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Inferential narrative comprehension ability of young school-age children on the autism spectrum

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Abstract

Background and aims: The purpose of the current exploratory study was to describe the inferential narrative comprehension skills of young school-age children on the autism spectrum who, as a group, are at high risk of significant and persistent reading comprehension difficulties. Our aim was to investigate whether the anticipated difficulties in inferential narrative comprehension in the group of children with autism could be explained by the children's structural language ability as measured using a broad-spectrum standardized language test.

Methods: The participants were 35 children with a diagnosis of autism spectrum disorder (ASD), aged between 5;7 and 6;11, who attended their first year of formal schooling, and 32 typically developing (TD) children, matched to the ASD group for age and year of schooling. Children on the autism spectrum were divided into below normal limits (ASD_BNL, standard score ≤80; $n = 21$) or within normal limits (ASD_WNL, standard score >80; $n = 14$) on a standardized language test. All children participated in a narrative comprehension task, which involved listening to a novel story, while looking at pictures, and answering eight comprehension questions immediately afterwards. Comprehension questions were categorized into factual and inferential questions, with further categorization of the inferential questions into those tapping into the story characters' internal responses (mental states) or not. Children's responses were scored on a quality continuum (from 0: inadequate/off topic to 3: expected/correct).

Results: Our results showed significantly lower scores across factual and inferential narrative comprehension in the ASD_BNL group, compared to the ASD_WNL and TD groups, supporting the importance of structural language skills for narrative comprehension. Furthermore, the TD group significantly outperformed the children in the ASD_WNL group on inferential comprehension. Finally, the children in the ASD_WNL group showed specific difficulties in answering the internal response inferential questions compared to their TD peers.

Conclusions: Results from this exploratory study highlight the difficulties children on the autism spectrum may have in inferential narrative comprehension skills, regardless of sufficient structural language skills at word and sentence level. These findings support the importance of routinely assessing these narrative comprehension skills in children on the spectrum, who as a group are at high risk of persistent reading comprehension difficulties.

Implications: In this study, we demonstrate how narrative comprehension can be assessed in young school-age children on the autism spectrum. The scoring system used to categorize children's responses may further assist in understanding children's performance, across a quality continuum, which can guide detailed goal setting and assist in early targeted intervention planning.

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Many children on the autism spectrum demonstrate difficulties in oral language development (Kwok et al., 2015), which strongly impacts their outcomes in academic, vocational, health, and social spheres. One oral language skill that is critical for successful communication, social interaction, and reading comprehension is inferential narrative comprehension. For example, growing evidence indicates the important concurrent and predictive association between inferential narrative comprehension and reading comprehension (Cain et al., 2001; Kendeou et al., 2008; McIntyre et al., 2020; van Kleeck, 2008). To date, however, there is little detailed information about the inferential narrative *comprehension* abilities of young children on the spectrum (Norbury & Bishop, 2002; Nuske & Bavin, 2011; Young et al., 2005) as most previous research has focused on the narrative *production* of this group of children (see, e.g., Baixauli et al., 2016). Investigation of inferential narrative comprehension abilities is particularly important given that inferential comprehension strategies can be taught to children with developmental disabilities who demonstrate difficulties in these skills (Dawes et al., 2019; Desmarais et al., 2013; van Kleeck et al., 2006). The current exploratory study addresses this gap in the literature by investigating the oral narrative comprehension skills in a group of young school-age children on the autism spectrum compared to their typically developing (TD) peers (i.e., those without autism or other developmental disability diagnoses).

Narrative comprehension

Narratives may be conceptualized as a sequence of goal-directed actions aimed at solving a problem (Trabasso & Nickels, 1992). Paris and Paris (2003) argue that narrative comprehension relies on the development of a range of skills including visual and mental perspective taking (i.e., theory of mind [ToM]) and story grammar. Although both factual (i.e., understanding explicitly stated information) and inferential (i.e., understanding information that is not explicitly stated by making links) comprehension are important, to *fully* comprehend spoken or written narratives (and construct a coherent and complete mental representation), the listener or reader needs to: (a) infer causal relationships between events or actions, (b) identify the goal and internal states of the characters, and (c) draw on background or contextual knowledge in order to fill gaps or make predictions (Cain, 2003; Kintsch, 2005; Rapp & van den Broek, 2005; van Kleeck, 2008).

The ability to make causal connections between events and actions takes place early in development, well before children learn how to read. Van den Broek et al. (2005) proposed broad developmental steps in inferencing. Based on their proposal, children develop the ability to create inferential links between concrete and physical events (e.g., a child breaks a toy by dropping it on the ground) before the ability to create links between abstract and internal events (e.g., the child is feeling sad and wants to repair the toy). A few researchers have attempted to identify/attach more precise ages to oral narrative inferencing abilities. To illustrate, by 4 years of age children may be able to provide adequate answers to questions about the character's main problem (Filiatrault-Veilleux et al., 2016). Mental state inferences would also appear early in development, at approximately 3–4 years of age (Ford & Milosky, 2003, 2008; Spackman et al., 2006), coinciding with steps in ToM development in TD around this age (Wellman & Liu, 2004). By the age of six, TD children are able to infer consequences of actions or events, infer the attempts to solve a problem, and may be able to predict what will happen next (Adams et al., 2009). Various approaches to assessing these skills have been developed to date.

