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ORIGINAL PAPER

Patterns of Reading Ability in Children with Autism Spectrum Disorder

Kate Nation · Paula Clarke · Barry Wright · Christine Williams

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Abstract This study investigated reading skills in 41 children with autism spectrum disorder. Four components of reading skill were assessed: word recognition, nonword decoding, text reading accuracy and text comprehension. Overall, levels of word and nonword reading and text reading accuracy fell within average range although reading comprehension was impaired. However, there was considerable variability across the sample with performance on most tests ranging from floor to ceiling levels. Some children read accurately but showed very poor comprehension, consistent with a hyperlexia reading profile; some children were poor at reading words and nonwords whereas others were unable to decode nonwords, despite a reasonable level of word reading skill. These findings demonstrate the heterogeneous nature of reading skills in children with ASD.

Keywords Reading · Language · Comprehension · Autism · Hyperlexia

Introduction

Although there is a general assumption that reading is a relative strength for children with autism spectrum disorders (ASD), systematic data concerning levels of reading ability in this population are lacking. Two rather different perspectives can be drawn from the existing literature. First, it is well accepted that poor oral language skills place children at high risk for literacy failure (e.g., Bishop & Snowling, 2004; Catts & Kamhi, 2005), and since many children with autism have language impairments (e.g., Tager-Flusberg & Joseph, 2003), difficulty with learning to read is to be expected. In contrast to this expectation, numerous case studies describe exceptional levels of reading skill in some children with autism (e.g., Turkeltaub et al., 2004). Clearly however, one needs to be cautious when generalising from single case studies, especially given the wide variation in cognitive and linguistic skills seen in individuals with an ASD.

Reading is a complex skill and to read even a simple sentence demands a number of skills ranging from recognising each individual word through to understanding the intended meaning of a text. Broadly, Perfetti, Landi, and Oakhill (2005) describe two major classes of processing events that are necessary for successful reading comprehension: (1) the identification of words and (2) the engagement of language processing mechanisms that assemble words into messages. Together, ''these processes provide contextually appropriate word meanings, parse word strings into constituents, and provide inferential integration of sentence information into more complete representations of extended text.'' (Perfetti et al., 2005, p. 229). It is clear that successful reading comprehension demands that both sets of processes operate adequately: without adequate reading accuracy, reading comprehension will fail, and being able to read words accurately is no guarantee that successful comprehension will follow. As these two sets of processes can develop out-of-step (Hoover & Gough, 1990; Nation, 2005; Perfetti et al.,

K. Nation (✉)
Department of Experimental Psychology, University of Oxford, South Parks Road, Oxford OX1 3 UD, UK
e-mail: kate.nation@psy.ox.ac.uk

P. Clarke
Department of Psychology, University of York, York, UK

B. Wright · C. Williams
Child and Adolescent Mental Health, Selby and York Primary Care Trust, York, UK

2005), it is important to consider them separately when assessing how well children with autism read.

Reading Accuracy and Autism

A number of studies highlight good reading accuracy skills in both adults (Rumsey & Hamburger, 1990) and children (Minshew, Goldstein, Taylor, & Siegel, 1994; O'Connor & Hermelin, 1994; O'Connor & Klein, 2004) with autism, and in some samples, reading accuracy is in excess of IQ-expected levels (Mayes & Calhoun, 2003; Szatmari, Tuff, Finlayson, & Bartolucci, 1990).

Frith and Snowling (1983) investigated aspects of reading accuracy in a group of nine children with autism, relative to a group of normally-developing children matched for reading level. One question they addressed concerned the strategies children with autism used to read words. They reasoned that rather than decoding or deciphering words using a phonological 'sounding-out' strategy, children with autism may capitalise on rote memorisation and recognise words on the basis of shape or pattern recognition. To test this idea, Frith and Snowling asked children to read aloud nonwords. As nonwords need to be decoded on the basis of letter-sound associations, if children with autism read by relying heavily on visual strategies, nonword reading should be compromised. However, children with autism were indistinguishable from control children in terms of nonword reading. This suggests that they were as skilled as normally-developing children of equivalent reading level at using phonological-based reading strategies.

