Loss of Language in Early Development of Autism

and Specific Language Impairment

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Abstract

Background: Several authors have highlighted areas of overlap in symptoms and impairment among children with autism spectrum disorder (ASD) and children with specific language impairment (SLI). By contrast, loss of language has been reported as relatively specific to autism. The present study aimed to examine the incidence of language loss and language progression of children with autism and SLI. Methods: We used two complementary studies: the Special Needs and Autism Project (SNAP) and the Manchester Language Study (MLS) involving children with SLI. This yielded a combined sample of 368 children (305 males and 63 females) assessed in late childhood for autism, history of language loss, epilepsy, language abilities and nonverbal IQ. Results: Language loss occurred in just 1% of children with SLI but in 15% of children classified as having autism or autism spectrum disorder. Loss was more common among children with autism rather than milder ASD and is much less frequently reported when language development is delayed. For children who lost language skills before their first phrases, the phrased speech milestone was postponed and long-term language skills tended to be lower than children with autism but without loss. For the few who experienced language loss after acquiring phrased speech, subsequent cognitive performance was poor. Conclusions: Language loss is highly specific to ASD. The underlying neuro-developmental abnormality may be more prevalent than raw data might suggest, its possible presence being hidden for children whose language development is delayed.

Keywords: Language loss, Autism, Specific Language Impairment (SLI), early language development, SNAP
Abbreviations: Special Needs and Autism Project (SNAP), Manchester Language Study (MLS), Specific Language Impairment (SLI), Social Communication Questionnaire (SCQ), Autism Diagnostic Observation Schedule – Generic (ADOS-G), Autism Diagnostic Interview-Revised (ADI-R)
Loss of Language in Early Development of Autism and Specific Language Impairment

There are areas of overlap in symptoms and impairment among children with autism and specific language impairment (SLI). Children with SLI have deficits in language learning and use that cannot be explained by factors such as low nonverbal IQ, hearing impairment or neurobiological damage (Leonard, 1998). It has been argued that there is a subgroup of children with autism who have a core language deficit similar to that present in SLI, i.e. that there are cases of autism with SLI (Kjelgaard & Tager-Flusberg, 2001; Whitehouse, Barry & Bishop, 2007). Limited language is just one aspect of a more general problem of restricted communication among children with autism whom additionally have deficits in social behaviour and also present with restricted/repetitive behavioural repertoires and interests (American Psychiatric Association, 2000). A smaller literature has pointed out how a proportion of children identified as SLI may exhibit the social and behavioural abnormalities commonly associated with autism (Bishop & Norbury, 2002; Conti-Ramsden, Simkin & Botting, 2006; Howlin, Mawhood & Rutter, 2000).

A feature of autism that has been reported as relatively specific to this condition is that of developmental regression (Shinnar et al., 2001), in which apparently normal development is followed by a faltering of skill acquisition and frequent loss of, or failure to use, existing language and social skills. Termed ‘autistic regression’, it is reported as occurring in 15-40% of children with autism, commonly in the second year of life (Lord, Shulman & DiLavore, 2004; Luyster et al., 2005; Richler et al., 2006; Tuchman & Rapin, 1997). It is usually followed by recovery and improvement in skills. By contrast, in the developmental SLI literature, regression is rarely reported.

If regression, and specifically loss of language, is uncommon among children with SLI, this would be a striking specificity, and one which would suggest that the impairment in language seen among many children with autism may arise from neuro-developmental
processes that may have some quite distinct elements from those underlying language impairment in SLI. Moreover, if we can only infer such distinctive processes through the loss of already acquired skills these processes may in fact be occurring in other children who have yet to acquire those skills. For these slower developing children there may be no readily reported surface expression of their anomalous neurodevelopment.

