

Ambiguous pronoun use in narratives of children with Autism Spectrum Disorders

Child Language Teaching and Therapy
2016, Vol. 32(2) 241–252

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DOI: 10.1177/0265659015602935

clt.sagepub.com



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Abstract

This study explored pronoun production and general syntactic abilities in story retelling and story generation among children with autism spectrum disorders (ASD). Twenty-four children diagnosed with ASD, ages 6;1–14;3 and 17 typically-developing (TD) children ages 5;11–14;4 participated in the study. The linguistic measures for general syntax were sentence complexity and morpho-syntactic errors. The pronoun production measure was referential use of third person subject, object and possessive pronouns. The results revealed no group differences in general syntactic measures in either task. The ambiguous third person pronoun measure showed different results between the two tasks. Although there was no difference between the groups in the retelling task, children with ASD produced more ambiguous pronouns in the story-generation task than did the TD children. Interestingly, this pattern was shown for different types of pronouns, suggesting a cognitive deficit in monitoring the listener's mental model.

Keywords

autism, narratives, pragmatics, pronouns, syntax

I Introduction

The ability to use pronouns appropriately is crucial for understanding conversation and narratives (Ariel, 2001; Berman, 1996; Hickmann et al., 1995). Several studies have found that children with autism spectrum disorders (ASD) have deficits in narrative abilities (Diehl et al., 2006; Norbury

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et al., 2013; Tager-Flusberg and Sullivan, 1995), but most have focused on narrative structure (e.g. formal opening, explicit mention of the theme, gist of the story, global structure, and formal ending). The current study adds a new viewpoint to the study of ASD, by comparing different features of pronoun use and more general syntactic abilities in two narrative tasks: reconstructing a story in a retelling task and generating a story without a model in a story-generation task.

1 Narrative analysis in ASD

Condouris et al. (2003) demonstrated that children with ASD performed worse on spontaneous speech measures compared to standardized measures. The authors suggested that the discrepancy was due to primary impairments in pragmatics and social reciprocity. Deficits in the social aspects of language might have prevented children with ASD from using their full range of vocabulary and grammatical constructs during spontaneous conversations. The definitions of pragmatic deficit depend on the perspective of the study. However, there is a consensus that children with ASD present a pragmatic deficit (see, Norbury et al., 2013, among others), and that different cognitive factors affect the pragmatic aspects of language comprehension and production. A number of theories have been proposed to explain these specific pragmatic deficits. One explanation can be impairment in Theory of Mind (ToM) (see, Happé, 1994, among others). ToM represents the knowledge of what the partner participating in the discourse knows; thus, deficits in ToM can affect linguistic performance related to this knowledge. Another explanation relates to perspective taking, which refers to the ability to know that people experience events differently (Hamilton et al., 2009). Weak central coherence, which means interpreting utterances in isolation rather than integrating information from many sources, is another factor that affects pragmatics in children with ASD (Norbury and Bishop, 2002). Loukusa and Moilanen (2009) reviewed 20 studies involving pragmatic language and inference abilities in individuals with Asperger syndrome and high-functioning autism. The authors suggested that the explanations for pragmatic deficits may vary between individuals with ASD and even within the same individual across different developmental stages. The current study does not aim to distinguish between the various explanations provided above, but rather to explore the specific characteristics of language that are affected by pragmatic deficits.

As narratives are more structured than discourse, but more natural than standardized assessments, a narrative-production task can be used as a midway test between formal testing and spontaneous speech (Botting, 2002). In addition, narrative construction requires the mastery of a range of linguistic skills such as lexical ability, syntax, and pragmatics. Narrative analysis has two main advantages: it samples children's language in a natural context and it allows comparison of different linguistic features within the same task. In the current study, story generation and story retelling by children with ASD were used to explore language features in the domains of general syntax and the interface between syntax and pragmatics.