A limitation of these studies is that they only included children who were reading at a reasonably advanced level. For example, Minshew et al. (1994) recruited high-functioning children, and the mean verbal IQ of their sample was 97. Frith and Snowling's study selection criteria demanded that all participants had essentially age-appropriate reading skills, according to a standardised test. Thus, these studies permit few conclusions to be made concerning levels of reading accuracy competence across a population of children with an ASD. In line with this caution, descriptions of individuals with ASD point to considerable variability in levels of word and nonword reading accuracy (for review see Nation, 1999). As noted above, it is difficult to generalise from single case data and as different researchers measure reading ability in different ways, comparison across studies is also difficult. Nevertheless, a number of case descriptions indicate that some children with ASD are very poor at reading nonwords, despite the fact that they are relatively skilled at reading words (Aaron, Fantz, & Manges, 1990; Goldberg & Rothermel, 1984). This suggests that for some autistic children at least, reading accuracy may not be underpinned by adequate phonological decoding skills, as is the case in normal reading development (e.g., Goswami & Bryant, 1990).

Reading Comprehension and Autism

Turning to the other component of reading ability, there is broad agreement that children with autism have impaired reading comprehension, an observation first made by Kanner (1943, reprinted in Kanner, 1973, p. 42) in his original description of autism: ''the children read monotonously, and a story ... is experienced in unrelated portions rather than its coherent totality''. Despite the high-functioning nature of the sample recruited by Minshew et al. (1994), levels of reading comprehension were significantly lower in the children with autism relative to IQ-matched controls. Consistent with this, the children in Frith and Snowling's study performed less well than controls on a test of reading comprehension, despite the fact that the two groups of children were well-matched in terms of reading accuracy.

This profile of impaired reading comprehension but well-developed word recognition skills is consistent with the pattern of reading behaviour seen in hyperlexia, the term given to children who, despite pronounced cognitive and linguistic deficits, show remarkably advanced word recognition skills (Grigorenko, Klin, & Volkmar, 2003; Nation, 1999). Such apparently well-developed reading skills are usually only superficial. Reading accuracy is well-developed and precocious but reading comprehension is severely impaired. Although it is clear that a hyperlexic-like reading pattern may occur in non-autistic children (Nation, Clarke, & Snowling, 2002; Snowling & Frith, 1986), there is a strong association between autism and hyperlexia. Many children who have a hyperlexic reading profile are autistic, or show features of autism (e.g., Grigorenko et al., 2002). It is not clear why this is the case but Nation (1999) speculated that a number of factors may be important: a particular pattern of cognitive and linguistic strengths and weaknesses, a tendency to be interested in local features rather than global coherence, and a preoccupation with text and reading. As these features tend to cluster together in people with autism, patterns of hyperlexic reading are therefore more common in this group.

In summary, there is evidence that some children with autism can read accurately, but even amongst these children, levels of reading comprehension are poor (Frith & Snowling, 1983; Minshew et al., 1994; O'Connor & Klein, 2004; Snowling & Frith, 1986). Thus, it is tempting to conclude that many children with autism are hyperlexic, especially given the observation that many children with hyperlexia are autistic, or show features of autism (Grigorenko et al., 2002; Nation, 1999). However, it is

difficult to generalise studies reporting good levels of reading accuracy in children with autism as samples were selected on the basis of cognitive ability or reading ability. Excluding children with poor language and literacy may result in an overestimation of levels of reading accuracy in children with autism. Given the severe oral language impairments that characterise many children with autism (Kjelgaard & Tager-Flusberg, 2001; Lord & Paul, 1997; Tager-Flusberg & Joseph, 2003), and the close relationship between oral language impairment and difficulties with learning to read (Bishop & Snowling, 2004; Catts & Kamhi, 2005; Nation, Clarke, Marshall, & Durand, 2004), poor reading in at least some children with an ASD is to be expected. By using standardised tests that assess different aspects of reading, the present study investigated a range of reading skills in a population of children with ASD. The following questions and predictions were explored:

1. What is the level of reading ability in a relatively large and relatively broad population of children with ASD? Based on the literature reviewed above, and given the heterogeneous nature of ASD, we anticipated considerable variation in levels of reading ability in our sample.
2. What are the levels of component reading skill (accuracy and comprehension)? There is clear evidence that reading comprehension is often impaired in children with ASD and therefore we anticipated depressed levels of reading comprehension in our sample. Given the association between poor reading comprehension and oral language comprehension (e.g., Nation et al., 2004), we predicted that children with poor reading comprehension would show concomitant weaknesses in aspects of oral language.
3. Do discrepancies between (relatively strong) reading accuracy and (relatively weak) reading comprehension characterise the reading profile of children with ASD? Children described as hyperlexic are often autistic, or show autistic features (e.g., Grigorenko et al., 2002; Nation, 1999). By examining discrepancies between accuracy and comprehension in our sample, we aimed to explore the extent to which a 'hyerplexic' profile typifies patterns of reading behaviour in children with ASD.
4. Finally, we investigated levels of nonword reading in our sample. Some case reports suggest that some children with ASD show unexpected difficulties with decoding novel words (e.g., Aaron et al., 1990; Goldberg & Rothermel, 1984). We examined the extent to which nonword reading deficits characterise the pattern of reading skills seen in a relatively large population of children with ASD.

Method

Participants

Children were recruited from a Child and Adolescent Mental Health Clinic serving the City of York and surrounding areas. To explore patterns of reading in as general a sample as possible, we imposed only two selection criteria. Chronological age was the first criterion. In the UK, children begin formal literacy instruction before their 5th birthday, and by 6 years, reading skills are becoming reasonably well established in the normal population. We therefore recruited children from 6 years upwards. An upper limit of 15 years was chosen. Our second selection criterion was that language skills were sufficient enough to allow them to participate in our study. No formal criterion was employed. Instead, clinicians were asked to refer children they considered to have ''measurable language skills, however minimal''. On the basis of these criteria, 68 families of children with an autism spectrum disorder aged between 6 and 15 years of age were sent an information sheet about the study and invited to take part. Forty families agreed to take part; one family had two children with autism, making a total of 41 children (36 boys and 5 girls). The mean age of the sample was 10.33 years.

The children varied as to their particular diagnosis on the autistic spectrum. Diagnoses had been made by experienced clinicians using research diagnostic criteria in a multidisciplinary diagnostic forum, according to ICD-10 (World Health Organization, 1993) criteria. Sixteen children fulfilled criteria for autism (including one child with Fragile-X syndrome), 13 for atypical autism and 12 for Asperger's syndrome. This relatively high proportion of children with Asperger's syndrome probably reflects our request that minimal language skills be in place.

Materials and Procedure

Children were tested in their homes or in a quiet room in their schools. The tests were presented in a single session lasting approximately 1.5 h. Rest periods were allowed as required.

We made four assessments of reading, three tapping aspects of reading accuracy and one tapping reading comprehension.

Reading Accuracy

The first measure of reading accuracy was decoding, measured by a nonword reading test, *The Graded Nonword Reading Test* (Snowling, Stothard, & McLean, 1996). This provides a relatively pure measure of decoding as children need to apply letter-sound rules in order to read aloud items

they have never seen before. The nonword reading test comprises 10 one-syllable and 10 two-syllable nonwords and is standardised on a UK sample.[1] Our second measure of reading accuracy tapped word recognition and was assessed using the reading subtest of the *British Ability Scales* (BAS-II; Elliot, Smith, & McCulloch, 1996), an untimed test in which children read aloud single words presented one-at-a-time out of context. Our third measure of reading accuracy assessed how well children read connected text. This was assessed using the *Neale Analysis of Reading Ability-II* (NARA-II; Neale, 1997). This test requires children to read aloud short passages of text. The number of errors they make is noted and used to form a reading accuracy score.

Reading Comprehension

The NARA-II also provided a measure of reading comprehension. After reading each passage, children were asked questions to assess their understanding of what they had read. Some of the questions tapped literal understanding of the passage, whereas others required an inference to be made.