The Autism Diagnostic Interview has provided a framework for systematic recording of loss of spoken language after the first 3-5 word stage of acquisition (Le Couteur et al., 1989; Lord, Rutter & Le Couteur, 1994). Language loss may be associated with non-language regression such as social withdrawal and lack of social interest, decreased use of eye gaze to regulate social interaction, loss of gestures such as waving bye-bye, and sometimes a loss of play and fine motor skills (Ozonoff, Williams & Landa, 2005; Werner & Dawson, 2005).

To examine the issue of language loss in autism and SLI we compared data from two complementary studies: the Special Needs and Autism Project (SNAP; Baird et al., 2006) and the Manchester Language Study (MLS) involving children with SLI (Conti-Ramsden & Botting, 1999; Conti-Ramsden, Crutchley & Botting, 1997). Specifically, we were interested in addressing the following questions:

1. What is the incidence of reports of language loss in autism and SLI?
2. What is the relation between language loss and language development?
   a. When is language loss evident?
   b. Is there a relation between reported language loss and timing of language acquisition?
   c. Is there a relation between language loss and language performance in late childhood?
3. Does language loss mark a neuro-developmental anomaly of a minority of children with autism or could that anomaly be more widespread but hidden when language
development is delayed? Could differential language delay explain any difference in reported rates of loss in autism and SLI?

Methods

Samples
The SNAP sample was drawn from a total population cohort of 56,946 children. All those with a current clinical diagnosis of PDD (N=255) or considered ‘at risk’ for being an undetected case by virtue of having a statement of Special Educational Needs (SEN; N=1,515) were surveyed (mean age=10.3, SD=1.1) using the Social Communication Questionnaire (SCQ; Berument et al., 1999). A stratified subsample (coincidentally also N=255; 223 boys, 32 girls) drawn from across the range of SCQ scores received a comprehensive diagnostic assessment including standardized clinical observation (Autism Diagnostic Observation Schedule - Generic (ADOS-G); Lord et al., 2000) and parent interview assessments of autistic symptoms (Autism Diagnostic Interview-Revised (ADI-R); Lord et al., 1994), language and IQ, psychiatric co-morbidities and a medical examination. The children were aged 9 to 14 years at assessment (mean=12.0, SD=1.1). The team used ICD-10 (World Health Organisation, 1993) to derive a clinical consensus diagnosis of childhood autism, ‘other autism spectrum disorder’ (ASD) or no ASD. The no ASD SEN group included a variety of medical, sensory and developmental diagnoses, including a group with specific language impairment (n=9).

The MLS is a cohort of children recruited from 118 language units attached to English mainstream schools. No specific SLI criteria were used at selection (rather, their enrolment in a language unit and the absence of other diagnoses were used as identification criteria). Of the 242 children sampled (aged 6;2 to 7;10 years) 185 were males and 57 females. These children were reassessed at 8, 11 and 14 years of age. For the analyses in this paper we focussed on the 113 children (82 males and 31 females; mean age=14.4 (SD=0.75)) who participated in the fourth wave of data collection during
which they were formally assessed for autism and close in age to the SNAP sample. The MLS sample excluded those with a diagnosis of autism at age 7, but interestingly 28 of the 89 participants analysed here recorded ADI-R autism (n=14) and/or ADOS-G autism/ASD (n=23) at age 14 years. Together the SNAP and the MLS samples yielded a combined sample of 368 children assessed in late childhood (305 males, 63 females) for whom informed consent was obtained. The SNAP study was approved by the South East Multicentre Research Ethics Committee (REC) (00/01/50). Ethical approval for the MLS was given by the University of Manchester.