2 Syntax of children with ASD

Studies that tested the syntactic abilities of children with ASD have shown mixed results. Some studies have shown syntactic impairment, while others presented intact ability. For example, studies that presented syntactic impairment found past tense omissions in elicited production (Roberts et al., 2004) and a tendency for syntactically less complex utterances in production (Capps et al., 2000; Eigsti et al., 2007). In contrast, other studies have shown intact syntax: complete production of complex sentences in an elicitation task (Friedmann and Novogrodsky, 2008), typical length of stories and syntactic complexity in a story-recall task (Diehl et al., 2006), and typical grammatical

capabilities based on structured measurements (Kelley et al., 2008; Terzi et al., 2014). These mixed results are potentially due to the heterogeneous nature of the ASD population.

3 *Pronoun production: An interface between syntax and pragmatics*

The use of third-person pronouns versus full noun phrases (NPs) reflects differentiation between new characters and those that have already been introduced (Ariel, 2001; Arnold et al., 2009). It requires taking perspective and pragmatic judgments about which expression is appropriate within the discourse context. When a referent enjoys a prominent discourse status, speakers tend to refer to it with underspecified expressions, such as pronouns (Arnold et al., 2009). To produce clear pronouns, the speaker must monitor the listener's mental model of the discourse: what is part of the interlocutors' common knowledge during the discourse versus what is new to them, namely the common knowledge that is created during the discourse (Ariel, 2001).

Young children often use pronouns in discourse without any clear antecedents (Hendriks et al., 2014; Matthews et al., 2006; Wigglesworth, 1997). They master the ability to produce pronouns with clear referents during elementary school (Hickmann et al., 1995; Wigglesworth, 1997). The production of ambiguous¹ pronouns may reflect an immature ToM in young children, in that they are unable to take the listener's perspective into account. This might reflect a link between linguistic ability and cognitive deficit among children with ASD (e.g. Baron-Cohen, 1988; Loukusa and Moilanen, 2009; Tager-Flusberg and Anderson, 1991).

The literature presents varying results regarding subject pronoun use in children with ASD. Differences between studies may reflect differences in participant symptom severity, along with differences in narrative stimuli. For example, Tager-Flusberg (1995) compared subject pronoun use of 10 children with ASD ages 10–12;1 to a group of typically-developing (TD) children matched on verbal mental age, based on a receptive vocabulary assessment (average chronological age 6;8). In elicited stories told by the children using a picture book, no significant group differences were found in their references to the main character. Developmentally, TD children up to 7 years of age may still use subject pronouns without clear antecedents (Wigglesworth, 1997). One explanation for the similar performance of the two groups in the Tager-Flusberg (1995) study could be that both groups of children had verbal mental ages below 7 years, an age when TD children still use ambiguous subject pronouns.

If ambiguous subject pronoun use is part of the global language delay of children with ASD in Tager-Flusberg's (1995) study, the prediction would be that older children with ASD without language delay would use subject pronouns unambiguously. Arnold and colleagues (2009) compared the performance of 23 children with ASD aged 11–15 years to a group of TD children matched on age and IQ. The results showed no differences between the groups in the use of third-person subject pronouns with a clear reference, but an overuse of explicit NPs in the group of children with ASD compared to the TD children. However, three other studies showed that children and adults with ASD produced significantly more ambiguous subject pronouns than did typically-developing controls (Collé et al., 2008; Norbury and Bishop, 2003; Novogrodsky, 2013). Norbury and Bishop (2003) found that 6- to 10-year-old children with ASD produced significantly more ambiguous subject pronouns for the two main protagonists (the boy and the dog in the 'Frog story') than did TD children. Collé et al. (2008) found that although adults with ASD were not different from controls in their use of ambiguous subject pronouns to refer to the main protagonist (the boy in the 'Frog story'), they produced more ambiguous subject pronouns when referring to the other characters. These results suggest that individuals with ASD have delays in their ability to use subject pronouns to refer to characters in a story, with impairments in references to protagonists in middle childhood, but improving by adulthood.