Oral Language Skills

Two measures of oral language skill were made. Receptive vocabulary was assessed using the *British Picture Vocabulary Scale-II* (BPVS-II; Dunn, Dunn, Whetton, & Burley, 1997). Children are presented with four pictures and asked to point to the picture which represents a word spoken aloud by the tester. The comprehension subtest from the *Wechsler Intelligence Scale for Children* (WISC-III^{UK}; Wechsler, 1992) provided a measure of oral language comprehension. This test requires children to understand language in the absence of concrete or pictorial context; it also requires them to use world knowledge, an important requirement for establishing reference and understanding intended meaning (e.g., Milosky, 1990).

Nonverbal Ability

The *Block Design* subtest from the WISC-III^{UK} provided an estimate of nonverbal ability.

[1] *The Graded Nonword Reading Test* is standardised on a UK sample of 653 children aged between 5 and 11 years. The test manual reports age equivalents and centile scores, but not standard scores. Following the procedures of Briscoe, Bishop and Norbury (2001), data from the standardisation sample were transformed to form standard scores which were then used to quantify the performance of children in the present study. Standard scores for the older children in the present study (aged 14 and 15 years) were obtained from a group of 50 15-year old typically-developing adolescents reported by Snowling, Bishop, and Stothard (2000). Consistent with Snowling et al., the test was made more difficult for the older children by adding five nonwords (*strumbesh, delathode, tralishent, grikimest, pragendent*).

Results

Levels of Reading Skill

Nine children were completely unable to read. These were amongst the youngest in the sample (mean age 7.28 years; mean age for the remaining sample was 10.85 years) and included six children with autism (4 boys and 2 girls), and three with atypical autism (3 boys). These children were excluded from further analyses. Table 1 summarises the performance of the remaining 32 children on tests of reading, language and nonverbal ability. Note that some children performed below the floor of standard scores on some of the tests. To be conservative, a score one point below the standardisation floor was awarded (for example, the NARA-II standard score floor is 70; children failing to attain this level of performance were awarded a standard score of 69). Mean standard scores for the three measures of reading accuracy (word reading, text reading and nonword reading) were within normal range. In contrast, reading comprehension was, on average, about 1SD below population norms. However, it is important to note the extreme variability within the sample: as is clear from the range of scores shown in Table 1, performance on these measures of reading—and indeed most of the tests in the battery—varied from floor to ceiling levels (range information for each test is also provided in Table 1).

Component Reading Skills

To investigate patterns of reading performance in more detail, our next set of analyses examined four component reading skills, namely the ability to read aloud single words presented out of context, the ability to decode nonwords, the ability to read connected text accurately and the ability to comprehend text. Table 2 shows the correlation between these four components of reading skill. Although the tests inter-correlated at a statistically significant level, the correlations were fairly modest in size and were smaller than those observed in samples of typically-developing children. To illustrate, correlations taken from Nation and Snowling's (1997) study of 184 7–11 year old children are shown in parentheses in Table 2. Fisher exact tests were used to investigate whether the size of each correlation was significantly greater in the normative sample compared to the children with ASD. The correlations between word reading and text reading ($z = 2.37$), word reading and comprehension ($z = 2.84$), nonword reading and text reading ($z = 2.96$), nonword reading and comprehension ($z = 1.96$), and text reading and comprehension ($z = 3.11$) were all significantly larger in the normative sample than in the ASD group; the difference in magnitude of the correlation between word reading and nonword reading between

Table 1 Performance of children on measures of reading, language and nonverbal ability

	M	SD	Range	Test range
Age[1]	10.85	2.67	6.5–16.5	
Reading accuracy				
Word[2]	96.56	23.37	55–145	55–145
Text[2]	95.53	16.31	69–123	70–130
Nonword[2]	90.83	17.87	69–120	70–120
Reading comprehension[2]	82.34	14.82	69–121	70–130
Language skills				
Vocabulary[2]	89.97	23.69	39–137	40–160
Comprehension[3]	3.67	3.61	1–13	1–19
Nonverbal ability[3]	8.4	5.58	1–19	1–19

Note: [1] years; [2] standard scores ($M = 100$, $SD = 15$); [3] scaled score ($M = 10$, $SD = 3$)

the two groups did not reach statistical significance ($z = 1.44$). Taken together, these observations suggest that in children with ASD, component reading skills have a tendency to develop out of step with each other.