*Measures Common across Samples*

*Autism, loss of language and epilepsy.*

Formal clinical diagnosis was available only for the SNAP sample, but both samples were assessed in late childhood by specifically trained psychologists using the ADI-R (Lord et al., 1994), an interview with the main carer, and the ADOS-G (Lord et al., 2000), a structured observation. The ADI-R generates an algorithm score based on behaviours in three domains: verbal and non-verbal communication, social interaction and repetitive and stereotyped behaviours. The algorithm codes are based on behavioural descriptions of the child at 4-5 years of age for some items and of ‘ever’ for other items. There is an established cut-off for childhood autism (Lord et al., 1994) and a suggested cut-off for ‘all ASDs’ (i.e. including autism and other ASDs) (Risi et al., 2006). The ADOS-G consists of 4 modules, each appropriate to different levels of speech and language competence. It is designed to elicit particular behaviours with a number of ‘presses’, and scores social communication and social interaction. The ADOS-G algorithm score has established cut-offs both for childhood autism and ASD. The ADI-R places substantial emphasis on reported behaviour in the 4-5 year old period, whereas the ADOS-G is concerned solely with contemporaneous behaviour.
The ADI-R has specific questions about regression of language and other skills, including social interest and responsiveness. Strict language regression is defined as “loss of 5 words used communicatively for 3 months before loss” with or without loss of skills in other areas. The ADI-R also enquires systematically about epilepsy (febrile or non-febrile seizures, past or present or both).

Language and IQ measures.

Receptive, expressive and total language scores were obtained using the Clinical Evaluation of Language Fundamentals – Revised UK ( CELF-R; Semel, Wiig & Secord, 1987). IQ was measured using the Wechsler Intelligence Scale for Children (III-UK; Wechsler, 1992), Raven’s Standard Progressive Matrices or Coloured Progressive Matrices (Raven, Court & Raven, 1990a,b) depending on the child’s ability.

Current SLI was defined by the absence of autism or ASD, performance IQ of 80 or more, and one of CELF expressive, receptive or total standard scores less than 77.5 (1.5SD below the mean). Historic SLI was defined by available psychometric or clinical data that indicated the participant met criteria for SLI at some previous time point (Conti-Ramsden & Botting, 2004; Durkin & Conti-Ramsden, 2007). For most such children examined here performance IQ had subsequently declined below 80.

Analysis

All analyses in this paper were performed within the statistical package Stata, version 9 (StataCorp, 2005).

The analysis of the timing of the language milestones needed to account for the natural ordering of the events for which the phrased speech milestone cannot occur before the subject has experienced the single words milestone. We assume that a subject is not at risk for the second event until the first has occurred and define the risk interval for the second milestone as a gap time, where zero time is the time at which the first words milestone was achieved. We analysed the distribution of times to achieve first words,
times to first phrases and times to progress from words to first phrases using standard Kaplan-Meier (Kaplan & Meier, 1958) plots and tested for group differences using Cox survival models (Cox, 1972).

Calculation of gap times was complicated where the phrased-speech milestone had not yet been achieved (a censored observation) and where milestones were imprecisely recorded. For 15 participants one or both milestones were reported merely as falling below or above the cut-off of 24 and 33 months for normal development of first words and first phrases respectively. The unknown but normal or delayed onsets were imputed using the hotdeck procedure as implemented in Stata by Mander and Clayton (1999). This replaced the uncertain onsets with randomly selected observed values from subjects matched on sex, disorder group (four categories of ADI-R autism, ADOS-G ASD but not ADI-R autism, language disorders and other), normal/delayed speech onset indicators and whether or not the milestone was reached. We generated 25 complete (imputed) data sets, each with different imputed values to reflect our uncertainty in their true value. Using the Stata procedure micombine (Royston, 2004) estimates of means and other parameters of interest were obtained by averaging results from each dataset and valid standard errors calculated that accounted for between- and within-imputation variation (Rubin, 1987).

Analyses were performed with and without including IQ as an additional covariate.

Often overlooked in studies of language impaired participants is how a notable proportion of language scores fall below the region of reliable test standardisation or even below the range of reliable raw-score evaluation. When such participants are routinely assigned a minimum score (the test floor) this is commonly a substantial over-estimate of actual performance. To account for this we estimated group means and partial associations with predictors using the intreg Stata command that properly considers such scores as implying a true score equal or less than this test-floor value on the assumption
that, conditional upon the predictor variables, the true scores are normally distributed in the population (e.g. Long & Freese, 2006).