Studies that analysed narratives focused mostly on subject pronouns, possibly because these pronouns are the most frequent. However, other pronouns, such as object pronouns and possessive pronouns also appear frequently in narratives and can mirror the same difficulty as subject pronouns. If ambiguous subject pronouns are used by children with ASD due to a pragmatic deficit (linked to deficits in cognition such as in ToM, perspective taking or weak central coherence), we predicted that we would find similar patterns in other types of pronouns such as object pronouns, possessive pronouns and reflexives. To the best of our knowledge, object pronouns, reflexives, and possessive pronouns have not been explored in narratives of children with ASD.

4 Aims of the current study

The current study predicted that in general syntax, as measured by the complexity of sentences and morpho-syntactic errors children with high-functioning ASD would not show significant difference compared to TD children. In contrast, children with ASD were predicted to produce more ambiguous pronouns compared to the TD children in both tasks and for all types of pronouns.

II Method

1 Participants

Twenty-four children diagnosed with ASD, confirmed by the Autism Diagnostic Interview-Revised (ADI-R) (Lord et al., 1994) and by the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2000), and 17 TD children participated in the study.² Participants were recruited from the Boston area, USA. Groups were matched on age and verbal cognitive abilities based on their performance on the Woodcock–Johnson III (Woodcock et al., 2001) (Table 1). There were no significant differences between the two groups for age ($t(39) = 0.48, p = .39$) or cognitive scores ($t(35) = 1.29, p = .21$). By matching the groups on age, we controlled for the linguistic experience of the two groups (Jarrold and Brock, 2004), which is an important variable when testing a task that is influenced by experience, such as narrative production. The children were matched on verbal cognitive ability because narrative production is a complex linguistic task, which requires a certain level of cognitive ability and linguistic knowledge (Tager-Flusberg, 2004). The groups were matched for both mean and range of cognitive ability (Tager-Flusberg, 2004), with cognitive ability ranging from 79 to 120. This limited the results to a subgroup of children with ASD, with relatively high levels of cognitive ability. Cognitive ability scores were not available for five of the TD children, but their language scores, as measured by their performance in both story tasks based on Botting's (2002) normative scores, were within the normal range for their age.

Table 1. Groups matched on age and cognitive ability (SD).

Group	Number	CA-mean	CA-range	Verbal cognitive ability-mean
ASD	24	10	6;1–14;3	98 (11)
TD	17*	9;9	5;11–14;4	95 (9)

Note. * The cognitive ability (CA) scores refer to only 12 of the 17 typically-developing participants.

2 Materials

Each child participated in two tasks: story retelling (*The bus story* Renfrew, 1991) and story generation (*The frog story: 'Frog, where are you?'* by Mayer, 1969). For the 'Bus story' (Renfrew, 1991), while looking at a 12-picture story book, the child was told a story about a bus that escaped from its driver. The child was then asked to retell the story as closely to the original as possible while looking at the pictures. In the 'Frog story' (Mayer, 1969), the child was asked to look through a 24-picture story book and tell the story from the beginning, using the pictures as prompts. In this story, a boy and his dog search for a lost pet frog. These two tasks have been used widely in research on typical language development (e.g. Berman, 1996; Renfrew and Geary, 1973) and in studies of children with language deficits (e.g. Botting, 2002; Collé et al., 2008; Tager-Flusberg, 1995; Van der Lely, 1997). The two tasks were presented in counter-balanced order.

3 Analysis

Narratives were recorded and later transcribed using Software for the Analysis of Language Transcripts (SALT; J. F. Miller and A. Iglesias, 2008). The number of utterances and words were calculated by SALT. Four people took part in the transcript coding: one coder marked the different types of complex sentences, one coded syntactic errors, and the other two did the pronoun coding.

a Syntactic features. The first author coded the type of complex sentences in the story. These included coordination sentences ('he checked the hole and the gopher hit him'); subordinate sentences ('when the boy was asleep, the frog escaped'); verb complement sentences ('the boy didn't know it was a deer'); noun complements ('it might have been his fault that the frog was gone for any other reason'); and relative clauses ('once upon a time, there was a boy who had a frog and a doggie' and 'a male deer who chased the dog right into the water').