Deficits in Reading Comprehension

Sixty-five percent of our sample showed poor reading comprehension, as defined as standard scores at least 1SD below population norms, and 38% scored more than 2SDs below population norms (i.e., standard scores of 70 and below, the floor of the test). However, it would be wrong to consider all of these children as hyperlexic as many showed concomitant difficulties with reading accuracy. The relationship between word reading and reading comprehension is shown in Fig. 1. Cases below the line indicate children for whom reading comprehension was poor, relative to word reading ability. Particularly striking are those cases falling towards the bottom right quadrant of the scatterplot. Despite high levels of word reading ability, reading comprehension was very poor. Thus, these children showed poor reading comprehension despite achieving a satisfactory level of word reading.

Of the 32 children with measurable reading ability, 20 achieved word-reading levels in the normal range or above (i.e., a standard score above 85). Ten of these children also had reading comprehension within the normal range or above, whereas 10 showed impaired reading comprehension (i.e., below 85). Table 3 summarises the performance of these two subgroups of skilled and less-skilled comprehenders on the various measures of reading and language. The two groups were similar in age and nonverbal ability, and not surprisingly, the two groups did not differ on any of the measures of reading accuracy. Interestingly however, the less-skilled comprehenders showed impairments in vocabulary, and in oral language comprehension, relative to the skilled comprehenders. Thus, impairments in reading comprehension are accompanied by weakness in oral language skills in this group of children. Consistent with this group comparison, across the entire sample there was a strong correlation between reading comprehension and vocabulary ($r = 0.72$, $P < .01$) and oral language comprehension ($r = 0.67$, $P < .01$).

Table 2 Correlation coefficients for word reading, nonword reading and reading comprehension [coefficients in parentheses taken from Nation & Snowling's (1997) normative sample]

	Word	Nonword	Text reading	Comprehension
Word reading	–	.69** (.83**)	.69** (.92**)	.475** (.75**)
Nonword reading		–	.502* (.79**)	.410* (.60**)
Text reading			–	.568** (.87**)
Comprehension				–

* $P < .05$; ** $P < .01$.

Discrepancies between Reading Accuracy and Reading Comprehension

The NARA-II provides a useful tool for assessing the extent to which children with ASD show deficits in reading comprehension, relative to the level expected on the basis of text reading accuracy. As illustrated in Table 2, the

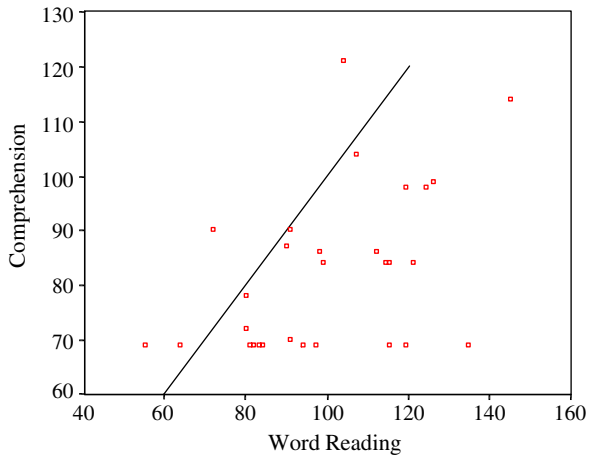

Fig. 1 Scatterplot showing the relationship between single-word reading and reading comprehension ($N = 32$). Reference line indicates parity between two measures

Table 3 Comparison of performance on measures of reading, language and nonverbal ability for children with skilled vs. less-skilled reading comprehension