**Results**

*Classification and Incidence of Language Loss*

In order to avoid possible confounding effects of epilepsy and to ensure greater comparability with the SLI sample, where epilepsy was an exclusion criterion, the 23 participants with definite previous or current epilepsy were excluded (data combined from the ADI-R, contemporaneous health records and hospital notes for the SNAP cohort; from the ADI-R only for the MLS cohort). In addition, only children who had both ADI-R and ADOS-G data were included yielding a final combined sample of 313 children.

We considered five classification rules for autism/ASD, though always hierarchically with an order of precedence of autism over ASD over SLI.

- **Rule (a):** (1) autism according to the ADI-R,
  (2) No autism on the ADI-R but above the ASD threshold on the ADOS-G
  (3) some other category.

- **Rule (b):** (1) autism according to both ADI-R and ADOS-G
  (2) ASD or autism on ADI-R and ADOS-G (but not autism on both) where ASD on the ADI-R was defined by criteria for autism on the social and one of the communication or repetitive domains
  (3) some other category.

- **Rule (c):** (1) ADI-R or ADOS-G autism
  (2) ADI-R or ADOS-G ASD
  (3) some other category.

- **Rule (d):** standard ADOS-G classification.

- **Rule (e):** available only for the SNAP sample: an overall consensus clinical diagnosis (Baird et al., 2006).
Both current and historic SLI (i.e. not current) classifications were considered.

[Table 1 about here]

Table 1 shows, for the 313 subjects with both ADI-R and ADOS-G data, the distribution of language loss, one row for each of the five autism spectrum classifications considered with those not classified as autism spectrum being reclassified as SLI or other in each case. Regardless of the way in which autism/ASD was defined, reports of language loss were very rare within current or historic SLI but make up a substantial minority within autism, with intermediate rates in ASD that varied with classification rule. This remained true even where autism/ASD was defined solely by ADOS-G criteria (24% in autism, 13% in ASD, 0% in current SLI, 3% in both historic SLI and other), and thus entirely independent of the language loss report typically made some 10 years later than the age at loss. Regardless of classification rule, the frequency of language loss in ASD was too low for useful separate analysis as to timing and outcome. Where loss was not reported, language and IQ outcomes were broadly similar for classifications (a), (c) and (e). For classifications (b) and (d), that required symptoms evident through current ADOS-G functioning, the autism group had lower language and IQ than the corresponding ASD group. There was little evidence of such a difference where loss had been reported. The current and historic-SLI groups had remarkably similar mean current language scores, the historic cases having lower IQ, a common reason for their failing the current-SLI criterion (Botting, 2005; Leonard, 2003).

The primary focus of this paper is on the children with reported language loss. These appear only exceptionally in either SLI group. Moreover, when a classification divided the participants with language loss between autism and ASD groupings, this division did not suggest any marked heterogeneity in language or IQ outcome. Thus, for the remainder of the paper we report primarily using the classification that yielded the largest and simplest groups, namely the autism/ASD classification Rule (a) (that gives
dominance to the ADI-R report). In the remainder of the results autism thus refers to ADI-R autism. Some findings are supported by alternative estimates from the ADOS-G only grouping (Rule d) that is independent of the language loss data. Since most historic-SLI cases still showed substantial language (and in many cases IQ) impairment the chosen SLI classification combined current and historical cases.

The rates of loss were very similar regardless of study. For example, for the SNAP and MLS studies respectively, rates of language loss were for Rule (a) autism 19% and 15%, Rule (a) ASD 0% and 0% and for Rule (b) autism 31% and 25% and Rule (b) ASD 15% and 11%. Dividing the Rule (a) autism group by the median performance IQ gave very similar rates of language loss (18.6% in low (<80), 16.9% in high (≥80)).