Assessment of inferential narrative comprehension

Narrative comprehension has been assessed in various ways, including different question types, prompts, and material types (see Filiatrault-Veilleux et al., 2015). Question types can include: (a) factual versus inferential questions (Young et al., 2005); (b) text-connecting, coherence, or text-based questions (for which answers can be found in text, e.g., Cain et al., 2001) versus gap-filling questions (Norbury & Bishop, 2002); or (c) elaborative questions, for which connections with background knowledge are required (e.g., Cain et al., 2001). Paris and Paris (2003) further distinguished between inferencing questions about characters' feelings, dialogues, causal relations, predictions, and themes, in line with the importance of causal inferences for narrative comprehension and how they are hierarchically connected to elements of story grammar (Makdissi & Boisclair, 2006; van Kleeck, 2008). This distinction may be particularly useful when evaluating the inferential narrative comprehension skills of children on the autism spectrum as it allows for investigation of relative strengths and weaknesses that may align with core (e.g., social communication) and associated

(e.g., ToM delays and differences) features. Inferencing can involve either coherence inferences (text-based or bridging) that are essential for making links between premises in a text, or they can be elaborative inferences that connect with one's general knowledge and enrich text representation (e.g., Cain et al., 2001).

Responses required as well as scoring of children's responses differ between study assessment methods, from prompts leading to dichotomous ratings (correct/incorrect) to requests for elaborations of responses that were rated by quality. For example, Westerveld and Roberts (2017) rated children's responses as correct or incorrect. In contrast, Paris and Paris (2003) asked children to explain "why" to obtain a richer understanding of the depth of the children's inferencing ability. They provided a scoring rubric (0–2 points) to distinguish between wrong answers, appropriate answers derived from a single picture, and appropriate answers based on integrating information from multiple pictures. Other researchers have extended this scoring system in an attempt to more closely appraise the quality of children's responses to inferential questions (Adams et al., 2009; Desmarais et al., 2013; Filiatrault-Veilleux et al., 2016; Lynch & van den Broek, 2007). In these studies, children's responses were categorized into (a) expected, (b) incomplete, (c) low contingency, and (d) inadequate or off topic. Categorizing children's responses in this way allows for a more nuanced analysis of children's performance, and ultimately provides detailed information for effective intervention strategies that can be used in clinical practice.

Finally, assessment of inferential comprehension also varies in terms of the materials that are used during the listening task. Filiatrault-Veilleux et al. (2015) in their scoping review found a wide range of tasks to measure inferential comprehension in children ages 3–6 years, including experimental short stories, story books, published assessments, or short videos, which were either read aloud, or presented via audio or video output.

Inferential comprehension in children with language disorders

Research has explored inferential narrative comprehension development and difficulties in preschool children with language impairment (Kendeou et al., 2008; Rapp & van den Broek, 2005; Reuterskiöld Wagner et al., 1999) as well as school-age children with identified language difficulties (Adams et al., 2009; Botting & Adams, 2005; Bowyer-Crane & Snowling, 2005; Dawes et al., 2018; Dodwell & Bavin, 2008; Ryder et al., 2008). These studies show that children with language disorders have difficulties in completing inferential comprehension tasks. For example, Dodwell and Bavin (2008) found significant differences between 6-year-old children with specific language impairment (SLI, now termed as developmental language disorder [DLD]) and their age-matched peers on inferential questions of the comprehension task from the *Expressive Receptive Recall of Narrative Instrument* (Bishop, 2004), but not on the factual questions, indicating language disorder puts children at particular risk of inferential comprehension difficulties.

Dawes et al. (2018) set out to identify in more detail the language and cognitive skills contributing to narrative inferential comprehension in a group of 67 children with DLD, aged between 5;2 and 6;2. Children watched and listened to a story on an iPad and were asked 14 inferential questions and 10 literal questions while looking at the pictures for a second time. All questions were scored on a 0–2 scale. Results indicated significant associations between inferential narrative comprehension and children's ability to produce coherent narratives (i.e., narrative macrostructure), their use of vocabulary and syntax during story retell, literal comprehension, vocabulary knowledge, and ToM. Although only narrative macrostructure and ToM were *independent* significant predictors of inferential comprehension, these results highlighted the importance of both oral language proficiency (at text level) and cognitive skills for answering inferential comprehension questions. These results may potentially help explain why children on the autism spectrum, who show both delays and deviance in ToM development relative to TD peers (Peterson et al., 2005), combined with language delays (e.g., see review by Kwok et al., 2015) demonstrate inferential narrative comprehension difficulties, regardless of their oral language proficiency at word- and sentence level (i.e., structural language skills, including vocabulary, and morpho-syntax; Norbury & Bishop, 2003).