	Less-skilled comprehenders (N = 10)			*Skilled comprehenders (N = 10)*			
	M	*SD*	Range	*M*	*SD*	Range	*F*
Age[1]	10.06	2.87	7.11–15.04	10.5	2.47	6.06–14.20	< 1.0
Reading accuracy							
Word[2]	110	14.14	91–35	111.6	17.28	90–145	< 1.0
Text[2]	103.5	12.2	87–121	104.3	13.08	88–123	< 1.0
Nonword[2]	100.56	18.28	69–120	99.61	10.83	84–120	< 1.0
Reading comprehension[2]	75.1	7.66	69–84	98.3	12	86–121	26.57**
Language skills							
Vocabulary[2]	87.44	13.58	67–109	110.9	14.48	96–137	13.17**
Comprehension[3]	2.13	2.8	1–9	6.6	3.66	1–13	8.13**
Nonverbal ability[3]	7.67	6.62	1–18	11.89	5.06	4–19	1.9

Notes: [1] years; [2] standard scores ($M = 100$, $SD = 15$); [3] scaled score ($M = 10$, $SD = 3$)

** $P < .01$

correlation between accuracy and comprehension was significant ($r = 0.568$, $P < .05$) but substantially lower than the correlation seen in Nation and Snowling's (1997) normative study ($r = 0.87$, $P < .01$; Fisher's exact $z = 3.11$, $P < .01$). In addition, the majority of our group of children with ASD showed a discrepancy between reading comprehension and reading accuracy and for some children the gap between the two sets of skills was substantial. Of the 32 children with measurable reading skills, 10.3% achieved a comprehension score that was in excess of 2 SDs below their accuracy score (a gap greater than 30 standard score points; mean difference = 49.3 standard score points, range 46–52). A further 24.12% obtained a comprehension score 1–2 SDs below their level of reading accuracy (mean difference = 19.85 standard score points, range 16–26). Although the majority of the sample (65.5%) achieved comprehension and accuracy scores within 1SD of each other, it is worth noting that even for these children, comprehension scores were lower than accuracy scores (mean difference = 5.84 standard score points, range 0–14). Only one child showed the reverse pattern obtaining a comprehension score three points in excess of his reading accuracy score. Thus, these observations suggest that difficulties with reading comprehension are not uncommon in children with ASD and that for approximately 35% of the population of children who can read single words at a reasonable level, reading comprehension is at least 1SD below text reading accuracy levels.

Unfortunately, the NARA-II manual does not provide information concerning the frequency or magnitude of accuracy-comprehension discrepancies in the standardisation sample. However, we were able to address this issue using normative data from 562 normally-developing children aged between 7 and 12 years (Nation & Snowling, unpublished data). This representative sample achieved a mean accuracy standard score of 98.22 (*SD* 12.03), a mean comprehension score of 94.09 (*SD* 10.70), and the correlation between accuracy and comprehension was 0.718. Consistent with this high correlation, the majority of children in the sample (88.6%) achieved a comprehension score within 1SD of their accuracy score. A further 10.9% obtained a comprehension score 1–2 SDs lower than their accuracy score (compared to 24.12% in the ASD group); only 0.5% of the sample obtained a comprehension score more than 2SDs below their accuracy scores (compared to 10.3% in the ASD group). Finally, in sharp contrast to the sample with ASD where only one child showed the reverse pattern of accuracy scores in advance of comprehension, 36.8% of the normative sample showed this reading profile.

Deficits in Decoding

Although problems with reading comprehension characterised the majority of children in the group, it is worth noting that many of the children were poor at decoding nonwords. Of the sample of 32 children who were able to read words at all, 42% were at least 1SD below population norms for nonword reading and 22% of the sample scored at least 2SD below population norms. As noted above, in the normal population, the correlation between word and nonword reading is high (for example, Nation & Snowling (1997) reported a correlation of 0.83; Snowling et al. (1996) reported a correlation coefficient of 0.78 between nonword reading and word recognition; Torgesen, Wagner, & Rashotte (1999) reported correlation coefficients between 0.78 and 0.80 between these two variables). The correlation of .69 between word and nonword reading in our sample of children (shown in Fig. 2) suggests that word recognition (word reading) and phonological decoding (nonword reading) are not so tightly linked in this group. Perhaps most striking are those children who, despite adequate levels of word reading, were poor at decoding nonwords. While these children were low in number (to

