores.

	SLI	ALI	ANL	Group differences ($p<.05$)
Information	7.1 (1.1)	6.3 (1.0)	12.3 (1.1)	ANL>SLI=ALI
Similarities	7.6 (1.0)	7.0 (0.4)	11.1 (0.6)	ANL>SLI=ALI
Arithmetic	7.0 (0.8)	6.6 (0.5)	10.8 (0.6)	ANL>SLI=ALI
Vocabulary	6.6 (0.8)	5.3 (0.4)	8.8 (0.6)	ANL>SLI=ALI
Comprehension	7.4 (0.5)	4.6 (0.5)	7.6 (0.8)	ANL=SLI>ALI

Table 4. Weighted, PIQ adjusted, mean (SE) BPVS and CELF-3 scores. (TL = Total Language, RL = Receptive Language, EL = Expressive Language).

	SLI	ALI	ANL	Group differences (p<.05)
BPVS	84.8 (2.5)	87.3 (2.4)	104.3 (2.0)	ANL>ALI=SLI
CELF-TL	70.3 (2.3)	68.7 (0.9)	97.8 (3.2)	ANL>SLI=ALI
CELF-RL	78.3 (2.1)	70.7 (0.9)	95.6 (2.8)	ANL>SLI>ALI
CELF-EL	69.6 (1.9)	70.9 (1.5)	99.5 (3.6)	ANL>ALI=SLI
CELF RL/EL difference	8.7 (2.8)	-0.2 (1.4)	-4.0 (2.0)	SLI>ALI=ANL
BPVS-CELF-RL difference	6.4 (3.3)	18.0 (2.2)	9.6 (2.8)	ALI>ANL=SLI

Figure 1. CELF-3 weighted, PIQ adjusted subtest scores (standard error bars shown). (Receptive Language: CD = Concepts & Directions; WC = Word Classes; SR = Semantic Relationships; Expressive Language: FS = Formulated Sentences; RS = Recalling Sentences; SA = Sentence Assembly).