**Language loss, diagnostic group and language acquisition milestones**

Of the 28 participants with reported language loss, 25 (89%) occurred to participants with autism according to the ADI-R. Of the three children with language loss but not autism one had suffered a stroke at age 2, one had Down syndrome and had developed acute leukaemia at 24 months requiring extended hospitalization, and the third had inconsistent reports of epilepsy and language loss that occurred during maternal hospitalization.

For the remaining analysis we examined the four groups (1) ADI-R autism and language loss (N=25), further divided into 2 subgroups depending on whether the language skills were lost before (N=18) or after (N=5) the phrased speech milestone (unavailable for 2 children from the MSL sample), (2) ADI-R autism but no language loss (N=109), (3) ADOS-G ASD but not ADI-R autism (N=30, none of whom had language loss) and (4) Current or history of SLI/language disorders without language loss (N=69).

Loss of language was reported between the 12\textsuperscript{th} and 33\textsuperscript{rd} month of age in 22 of these 23 cases, the exception being reported as occurring at age 69 months (but see discussion). Table 2 shows the median ages of acquisition of language milestones. It is
striking that the (combined) group of children with subsequent language loss showed a median age of first words acquisition markedly younger than all the groups without loss. These differences remained significant within a Cox analysis after controlling for sex (p<0.001 versus SLI; p<0.001 versus ASD; p<0.001 versus autism with no language loss).

The Kaplan-Meier estimator of Figure 1 shows how the proportion of children achieving the first words milestone increases with age. Using the 24 month criterion 64% of SLI, 62% of ASD and 53% of children with autism without language loss were late in developing single word speech, but this was the case for only 12% of children with autism who experienced loss. This picture was similar using the other autism/ASD classifications of Table 1. For example, using the ADOS-G only autism/ASD classification (Rule d of Table 1) gave medians for age at first-words of 16 and 11 months for the autism and ASD loss groups, but 24 and 29 months for the autism and ASD no-loss groups.

[Table 2 about here]

[Figure 1 about here]

For phrased speech, Table 2 and Figure 2 show the median age of acquisition and the proportion achieving the milestone for the three no-loss groups and the language-loss group divided according to whether the loss occurred before or after acquisition of phrases. Again, those reporting subsequent loss had shown the most rapid development, achieving the milestone much like typically developing children. Those who experienced loss between the word and phrase milestones showed clear delay in achieving the phrase milestone compared to other groups. This delay is still more evident in the time distributions for the progression from words to phrases in Table 2 and Figure 3 (Cox analysis: p=0.001 versus SLI; p<0.001 versus ASD; p=0.003 versus autism and no language loss; p<0.001 versus autism and language loss after first phrases, i.e. with future language loss). The Figure suggests a slightly more rapid post-words development for the ASD children compared to autism.
Further Cox model analyses showed that for the sample as a whole higher IQ measured in late childhood was strongly associated with both rapid achievement of first words ($p=0.01$) and progression to phrases ($p=0.001$). However, accounting for IQ produced little change in the relative rates of language development among the groups of children, except for the small group of five children with language loss following phrased speech, for whom mean IQ was low (see Table 2) leading to co-linearity between group and IQ.

*Language loss and language performance in late childhood.*

So how does language loss relate to eventual expressive and receptive language performance in late childhood (age 10-14 years)? Group means adjusted for the test floor are shown in Table 2. Due to the small size of the loss-after-first-phrases group, a common variance was assumed for the two language loss groups. After controlling for gender, the results showed that compared to children with autism who lost language before first phrases, children with autism or ASD without loss do not have significantly better expressive language (autism difference=10.4, CI -5.9,26.7; ASD difference=5.8, CI -11.8,23.3) or receptive language (autism difference=7.0, CI -8.0,22.0; ASD difference=5.6, CI -12.6,23.8). However, while the expressive language of the SLI group was also not significantly better (difference 5.6, CI -10.3, 21.6), receptive language performance was relatively preserved (difference 16.4, CI 1.7,31.1). Both the language and IQ outcomes for the small group of children who lost language after gaining phrased speech were poor, but due to its small size not significantly worse than the outcomes for the lost-before-first-phrases group.