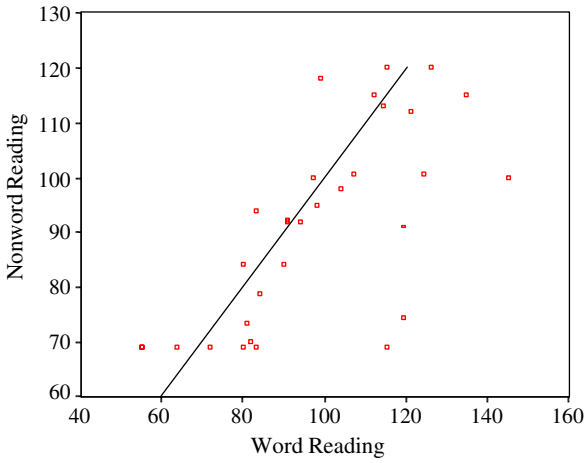

Fig. 2 Scatterplot showing the relationship between single word reading and nonword reading ($N = 32$). Reference line indicates parity between two measures

illustrate, 5 children (15.6%) were at floor on the nonword reading test despite achieving word reading standard scores in excess of 95), Fig. 2 highlights that low levels of nonword reading were not unusual in this population.

Discussion

This study permits a number of conclusions to be made concerning levels of reading ability in children with ASD. Of those families agreeing to take part in our study, 78% of children had measurable reading abilities in that they were able to read aloud single-words presented out of context. As a whole, the group showed normal-range levels of reading accuracy, but reading comprehension was lower. However, there was considerable variation within the group such that performance on all of the reading tests varied from near floor to near ceiling. Thus, group means are relatively uninformative when considering component reading skills in this group of children.

As anticipated, a large proportion of children showed impaired reading comprehension: 65% of the sample obtained reading comprehension at least 1SD below population norms, and about one-third of the sample showed very severe reading comprehension impairments. For some of these children, problems with reading comprehension may well have stemmed from inadequate reading accuracy: if children are unable to recognise or decode the words in a text, it is not surprising that they are unable to understand its meaning. However, of the 20 children who achieved normal range word reading skills, 10 showed poor reading comprehension. For these children, their poor comprehension could not be attributed to deficits in word- or text-level reading accuracy. Compared with children with normal-range reading comprehension skill, these children showed impairments in vocabulary and oral language comprehension, suggesting that impairments in reading comprehension accompany impairments in understanding language more generally (Bishop & Adams, 1990; Nation et al., 2004).

Given the high proportion of children with autism who experience difficulty with reading comprehension (despite possessing adequate levels of decoding ability), an important direction for future work is to pinpoint which aspects of the reading comprehension process are impaired. This is a vital first step if appropriate and well-targeted interventions are to be put in place. Comprehension is clearly a very complex process which may fail for a number of different reasons. O'Connor and Klein (2004) highlighted a number of aspects of the comprehension process that may be particularly problematic for people with autism: for example, a general difficulty with integrating information, difficulty understanding and resolving anaphoric reference, a difficulty with bringing prior knowledge to bear when reading text (see also Wahlberg & Magliano, 2004) and difficulties with comprehension monitoring. Encouragingly, O'Connor and Klein (2004) also reported data indicating that reading comprehension was facilitated in their sample of high-functioning students with ASDs when the experimenter focussed on an aspect of the comprehension process, for example, directing attention to the anaphoric link between a pronoun and its antecedent in a text. While it remains to be seen whether findings from such experimental manipulations can translate to a classroom situation when a child is working independently, O'Connor and Klein's study illustrates the importance of considering the underlying reasons why children with autism are poor at reading comprehension.