Autism spectrum disorder (ASD) and inferential comprehension

ASD is characterized by social communication impairments and restrictive and repetitive behaviors and interests (DSM-5; American Psychiatric Association, 2013). ASD is also associated with comorbid language impairments (Kwok et al., 2015), intellectual disability (~30%; Maenner et al., 2020), and delays and differences in ToM development (see, e.g., Baron-Cohen, 2000; Peterson et al., 2005). ASD is referred to as a "spectrum" due to the spectrum of support needs (from low to high) in both core (i.e., social communication and behavior) and associated features (e.g., cognitive profiles and intellectual functioning, oral language ability, and ToM). Significant heterogeneity is observed in the specific profile of strengths and needs observed in a specific individual with levels of support potentially divergent across areas.

Both core and associated features of ASD may impact narrative comprehension. Challenges in structural language skills at word (vocabulary) and sentence (morpho-syntax) levels may hamper children's understanding at the text level (e.g., narrative), similar to the difficulties observed in

children with DLD (Dawes et al., 2018). Structural language skills (vocabulary and syntax) have also been associated with ToM performance (Paynter & Peterson, 2010) and may thus directly or indirectly (via ToM) impact on inferential comprehension. Intellectual impairment puts children at risk for learning difficulties in general, consistent with the diagnostic criteria (American Psychiatric Association, 2013). Social communication impairments along with difficulties with ToM may also impact on narrative comprehension. ToM refers to perspective taking, including the ability to understand and predict behavior in oneself and other people, and requires understanding of mental states (belief, knowledge, and intentions). ToM difficulties may affect children's ability to understand the behavior of characters depicted in stories and thus influence their ability to answer questions regarding the story characters' mental states (e.g., questions referring to the characters' internal responses) and goal-directed actions. Taken together, challenges with social communication, ToM, and oral language may make children on the spectrum vulnerable to difficulties with inferential comprehension.

While limited, research to date indicates inferential comprehension difficulties in children on the spectrum compared to their TD peers (Norbury & Bishop, 2002; Nuske & Bavin, 2011; Young et al., 2005). For example, Norbury and Bishop (2002) examined the inferential comprehension skills of four groups of children, ages 6–10 years, all of whom demonstrated nonverbal ability within the normal range: (1) SLI or DLD ($n = 16$); (2) pragmatic language impairment (PLI; $n = 24$), (3) autism ($n = 10$), and (4) a TD control group ($n = 18$). Children were asked six questions (two factual and four inferential), after listening to five stories. Significant group differences in inferential comprehension were found between the autism and the control group and the authors reported "a trend" for the autism group to perform more poorly than the other groups (DLD and PLI) on inferencing questions. Further analysis showed that 70% of the children in the autism group demonstrated poor inferencing skills, compared to 25% in the DLD group. These results indicate that although inferencing difficulties are observed across clinical groups, an autism diagnosis seems an additional risk factor. However, the sample size was small, there was substantial variability in performance within each group, and the age range was relatively wide, considering the significant progress in narrative proficiency observed in typical populations during their first years of schooling, limiting conclusions that may be drawn (Heilmann et al., 2010; Westerveld & Gillon, 2010). However, providing further evidence of particular difficulties for individuals on the autism spectrum, similar results were found by Nuske and Bavin (2011) in a study of 14 children with ASD (ages 4;6 to 7;11) and 14 TD children (ages 4;2 to 5;4), matched for receptive vocabulary skills. After listening to six very short stories (5–7 sentences each), the children with ASD showed specific difficulties answering questions that required script inferencing (requiring the ability to incorporate background script knowledge), as opposed to factual questions or propositional inferencing questions (i.e., based on logical relations). Thus, while limited, emerging research supports challenges in inferential comprehension for children with autism relative to other groups.

The current study

We sought to describe the inferential narrative comprehension skills of verbal children (i.e., able to complete the verbal tasks) on the autism spectrum in their first year of schooling and compare their performance to TD peers matched for age and year of schooling. In the autism group, we investigated the impact of structural language ability (i.e., spoken language skills at word and sentence level as measured on a standardized language test) on children's inferential comprehension skills. We recruited a relatively large group of 35 children diagnosed with ASD, ranging in age from 5;7 to 6;11, who were all in their first year of schooling, and did not exclude children based on their performance on a standardized language test (e.g., Young et al., 2005). This allowed us to investigate the performance of two subgroups of children on the autism spectrum based on their structural language ability level. First, we compared their performance to that of a group of TD children matched for age and year of schooling. Unlike previous studies (Nuske & Bavin, 2011), this design ensures the children are matched for experience and exposure to the school curriculum. Second, we used an ecologically validated task containing a problem-oriented story that is reflective of the school curriculum, as opposed to short scripts (Nuske & Bavin, 2011) or reactive sequences (Norbury & Bishop, 2002), which may be more relevant for clinical practice. Third, we not only considered the children's performance on factual versus inferential comprehension questions, we also investigated children's inferential comprehension performance, specifically looking at causal inference type questions linked to the story characters' internal response (see Filiatrault-Veilleux et al., 2015). Finally, we adopted a fine-grained coding system for analyzing the children's responses (Desmarais et al., 2013; Filiatrault-Veilleux et al., 2016), which may in future inform intervention planning in particular.