*Language Loss: Would this be a common feature of autism if language was not so often delayed and could delay in language explain the absence of reports of loss in SLI?*
Given the specificity of language loss for autism, the question arises as to whether language loss marks a distinctive neuro-developmental anomaly that is specific to a minority of children with autism or is loss a fallable marker of an anomaly possibly more widespread in autism, but only evident in those children whose speech begins early enough for loss to be observable. Figure 4 shows the relative frequencies of children with language loss by age of attaining first words for the autism and SLI groups. In the autism group the estimated proportion declines steeply from 46% among the early speakers to zero among those most delayed. We applied the age-specific loss-of-language proportions of the autism group to the delayed age-distribution of the SLI sample. This suggested that, in spite of their delayed speech acquisition we would still have expected about 9 cases of loss in the SLI group compared to the single report of Table 1.

[Figure 4 about here]

A group difference was significant within a logistic regression controlling for age-at-first-word strata (OR=0.08, p=0.02). Thus the absence of language loss in SLI compared to autism is not due to differential delay in speech.

While loss of social engagement and reciprocity was reported for seven of the 23 language-loss participants with known age at loss, in only one case was the loss reported as preceding the language loss. There was a further participant from the SNAP sample who reported social loss without language loss. This was reported as occurring at 21 months of age.

Discussion

Although the samples differ, one epidemiological of special needs children and the other recruited from school units for children with clinical diagnoses of SLI, both were well characterized and assessed by research psychologists using standardized instruments. While sample ascertainment biases are possible, selection against children with language loss in the SLI sample would seem unlikely and rates of reported loss in those with ASD
were very similar across samples. A significant limitation is our reliance on retrospective report, for which errors in both the occurrence and dating of milestones can be problematic (Pickles et al., 1996). But since both samples were assessed roughly ten years from the target loss events the extent of bias is likely to be similar. For the SNAP sample contemporaneous casenote information was available for 16 of the 28 cases with language loss. Loss of skills or stasis/plateau was documented by paediatricians in 11/16 cases (69%). For these 11 cases the age of loss recorded in casenotes was 25.1 (SE=1.9) months compared to 28.4 (4.7) reported by parents in the ADI-R, a difference that was not significant (paired t-test; t=0.65, p>.10). The most discrepant was the case with ADI-R reported onset at 69 months where more contemporaneous casenotes reported loss from more than 20 words at age 24 months.

Our findings show that language loss is very strongly and specifically associated with the autism spectrum, and concentrated among those with definite autism. This confirms previous findings for autism and extends them to clarify that language loss is not a feature of other developmental disorders such as SLI. In addition, as noted by Lord et al. (2004), the group for whom loss is reported were predominantly those who had progressed comparatively rapidly, close to typical development, prior to disruption. For many of these children language loss is associated with switching from having the most advanced early language of children with autism/ASD/SLI to being among the slower, such that, again like Lord et al., the proportions achieving phrased speech by age 5 are similar. It may be that for the children who lose their language skills before their first phrases, the phrased-speech milestone is postponed while lost skills are re-learnt and the average long-term expressive and receptive outcome is at least as poor as the children without loss. By contrast, for the smaller number whose language loss is experienced after acquiring phrased speech the disruption may be greater with broader negative repercussions on subsequent development. This picture is heavily influenced by taking
proper account of the language-test floor since important differences in language outcomes can be masked if children with a range of low and very low scores are all assigned the same lowest-available standard score.