Although 32/41 of our sample had measurable word reading skills and as a group, the children showed average-for-age word reading ability, it is interesting to note that many children struggled to decipher nonwords. At first glance, this finding is surprising. Nonwords are meaningless strings of letters that need to be decoded using letter-sound correspondence rules; one might anticipate that this skill should be a relative strength for children with autism. Indeed, Minshew et al. (1994) found that nonword reading was relatively better than word reading in their sample of high-functioning children with autism. Generally, our data demonstrate rather low levels of nonword reading ability, and for some individuals, nonword reading skills were considerably below the level expected given their level of word reading ability. This may reflect the fact that our sample was not selected on the basis of either reading ability (cf. Frith & Snowling, 1983) or IQ (cf. Minshew et al., 1994). Our observations suggest one of two things. First, it could be that some

children with autism have difficulty applying phonological decoding strategies. Numerous findings point to a relationship between difficulties in the phonological domain and poor nonword reading (e.g., Bishop, Adams, & Norbury, 2004; Rack, Snowling, & Olson, 1992). Difficulties with oral language are not rare in populations of children with ASD and according to Tager-Flusberg and colleagues (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg & Joseph, 2003) approximately 50% of children with ASD show language deficits, including impairments in phonological processing (as indexed by poor nonword repetition for example). Potentially therefore, impairments in oral language may underlie the difficulties that some children in our sample had with poor nonword reading. Unfortunately however, we did not measure phonological processing but a reasonable prediction would be that those children with poorest phonological skills would show greatest difficulty with nonword reading. Alternatively (or additionally), the relative advantage of word reading over nonword reading observed in our study may be attributable to some children utilising rote memorisation or visual association strategies when reading. Clearly, such a strategy would assist word reading, but not nonword reading. Potentially, this pattern of reading may be encouraged or confounded by literacy instruction. Our anecdotal experience suggests that for some children with autism, reading instruction is more focussed on the on repetition of familiar materials rather than more phonic-based reading strategies.

The high levels of poor reading comprehension seen in this study are consistent with the view that hyperlexia is associated with autism (e.g., Grigorenko et al., 2002). Unfortunately however, the definition of hyperlexia remains unclear (Grigorenko et al., 2003; Nation, 1999). While the central feature of hyperlexia is word reading accuracy skills in advance of reading comprehension, several other features have been described including an unusual preoccupation with reading, very early (and sometimes spontaneous) onset of word recognition and a general mismatch between proficient reading accuracy on the one hand and the presence of cognitive and social deficits on the other. Grigorenko et al. (2003) recommended that the term hyperlexia be reserved for those individuals with pervasive developmental disorder who show all of these features of hyperlexia. They also recommended that the term ''reading comprehension disorder'' be adopted to describe those individuals (including non-autistic children) who show a discrepancy between reading accuracy and reading comprehension, but do not show the other features of hyperlexia. It is important for future work to establish the validity of this view by comparing children who show 'hyperlexic reading' but do or do not show additional features such as unusual preoccupation or early onset of reading ability. Only if there are significant differences between the two groups will it become important to make the distinction recommended by Grigorenko et al. (2003). Until this issue is resolved and the definition of hyperlexia clarified, it is premature to estimate the incidence of hyperlexia in our sample, especially as data concerning preoccupation with reading and onset of reading are limited. Nevertheless, it is clear that poor reading comprehension characterised the majority of children, and a sizeable proportion showed poor reading comprehension despite achieving adequate levels of reading accuracy.

Our data serve to highlight that reading is not a unitary construct and that component skills may dissociate in cases of developmental disorder. In our sample of children, we identified children with poor reading comprehension *and* children with poor nonword reading, relative to word reading ability. This observation offers a cautionary note for the assessment of reading in this population. Put simply, reliance on tests of word recognition is likely to overestimate children's reading competence in other areas, most notably reading comprehension skills, but for some children, decoding ability too. Very clearly, good or even precocious word reading ability does not guarantee adequate reading comprehension. While it is clear that aspects of reading may be a relative strength in some children with ASD, and may even serve as a tool for educational intervention (e.g., Williams, Wright, Callaghan, & Coughlan, 2002), it is important for both research and practice that the heterogeneous pattern of reading skills in children with autism is recognised.

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