Two research questions were addressed:

1. Compared to their TD peers, do children on the autism spectrum show difficulties in inferential comprehension, regardless of their structural language ability?
2. Do children on the autism spectrum show specific significant difficulties in answering inferential questions related to the story characters' internal response, regardless of their structural language ability?

Based on previous research, and given established challenges in ToM, we anticipated that the children on the spectrum would show difficulties in inferential comprehension, particularly in answering questions related to the story characters' internal response (Baron-Cohen, 2000; Nuske & Bavin, 2011).

Method

Ethics approval was granted by the University Human Ethics Committee (AHS/13/14/HREC). Approval was also provided by the authorized director from the Department of Education and the school principals. Written parental consent and child assent was obtained prior to the data collection.

Participants

Participants on the autism spectrum included all children ($n = 35$) whose parents agreed to a follow-up assessment when their child was in their first year of formal schooling (from an initial cohort of 57 children; Westerveld et al., 2017), who completed the narrative comprehension task and the core language subtests of the *Clinical Evaluation of Language Fundamentals-Preschool* (CELF-P2; Semel et al., 2006). Inclusion criteria for our initial study (Westerveld et al., 2017) included: (a) a verified diagnosis of ASD with a score of 11 or higher on the *Social Communication Questionnaire* (Rutter et al., 2003), consistent with previous research (Eaves et al., 2006); (b) an ability to speak in short phrases based on parent report; and (c) ability to participate in preschool activities (defined as being able to sit and complete tasks with an adult at the table for 5 min or more). To determine the participants' level of nonverbal ability, the visual reception and fine motor subscales of the *Mullen Scales of Early Learning* (Mullen, 1995) were administered at age 4 (initial study) and a developmental quotient (DQ) was calculated (see Westerveld et al., 2017). Children were not excluded based on their DQ scores. At the time of this follow-up study, participants were aged between 5 years, 7 months and 6 years, 11 months (mean age 6;2), with 30 males and five females. All primary caregivers spoke English as the main language at home, although two parents reported that another language was spoken in the home. We used mothers' level of education as a proxy for socioeconomic status with 32% of mothers having completed high school, and 63% of mothers reporting completing further education post high school, with data unavailable for two mothers. At the time of reassessment all children had completed at least 4 months of their first year of formal schooling.

The children with TD were drawn from a larger study aimed at creating normative data by collecting spoken language samples of young school-age children (Westerveld & Vidler, 2016). To qualify for inclusion, the participants met the following criteria: (a) attended year 1 of formal schooling; (b) were aged between 5;8 and 7;1 to match to the autism group; (c) spoke English as their first language; and (d) were progressing in line with grade expectations at school and had no history of speech and/or language impairment based on parent report. A total of 32 children were selected, ranging in age from 5;8 to 7;1 (mean age 6;4), with 13 boys and 19 girls. There were no statistically significant differences in age between the two groups of participants (ASD vs. TD) $t(65) = -1.769$, $p = .082$, $d = .43$. However, consistent with the gender bias in autism (e.g., Maenner et al., 2020), the autism group had more males than females and this difference in gender proportions was significant.

Procedures and measures

All children were assessed individually by certified practicing speech pathologists either at the child's school or at a venue convenient to the family. All sessions were audio-recorded for transcription and reliability purposes.

Language ability. To assess children's structural language skills, we administered the core language subtests from the *Clinical Evaluation of Language Fundamentals-Preschool* (CELF-P2; Semel et al., 2006) to the children in the autism group only. The core language scores (standard scores) are reported. We used a cutoff of SS80 to divide the children in the autism group into two groups: within normal limits (WNL) if their SS ≥ 80, and BNL (below normal limits) if their SS < 80. There were 21 children in the ASD_BNL group, Mean SS 63.29 (*SD* 11.17, range 45–78), and 14 children in the ASD_WNL group, Mean SS 98.14 (*SD* 11.13, range 82–122), with significant group differences on language ability, $t(33) = -9.056$, $p < .001$, $d = 3.12$. There were no significant group differences in age between the ASD_BNL and ASD_WNL

Table 1. Participant characteristics.