A second coder who was a native English speaker marked all of the morpho-syntactic errors in the narratives and, together with the first author, coded the type of errors: tense; missing argument; missing or incorrect preposition; missing or incorrect article; plural versus singular; and fragments.

b Pronoun production. Ambiguous third-person pronoun: A third coder who was blind to group status, coded all third-person pronouns for type of pronoun: singular or plural; subject, object, reflexive, or possessive; and judged whether they referred to a clear noun phrase or were ambiguous. Pronouns were coded as ambiguous if there was no antecedent prior to the pronoun (1), or if the pronoun referred to a different referent than that intended in the story (2) (Collé et al., 2008). The last category of ambiguity was coded if there was an agreement mismatch between two pronouns intended to refer to the same referent (3). Some special types of pronouns were counted separately, including expletive 'it' (4) and cataphora (5). Expletives were excluded from the analysis, and cataphoric pronouns were considered to be unambiguous. A fourth coder who was blind to group status coded half of the narratives for reliability. Agreement between coders exceeded 90%. Examples of coding:

1. No antecedent: 'Once upon a time there was a frog and he said frog where are you'; 'There lost his frog' (for both sentences, in the picture, the boy is looking for the frog).

'They climbed after him'; 'The doggie tried to push them under a honey tree' (in the picture the dog is pushing the beehive).

2. A different referent: 'The bees were chasing the dog. He had climbed up on rock and went into a tree.' In the story the boy climbed up the tree and not the dog.
3. Agreement mismatch: 'and they said mom, can I go outside to play.'
4. Expletive 'it': 'The mom says it is time for bed.'
5. Cataphora: 'When he saw that it is night outside, the frog escaped.'

III Results

I General syntactic measures

There was no significant difference in general syntactic measures between the groups in either task. However, children with ASD produced significantly more ambiguous pronouns than did the TD children in the story-generation task, but not in the story-retelling task.

In the story-retelling task, children with ASD produced marginally more utterances than did the children in the TD group ($t(39) = 1.82, p = .08$). However, there was no significant difference in the number of words between the two groups (Table 2). In the story-generation task, there was no significant difference in story length between groups, as measured by average number of utterances and words (Table 2).

As shown in Table 2, for both tasks, there were no differences between groups in the average number of complex sentences and morpho-syntactic errors in the two stories. Therefore, any difference in use of pronouns (shown in Table 3) could not be attributed to the length or complexity of the narrative.

2 Pronoun use

We predicted that children with ASD would produce more ambiguous pronouns than would the TD children. As shown in Table 3, there was no significant difference between the two groups in the average number of pronouns in the two stories, suggesting that children with ASD refer to characters in the story using pronouns, similarly to TD children, and that differences between the groups cannot be attributed simply to relative frequency of pronoun use. We further compared the clear and ambiguous pronouns in each story. As shown in Table 3, although the groups did not differ in ambiguous pronoun use in story retelling ('Bus story'), in the story generation ('Frog story') children with ASD produced significantly more ambiguous pronouns than did the TD children. The ASD group had significantly more agreement errors than the TD group in the story-generation task, but this type of error was infrequent in both groups (Table 3).

Previously published literature tested only subject pronouns. We expanded on this information by comparing the subject, object and possessive pronouns used by the two groups in the 'Frog story' (Figure 1). There were no instances of reflexive phrases in the current tasks. Similar to previous literature, both groups produced mostly subject pronouns: 71% in the ASD group and 65% in the TD group. All children in both groups produced subject pronouns. However, two children in each group did not produce object pronouns. In addition, two children with ASD and one TD child did not produce possessive pronouns. In order to include the children with missing data in the analysis, we used hierarchical logistic models with 'type of ambiguous pronouns' as the dependent variable. The results showed a marginal effect for group ($F(1, 69) = 2.86, p = .09$), a significant effect for type of sentence ($F(2, 69) = 8.29, p < .001$), and no effect for the interaction between group and type of sentence ($F(2, 69) = 1.89, p = .16$). Thus, a better model was only one with main

Table 2. Average number of utterances, words, complex sentences and morpho-syntactic errors in each story.