We make no claim that rates of language loss *per se* are under-reported. This may be the case but we present no evidence for it. However, our results suggest there is a need to question the assumption that the neuro-developmental anomaly that is indexed by language loss is a feature of a minority of children with autism. We want to argue that if loss of language is the most salient marker with the effect that delayed language may hide the presence or occurrence of the anomaly, then our current estimates must be considered minima (Lord et al., 2004; Ozonoff et al., 2005). We have shown, however, that delay does not explain the relative absence of language loss within SLI. This suggests that while language impairments associated with autism and SLI may have much in common some distinctive elements of aetiology may exist.

Lord et al. (2004) using more proximal retrospective report noted additional children for whom loss was reported in pre-linguistic social-communication behaviours, but suggested that these were less reliably reported and less salient to parents. Our own data on such non-linguistic losses, obtained after a much longer period of recall, identified very few additional cases of regression (Baird et al., in press). As with language loss, the absence of reported loss of social skills may be a poor indicator of normal neuronal development when social development is delayed. Also, being arguably more difficult to detect, loss of social skills and language may co-occur more often than reported, which would point to a more general disruption of development of communication rather than language *per se*. Lord et al. also argue that, even among those with loss of language, development prior to loss was rarely reported as entirely normal. Thus the neuro-developmental phenomenon underlying loss is most likely a feature of brain development in autism rather than arising from any independent environmental insult. That a failure in
social development should impact on linguistic cognitive development would not be surprising and is consistent with early findings from prospective studies of younger siblings of children with autism that show a slowing in development between the first and second birthdays for those children who later received an ASD diagnosis (Landa & Garrett-Mayer, 2006; Landa et al., 2007), a disturbed developmental trajectory also noted in the SNAP sample (Baird et al., in press). Though loss of skills may mark a genetically based subtype within autism, such a view has not been supported by family studies (Parr et al., 2006).

The ADI-R provided a standardized recording of both symptoms of autism and features of language development. However reliance upon this single retrospective report from late childhood is a limitation of this study. Two quite different improvements in design are called for. Firstly, a younger sample using standardized retrospective reporting but made closer in time to the relevant events and symptoms, able to record in greater detail the pattern of loss and re-acquisition of skills. Secondly, the addition of imaging and neurocognitive measures could help identify the nature of the neurodevelopmental anomaly that we have inferred as underlying the loss of skills and might help provide evidence of anomalous development among children with autism and delayed language.

Clinical Implications

The differential diagnosis between autism and SLI is a key clinical concern. During the preschool period, young children with poor language are not always easily diagnosed as having a primary language difficulty or a broader developmental disorder that includes the presence of impaired language skills. Within this context, our findings confirm that clinicians should enquire about language loss as part of the assessment of any child presenting with language difficulties, and re-iterate the importance of loss of language, as a ‘red flag’ for a possible autism diagnosis (Filipek et al., 2000).
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Table 1 Frequency of language loss by Autism Spectrum and SLI classifications with mean CELF total language score (TLS) and mean full IQ scores for 313 children with both ADI-R and ADOS-G.

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<td>18</td>
<td>24%</td>
<td>39</td>
</tr>
<tr>
<td>TLS</td>
<td>67.9</td>
<td>75.9</td>
<td></td>
<td>76.1</td>
</tr>
<tr>
<td>IQ</td>
<td>66.1</td>
<td>66.9</td>
<td></td>
<td>77.6</td>
</tr>
<tr>
<td><strong>Consensus</strong> (only SNAP sample)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>50</td>
<td>19</td>
<td>28%</td>
<td>59</td>
</tr>
<tr>
<td>TLS</td>
<td>73.4</td>
<td>72.8</td>
<td></td>
<td>76.5</td>
</tr>
<tr>
<td>IQ</td>
<td>74.6</td>
<td>63.1</td>
<td></td>
<td>80.1</td>
</tr>
</tbody>
</table>