	ASD_BNL $n = 21$ Mean (SD)	ASD_WNL $n = 14$ Mean (SD)	TD $n = 32$ Mean (SD)
Age in months	76 (5)	72 (3)	76 (5)
Range	67–83	67–79	68–85
SCQ[a] at age 4	16.1 (5.3)	15.3 (6.3)	–
Range	5–25	7–32	
DQ[a] at age 4	68.4 (16.8)	91.2 (16.9)	–
Range	44.0–99.2	64.9–119.2	
CELF-P2 CLS	63.3 (11.2)	98.1 (11.1)	–
Range	34–78	82–122	

Note: SCQ = Social Communication Questionnaire; DQ = developmental quotient; CELF-P2 = comprehensive evaluation of language fundamentals-preschool; CLS = core language score; ASD = autism spectrum disorder; BNL = below normal limits; WNL = within normal limits; TD = typically developing; SD = standard deviation.
[a]Measures administered before school entry (see Westerveld et al., 2017).

groups ($p = .171$), nor on the SCQ ($p = .701$). All demographic data are shown in Table 1.

Narrative comprehension. This task used the protocol described in Westerveld et al. (2004). This task has been used extensively in the past with young school-age children from New Zealand and Australia (e.g., Lennox et al., 2018; Westerveld et al., 2004), including preschool age children on the spectrum (Westerveld & Roberts, 2017). Children were asked to listen to a recording of the story "Ana Gets Lost" (Swan, 1992), while looking at the pictures on a computer screen. Following the first exposure to the story, children were asked eight comprehension questions, without access to the pictures (see Appendix A).

Comprehension scoring. Scoring of the children's answers to the eight questions followed a well-validated coding methodology consisting of classifying children's story comprehension answers in different levels of quality, inspired by the scoring system of the *Preschool Language Assessment Instrument–Second Edition* (Blank et al., 2003) and previously used with children with DLD (Desmarais et al., 2013) as well as with TD children (Filiatrault-Veilleux et al., 2016). Children's responses were categorized into (a) expected/correct (3 points); (b) incomplete (2 points); (c) low contingency (1 point); and (d) inadequate or off topic (0 points) (Adams et al., 2009; Desmarais et al., 2013; Filiatrault-Veilleux et al., 2016; Lynch & van den Broek, 2007). To create the scoring scheme, all participants' answers were combined into one document and then classified by agreement between the first two authors, with the second author blind to the participants' group condition. The participants' first responses alone were coded. To limit the impact of expressive language difficulties for the children in the autism group, the classification of the answers did not take into account phonological processes, syntax/grammar difficulties, or length of answers/sentences. The total score was calculated out of 24 points. The definitions, examples of responses, and scores attributed to each category are presented in Appendix B. To check the reliability of the coding system, a blind interrater analysis was then performed on 20 of the participants (~30%). Interrater reliability was 96% (i.e., agreement on scoring of 154 of the 160 responses).

As shown in Appendix A, questions 1, 6, and 7 were classified as factual questions (e.g., Who found Ana?), because they relied on information mentioned explicitly in the story, with a maximum score out of 9 points. Questions 2, 3, 4, 5, and 8 were classified as inferential questions (e.g., Why did Ana have to stay home?), because they relied on drawing inferences from provided information and answers were not explicitly mentioned, for an inferential score out of 15 points. To examine whether inferential questions targeting internal responses were more difficult for the participants on the spectrum, we sub-classified the inferential questions based on whether they required understanding of the character's internal response, i.e., mental state questions (e.g., Why did Ana get scared?), questions 3, 5, and 8, with a maximum score of 9 points, versus questions 2 and 4 which did not target mental states (e.g., "Why did Ana have to stay at home?") for a total score of 6 points.

Results

Data screening

There were no missing data. Data were screened for assumptions of parametric analyses. There were no outliers; however outcome variables were not normally distributed; thus Kruskal–Wallis H tests were conducted to compare groups, which allowed for inspection of the differences in mean rank scores between groups. Given differences in gender ratio between groups, data were screened for impact of gender on outcomes (four question types), which were all nonsignificant (all p's $> .318$); thus gender was not controlled in analyses. Effect sizes are reported as epsilon-squared and interpreted as 0.01 to <0.06 (small effect), 0.06 to <0.14 (moderate effect), and ≥0.14 (large effect). Subsequently, pairwise comparisons were performed using Dunn's (1964) procedure as recommended by Dinno (2015) following a Kruskal–Wallis test, to utilize the full dataset for comparisons, similar to one-way analysis of variance post hoc tests. Given the exploratory nature of the investigation, Bonferroni corrections for multiple comparisons were not made with statistical significance accepted at the $p < .05$ level (Perneger, 1998).

Group performance in narrative comprehension

We first examined the quality of the participants' responses by group for each question. As shown in Table 2, there was a range of performance on most questions, except for Q6 (factual question) with the TD group showing a ceiling effect. To address our first hypothesis and investigate whether the group differences in narrative comprehension ability could be explained by the children's autism status and/or their structural language ability, we examined the groups' (ASD_WNL, ASD_BNL, and TD) performance on the two types of questions, factual and inferential. As shown in Tables 3 and 4, there were no significant differences in mean rank scores between the TD group and the ASD_WNL group for factual comprehension; both the TD group and the ASD_WNL groups outperformed the ASD_BNL group with large effect sizes. Because of ceiling effects on Q6, we reran the analysis based on Q1 and Q7 only; this did not change the results. When evaluating performance on the inferential questions (total score), the mean rank score of the TD group was significantly higher than the mean rank score of the ASD_WNL group (large effect

Table 2. Quality of the responses by question by group, in number of participants (and percentage).