Type of sentence	Story retelling ('Bus story')			Story generation ('Frog story')		
	ASD	TD	t-test	ASD	TD	t-test
Number of utterances	14.7	12.5	$t(39) = 1.82, p = .08$	31.5	32.6	$t(38) = 0.33, p = .74$
Number of words	149.2	153.5	$t(39) = 0.1, p = .92$	287	330	$t(38) = 0.74, p = .46$
Complex sentences	8.8	10.9	$t(39) = 1.25, p = .21$	16.6	20	$t(38) = 0.78, p = .44$
Morpho-syntactic errors	1.16	0.76	$t(39) = 1.12, p = .26$	1.75	1	$t(38) = 1.35, p = .18$

Notes. ASD = autism spectrum disorders; TD = typically-developing.

Table 3. Average pronoun use in the stories.

Pronouns	Story retelling ('Bus story')			Story generation ('Frog story')		
	ASD	TD	t-test	ASD	TD	t-test
Number	12.3	12.7	$t(39) = 0.27, p = .79$	27.4	22.8	$t(38) = 1.07, p = .29$
Ambiguous	30%	20%	$t(39) = 1.13, p = .13$	50%	27%	$t(38) = 3.04, p < .01$
Agreement errors	2%	1%	$t(39) = 0.74, p = .23$	3%	0%	$t(38) = 2.23, p = .02$

Notes. ASD = autism spectrum disorders; TD = typically-developing.

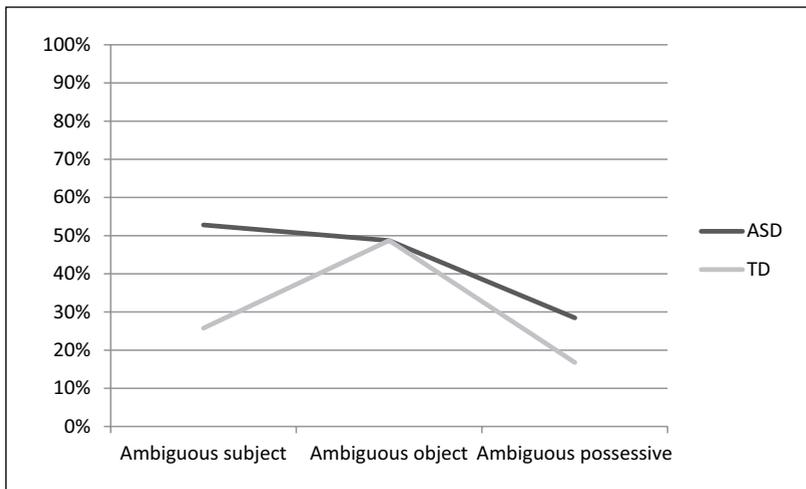


Figure 1. Average percentage of ambiguous pronouns for each pronoun type in the story generation task ('Frog story').

effects showing a marginal main effect for group ($F(1, 71) = 3.10, p = .08$) and a significant main effect for type of sentence ($F(2, 71) = 7.97, p < .001$). The main effect for group agrees with the results presented in Table 3, suggesting that children with ASD produce more ambiguous pronouns than did TD children. In addition, the model showed that there is a significant ratio difference of ambiguous pronouns between the three types of pronouns, as can be seen in Figure 1. In both groups, children produced more ambiguous subject pronouns than possessive pronouns

($t(71) = 2.16, p < .01$) and more ambiguous object pronouns than possessive pronouns ($t(71) = 3.89, p < .001$). No significant difference was found between subject and object pronouns ($t(71) = 0.07, p = .22$). Lastly, whereas children with ASD produced more ambiguous subject and possessive pronouns than TD children did, there was no significant difference in the production of object pronouns between the groups (Figure 1).