a Autism=ADI-R autism. ASD=Not ADI-R autism but above ADOS-G ASD cut-off
b Autism=ADI-R and ADOS-G autism, ASD=above ASD cut-off for both ADOS-G and ADI-R (i.e. above autism cutoff for social and either communication or restricted and repetitive behaviours domains)
c Autism=ADI-R or ADOS-G autism, ASD=above ASD cut-off for either ADOS-G or ADI-R (i.e. above autism cutoff for social and either communication or restricted and repetitive behaviours domains)
d Autism=ADOS-G autism, ASD=ADOS-G ASD
e Clinical diagnosis reviewing all assessments and notes.
f CELF expressive, receptive or total standardised language scores < 77.5 and performance IQ of 80 or above.
g Previous diagnosis but not meeting criteria for current diagnosis f.
h Not meeting criteria for Autism, ASD or SLI and including subjects with learning problems, hearing impairment, hyperkinetic and conduct problems, genetic and chromosomal disorders and medical conditions.
Table 2: Late childhood language scores and language development by disorder category and language loss.

<table>
<thead>
<tr>
<th>Disorder Category</th>
<th>N</th>
<th>Median of age of 1&lt;sup&gt;st&lt;/sup&gt; words*</th>
<th>Median of age of 1&lt;sup&gt;st&lt;/sup&gt; phrases*</th>
<th>Median of gap to 1&lt;sup&gt;st&lt;/sup&gt; phrases*</th>
<th>CELF ELS**</th>
<th>CELF RLS**</th>
<th>IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADI-R autism and language loss</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>loss before 1&lt;sup&gt;st&lt;/sup&gt; phrases</td>
<td>18</td>
<td>13 [12,18]</td>
<td>59 [48,60]</td>
<td>42 [30,49]</td>
<td>61.2 (24.7)</td>
<td>62.6 (23.2)</td>
<td>69.2 (19.8)</td>
</tr>
<tr>
<td>loss after 1&lt;sup&gt;st&lt;/sup&gt; phrases</td>
<td>5</td>
<td>12 [12,16]</td>
<td>23 [19,24]</td>
<td>7 [6,12]</td>
<td>53.9 (24.7)</td>
<td>47.0 (23.2)</td>
<td>50.0 (23.9)</td>
</tr>
<tr>
<td>No loss of language</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLI/Language disorders</td>
<td>69</td>
<td>24 [18,42]</td>
<td>48 [36,66]</td>
<td>12 [6,24]</td>
<td>66.9 (11.6)</td>
<td>78.3 (16.9)</td>
<td>81.0 (16.9)</td>
</tr>
<tr>
<td>ADOS-G ASD but not ADI-R autism</td>
<td>30</td>
<td>33 [18,45]</td>
<td>48 [26,57]</td>
<td>10 [6,15]</td>
<td>67.0 (19.5)</td>
<td>67.8 (28.0)</td>
<td>72.9 (20.3)</td>
</tr>
<tr>
<td>ADI-R autism</td>
<td>109</td>
<td>24 [18,36]</td>
<td>42 [30,60]</td>
<td>14 [9,24]</td>
<td>71.6 (21.4)</td>
<td>69.4 (24.9)</td>
<td>76.6 (23.0)</td>
</tr>
</tbody>
</table>

* The median was computed after imputing the unknown but normal or delayed onsets with the hotdeck procedure (25 imputations).
** Mean scores and standard deviations for ELS (expressive language score) and RLS (receptive language score) were estimated via interval regression to account for the censoring due to the floor of the test with common variance assumed for the two language loss groups due to the small number losing language after 1<sup>st</sup> phrases.
[] = Interquartile range
( )=Standard Deviation
Figure 1: Proportion achieving first words by age (Kaplan-Meier function) by group.
Figure 2: Proportion achieving phrased speech by age (Kaplan-Meier function) by group.
Figure 3: Proportion achieving phrased speech by time since achieving first words (Kaplan-Meier function) by group.
Figure 4: Rate of language loss by age of speech acquisition and group (as Table 2 Rule a: Autism N=134 except for 2 with missing age at first words, SLI N=70).