	ASD_BNL	ASD_WNL	TD
Question 1 (factual)			
0	7 (33.3)	0	2 (6.3)
1	3 (14.3)	1 (7.1)	3 (9.4)
2	3 (14.3)	2 (14.3)	4 (12.5)
3	8 (38.8)	11 (78.6)	23 (71.9)
Question 2 (inferential/other)			
0	17 (81)	2 (14.3)	1 (3.1)
1	1 (4.8)	3 (21.4)	4 (12.5)
2	0	2 (14.3)	7 (21.9)
3	3 (14.3)	7 (50)	20 (62.5)
Question 3 (inferential/internal response)			
0	18 (85.7)	6 (42.9)	3 (9.4)
1	2 (9.5)	4 (28.6)	8 (25.0)
2	1 (4.8)	1 (7.1)	6 (18.8)
3	0	3 (21.4)	15 (46.9)
Question 4 (inferential/other)			
0	13 (61.9)	1 (7.1)	0
1	6 (28.6)	3 (21.4)	5 (15.6)
2	1 (4.8)	4 (28.6)	11 (34.4)
3	1 (4.8)	6 (42.9)	16 (50.0)
Question 5 (inferential/internal response)			
0	14 (66.7)	3 (21.4)	0
1	3 (14.3)	2 (14.3)	3 (9.4)
2	3 (14.3)	6 (42.9)	13 (40.6)
3	1 (4.8)	3 (21.4)	16 (50.0)
Question 6 (factual)			
0	6 (28.6)	0	0
1	0	0	0
2	4 (19)	0	0
3	11 (52.4)	14 (100)	32 (100)
Question 7 (factual)			
0	11 (52.4)	2 (14.3)	0
1	2 (9.5)	2 (14.3)	1 (3.1)
2	0	0	3 (9.4)
3	8 (38.1)	10 (71.4)	28 (87.5)
Question 8 (inferential/internal response)			
0	17 (81)	2 (14.3)	2 (6.3)
1	3 (14.3)	6 (42.9)	3 (9.4)
2	1 (4.8)	3 (21.4)	17 (53.1)
3	0	3 (21.4)	10 (31.3)

Note: 0 = inadequate or off topic; 1 = low contingency; 2 = incomplete; 3 = expected/correct; ASD = autism spectrum disorder; BNL = below normal limits; WNL = within normal limits; TD = typically developing.

size); in turn the ASD_WNL group significantly outperformed the ASD_BNL group, with a large effect size.

To address our second hypothesis and investigate whether children on the autism spectrum would show specific significant difficulties in answering inferential questions related to the story characters' internal response, we evaluated group performance (ASD_WNL vs. TD) on the inferential questions tapping internal response (IR) versus more general inferential questions (other). Results revealed no group differences (ASD_WNL vs. TD) for inferential other ($p = .275$, $\eta^2 = 0.129$), but significant group differences on inferential comprehension IR, with a large effect size (0.344).

To further investigate these group differences in inferential comprehension, we considered the children's individual profiles. As shown in Table 5, there was some overlap in scores between the groups. On the inferential (other) questions, three children in the ASD_BNL group (14.2%) and 10 children in the ASD_WNL group (71.4%) performed within or above the interquartile range (IQR) of the TD group (as presented in Table 3) versus 21 of the TD children (81.2%). In contrast, none of the children in the ASD-BNL group and only six children in the ASD_WNL group (43%) performed within or above (one child) the IQR of the TD group versus 27 TD children (84%).

Discussion

The aim of the current study was to investigate the narrative comprehension skills (both factual and inferential) of a group of young school-age children on the autism spectrum compared to their peers without an autism diagnosis, matched for age and year of schooling. Overall, we found significantly lower scores across factual and inferential narrative comprehension in the ASD_BNL group, compared to the ASD_WNL and TD groups, with large effect sizes, supporting the importance of structural language proficiency measured at the word and sentence levels, for narrative comprehension.

Children on the autism spectrum showed greater difficulties in inferential comprehension than their peers without autism, regardless of their structural language ability consistent with our first hypothesis and previous research (Nuske & Bavin, 2011). When comparing the ASD_WNL group to their TD peers, the children on the autism spectrum demonstrated significant difficulties answering inferential comprehension questions, but performed equally well in factual comprehension (Nuske & Bavin, 2011; Young et al., 2005). Taken together, these findings indicate that children on the spectrum are at risk of demonstrating inferential comprehension difficulties, regardless of their structural language ability, similar to children with diagnosed language disorders (Norbury & Bishop, 2002; Nuske & Bavin, 2011; Young et al., 2005). Considering the importance of narrative comprehension for classroom participation and its links with reading comprehension (Kendeou et al., 2008; Paris & Paris, 2007; Storch & Whitehurst, 2002), these findings are of concern and highlight the importance of routinely assessing children's language skills beyond the word and sentence levels, as all children in the ASD_WNL group showed age-appropriate performance on the core language subtests of the CELF-P2 (SS 82–122).