To summarize, the results showed no differences between children with ASD and TD children in two measurements that represent general syntactic features of narratives: complex sentences and morpho-syntactic errors. This result was consistent across the two tasks. In the reconstructing-a-story task ('Bus story'), there was no difference between groups in pronoun use. However, in the story-generation task ('Frog story'), the ASD group produced significantly more ambiguous pronouns.

IV Discussion

The syntactic analyses showed no differences between children with ASD and TD children. This result agrees with previous studies that showed that children with ASD performed as well on morpho-syntactic measures as did IQ-matched controls (Diehl et al., 2006; Friedmann and Novogrodsky, 2008; Kelley et al., 2008; Tager-Flusberg, 2004; Terzi et al., 2014). The current results support the idea of preserved syntax in high-functioning children with ASD, showing the same pattern in two different tasks: reconstructing a story based on a model given by the examiner and generating a story based on the individual's language production abilities and narrative experience. The current results also expanded the findings of preserved syntax in narratives found in children with ASD matched for linguistic age (Tager-Flusberg and Sullivan, 1995) to groups matched on both chronological and language age. Although it may seem that the current results differ from those found by Norbury and Bishop (2003), when comparing the data from the two studies more closely, the conclusions are similar. In the current study, there were no differences between the groups on measures of sentence complexity and morpho-syntactic errors, whereas Norbury and Bishop (2003) showed that children with ASD produced fewer complex sentences and more syntactic errors compared to TD children. In both studies, the participants were children with high-functioning ASD, and the ages ranges were the same. However, in a description of the language profile of the participants, Norbury and Bishop (2003) mentioned that: 'Seven of the 12 children with high-functioning ASD had scores on both receptive and expressive language measures of more than $-1SD$ below the normative mean' (p. 299), suggesting language impairment in addition to ASD. In the current study, the children with ASD had normal verbal proficiency scores. It is assumed that the 7/12 ASD children with low language scores in the Norbury and Bishop (2003) study produced fewer complex sentences and more syntactic errors. The comparison of the current results with those of Norbury and Bishop (2003) reminds us that the language abilities of children with autism varies, and future studies that explore language in this population should consider the linguistic profiles of the participants.

Another important result is that both groups used a similar average number of pronouns in their narratives. This result emphasizes that differences in language use between children with ASD and TD children is not based on a quantitative measure of pronoun use, but rather on a qualitative measure of their clarity.

In contrast to the similarity between children with ASD and TD children in general syntax use and number of pronouns, the results showed different patterns across the two groups in pronoun usage. When retelling a story, children with ASD produced clear pronouns at a similar rate to the TD children, but in a story-generation task they produced a greater number of ambiguous pronouns. Whereas retelling a story requires repetition ability and has fewer linguistic demands,

generating a new story requires more narrative planning. When a model of the story was provided, children with ASD performed well due to their good repetition abilities (Diehl et al., 2006). In contrast, in the story-generation task, the children with ASD produced more ambiguous pronouns than did the TD children. These results agree with previous studies that showed higher rates of ambiguous pronouns in a story-generation task (Collé et al., 2008; Marinis et al., 2013; Norbury and Bishop, 2003; Norbury et al., 2013).

The pattern shown by the ASD group is similar to that of younger children when using pronouns with no clear antecedents (Wigglesworth, 1997). In both cases, this indicates that the child does not take into account the listener's needs: in young children, as part of developing ToM, and in children with ASD, as part of their ToM deficit. Moreover, when comparing the current results and those of Norbury and Bishop (2003) with van der Lely's (1997) findings, a dissociation between children with Specific Language Impairment (SLI) and ASD is shown: while children with SLI did not demonstrate impaired use of pronouns (van der Lely, 1997), children with ASD in the current study and in that of Norbury and Bishop (2003) did.