At group level, children in the ASD_WNL group showed significant difficulties in answering the internal response inferential questions, compared to their TD peers, consistent with our hypothesis that children on the spectrum would show specific difficulties with this type of inferential

Table 3. Group performance on the narrative comprehension task, raw scores, omnibus Krukall–Wallis comparison.

		ASD_BNL $n = 21$	ASD_WNL $n = 14$	TD $n = 32$	$\chi^2(2)$	p	ϵ^2
Factual (max 9)	Median (IQR)	5.0 (6.0)	9.0 (2.0)	9.0 (1.0)	17.76	<.001	.228
	Range	0–9	4–9	6–9			
Inferential (total) (max 15)	Median (IQR)	1.0 (3.0)	8.0 (5.5)	11.0 (3.0)	42.72	<.001	.199
	Range	0–10	1–15	5.0–15.0			
Inferential (IR) (max 9)	Median (IQR)	0 (1.5)	3.5 (4.25)	7 (2.75)	42.73	<.001	.204
	Range	0–4	1–9	2–9			
Inferential (other) (max 6)	Median (IQR)	0 (1.5)	4.0 (2.25)	5.0 (2.0)	33.25	<.001	.213
	Range	0–6	0–6	3–6			

Note: ASD = autism spectrum disorder; BNL = below normal limits; WNL = within normal limits; TD = typically developing.

Table 4. Post hoc comparison of narrative comprehension performance using Dunn's (1964) procedure.

	ASD_BNL $n = 21$	ASD_WNL $n = 14$	TD $n = 32$	ASD_WNL versus ASD_BNL		ASD_BNL versus TD		ASD_WNL versus TD	
	Mean rank	Mean rank	Mean rank	$\chi^2(1)$	p	$\chi^2(1)$	p	$\chi^2(1)$	p
Factual	20.80	40.43	41.33	−19.63	.002	−20.53	<.0001	−.900	.880
Inferential (total)	13.18	35.25	48.83	−22.07	.001	−35.65	<.0001	−13.58	.031
Inferential (IR)	13.43	34.50	48.98	−21.07	.002	−35.55	<.0001	−14.48	.021
Inferential (other)	15.20	39.00	45.80	−23.80	<.001	−30.59	<.0001	−6.80	.275

Note: ASD = autism spectrum disorder; BNL = below normal limits; WNL = within normal limits; TD = typically developing; IR = internal response.

comprehension task, which could not be explained by structural language impairment as these children all performed within expected ranges. Likewise, nonverbal IQ (as measured at age 4) appears unlikely to explain these difficulties given the ASD_WNL group showed, on average, performance within expected range ($M = 91.2$). Difficulties completing inferential comprehension questions that required understanding mental states is consistent with ToM accounts of autism and established difficulties with ToM (i.e., understanding and reasoning with mental states; see, e.g., review Baron-Cohen, 2000). This is in line with hypothesized links in TD by Dore et al.(2018, p. 1080) between ToM and narrative comprehension, where it is proposed that better ToM skills enable children to represent and monitor story characters' internal states (e.g., thoughts and emotions) during processing of narratives, enabling them to use this information to draw mental state inferences. Dore et al. (2018) argue that if their framework is correct then links between ToM and inferential comprehension would be stronger for mental state inferences, but not factual, which is consistent with our results if we take ASD diagnosis to be a proxy for ToM impairments. Thus, it follows that future research that includes measures of both ToM and comprehension monitoring would be of value to directly test this proposed framework in ASD. We acknowledge, however, individual differences were observed in inferencing ability within each of the groups, indicating in practice the need for individualized assessment consistent with heterogeneity observed in ASD as well as in TD.

It is acknowledged that our measure of structural language included elements of both vocabulary and syntax. Thus, scoring WNL on an overall measure does not rule out the possibility that specific elements of structural language such as syntax or more specific understanding of complement syntax may facilitate or hinder the ability to complete inferential comprehension questions requiring understanding of mental states. This is an important question for future research, as syntax more broadly (Paynter & Peterson, 2010), and complement syntax more specifically (Lind & Bowler, 2009) have been associated with ToM in previous studies. Thus, future research that explores the associations between vocabulary, syntax, ToM, and narrative comprehension, and ultimately reading comprehension, would be of value in advancing theoretical understanding of reading comprehension in ASD drawing from models (e.g., Dore et al., 2018) proposed for TD.

Limitations and future directions

We provide an initial, exploratory cross-sectional comparison of types of inferential comprehension skills in children with and without autism; however, we acknowledge a number of limitations. Given the exploratory nature of the study, we prioritized controlling Type 2 over Type 1

Table 5. Performance on inferential questions type (with percentage) by subgroup.