The poor performance of the ASD group across two types of pronouns supports the link between language deficit and cognitive impairment in these children (Happé, 1994; Hamilton et al., 2009; Loukusa and Moilanen, 2009; Marinis et al., 2013; Norbury et al., 2013; Norbury and Bishop, 2002). It is suggested that children with ASD err in pronoun use due to general deficits in referential facility and not due to syntactic constraints. The children with ASD produced more tokens of ambiguous subject and possessive pronouns compared with the TD group.

Both the TD and the ASD group performed poorly in their use of object pronouns. One explanation for this result is that few object pronouns were produced by the two groups (80 in the ASD group and 48 in the TD group, compared with 453 and 251 subject pronouns; and 95 and 88 possessive pronouns, respectively). In addition, 11 of 17 TD children were younger than 11 years of age. Recent studies showed that young TD children (preschool and elementary school age) tended to produce ambiguous pronouns (Hendriks et al., 2014; Novogrodsky, 2013), supporting the potential contribution of the younger TD children to the low performance at the group level. Thus, it is possible that the small number of object pronouns combined with 65% young participants in the TD group affected the result. Further research is needed to better understand the developmental trajectory of object pronouns in TD children in generating narrative tasks.

Interestingly, both groups produced significantly fewer ambiguous possessive pronouns compared with subject and object pronouns. A possible explanation for this result is that a possessive pronoun is followed by a noun ('his dog'), which provides a hint to the listener (the coders in the current study) for correct interpretation even for ambiguous possessives, as can be seen in the following example. 'The boy looked in a mole hole and then a mole popped out and he (ambiguous pronoun as it refers to the dog) was right under the bees' nest and his dog (the possessive refers to the boy) was jumping up the tree.' The possessive pronoun 'his' was coded as a clear pronoun, because it was clear that it is the boy's dog, although in the example presented above, 'his' refers to the pronoun 'he', which is the dog itself. The assumption here is that possessives are interpreted as clear pronouns due to the possessor that is linked to them (in the example above, the dog). A recent study tested comprehension of possessives and found typical performance in children with ASD (Perovic et al., 2012). In this study, 14 children with ASD aged 6;6–17 years performed similarly to controls on a picture-matching task of possessive sentences. The possessives were presented as in the following example: 'Bart's dad is petting a dog.' Subject possessives (Bart's dad) represent relations between two NPs and are different from possessive pronouns (his dad). In addition, the task in the current study was a production task, whereas Perovic et al. (2012) evaluated a comprehension task. Further research is needed to better understand the linguistically unique features of possessives and to what degree they are preserved in the language of children with ASD.

The current study has implications for both clinical assessment and intervention programs for children with ASD. The results suggest that story generation is a sensitive task for identifying difficulties with pronoun use and is more sensitive than story retelling. For intervention programs, it is suggested to use this hierarchy and to begin with story-retelling tasks, giving the child the correct model. Story retelling can function as a bridge for reducing ambiguous pronouns in story-generating tasks. This bridging is important for children with ASD who present different levels of language needs and for those children who might demonstrate a change in performance over time. In addition the current results emphasize the importance of focusing on all types of pronouns, not only subject pronouns.

In summary, the findings of the current study suggest that children with ASD produce more ambiguous pronouns than do TD children in a story-telling task. This difficulty is not limited to a specific syntactic structure, but is present in different referential environments of narratives, suggesting a cognitive deficit in monitoring the listener's mental model.

Acknowledgements

We thank Aaron Shield, Margarita Kaushanskaya and Noga Balaban for their comments on an earlier version of the manuscript. We thank Helen Tager-Flusberg for her support and for sharing this valuable data set. We thank the transcribers and coders from the Lab of Developmental Cognitive Neuroscience at Boston University.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by grant number U19 DC 03610 from NIDCD.

Notes

1. The terms ambiguous pronouns versus clear pronouns in this article follow the same usage as in Collé et al. (2008), Wheelwright and van der Lely (2008) and Norbury and Bishop (2003).
2. In the frog-story task, there were only 23 children in the ASD group as one child with ASD did not complete the task.

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