	ASD_BNL $n = 21$	ASD_WNL $n = 14$	TD $n = 32$
Inferential (internal response) max = 9			
0	11 (52.4)	0	0
1	5 (23.8)	2 (14.3)	0
2	1 (4.8)	2 (14.3)	1 (3.1)
3	2 (9.5)	3 (21.4)	0
4	2 (9.5)	1 (7.1)	4 (12.5)
5	0	2 (14.3)	3 (9.4)
6	0	1 (7.1)	6 (18.8)
7	0	1 (7.1)	7 (21.9)
8	0	1 (7.1)	8 (25)
9	0	1 (7.1)	3 (9.4)
Inferential (other) max = 6			
0	13 (61.9)	1 (7.1)	0
1	3 (14.3)	0	0
2	2 (9.5)	1 (7.1)	0
3	0	2 (14.3)	6 (18.8)
4	2 (9.5)	4 (28.6)	5 (15.6)
5	0	3 (21.4)	11 (34.4)
6	1 (4.8)	3 (21.4)	10 (31.3)

Note: ASD = autism spectrum disorder; BNL = below normal limits; WNL = within normal limits; TD = typically developing.

errors, acknowledging the limitation of the small sample size, and the need for replication with larger sample sizes in future research. The narrative task was not specifically designed to investigate inferential narrative comprehension skills. Future research should consider adding questions to better reflect the range of inferencing skills that are needed to understand the narrative (beyond those tapping into the characters' mental states), including text-connecting, coherence, or text-based questions, for which answers can be found in-text (e.g., Cain et al., 2001), as well as gap-filling (Norbury & Bishop, 2002) or elaborative questions, for which connections with background knowledge are required (e.g., Cain et al., 2001). We acknowledge inferential comprehension is a complex construct that relies on a wide range of language and cognitive skills (e.g., Dawes et al., 2018; Florit et al., 2011; Potocki et al., 2016; Silva & Cain, 2015). However, as our study was based on secondary analyses of data we were limited in the range of measures available which would have been valuable to explore as potential mechanisms, such as exposure to narratives (either classroom or speech pathology intervention), cognitive functioning (ToM, executive functioning, thinking, and reasoning), current nonverbal IQ, or more fine-grained measures of language and social-communication skills. As such, as proposed above, future research should incorporate additional measures, drawing from models proposed in TD such as the model of Dore et al. (2018). This will allow us to better explore the skills underpinning inferential comprehension abilities in young clinical populations, including those on the autism spectrum, and elucidate why children on the spectrum may display inferential narrative comprehension difficulties, regardless of their overall oral language proficiency at the word and sentence level (Norbury & Bishop, 2003).

Clinical implications

Assessment of inferential comprehension can vary in terms of scoring systems and materials (Filiatrault-Veilleux et al., 2015). In the current study, we used a fictional problem-oriented story that may be considered more difficult than the tasks used in previous studies, including scripts used by Nuske and Bavin (2011) or reactive sequences (Norbury & Bishop, 2002). However, we emphasize the importance of using ecologically valid story comprehension tasks that are frequently used in clinical practice (Westerveld & Gillon, 2010) and that closely align with the school curriculum in order to detect inferential comprehension difficulties in young children on the autism spectrum that are relevant to participation at school. The scoring system used in the current study to categorize children's responses may further assist in understanding children's performance, across the quality continuum (see Appendix A), that may inform detailed goal setting and individualized intervention planning (Desmarais et al., 2013; Filiatrault-Veilleux et al., 2016). For example, in a recent intervention study with children with DLD, coding the quality of responses revealed that most children progressively reached the expected/correct target (Desmarais et al., 2013).

We propose an assess-not-assume approach, as indicated by the variability observed within groups that highlights the need to not assume based on diagnosis and language level, nor to take a waiting-to-fail approach to narrative intervention for young children on the autism spectrum. The current study demonstrates how oral narrative comprehension can be assessed in young school-age children who are at high risk of future reading comprehension difficulties, providing an opportunity for early targeted intervention (see also van Kleeck, 2008). Until further research is conducted into the effectiveness of inferential narrative comprehension for young school-age children on the autism spectrum, we need to draw upon existing research that shows that inferential comprehension strategies can be taught through explicit instruction with 4- to 6-year-old children with language disorders (Dawes et al., 2019; Desmarais et al., 2013). Based on our current results, interventions aimed at supporting children's ability to make inferences about underlying thoughts and emotions, and predict the actions of other people or characters, for example during shared book reading, may be well suited to promote their inferential narrative comprehension and ToM abilities (Symons et al., 2005). This may also include making mental states tangible

through the use of thought bubbles to teach children to answer questions about mental states (Paynter et al., 2013). Further research on the interplay between structural language, ToM, and inferential comprehension and their links to reading development may provide an evidence-based framework for understanding the profiles of strengths and needs for students on the spectrum to support skills into the future.

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

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Appendix A— Categorization of the narrative comprehension questions.

		Type of question		Inferential question subtypes	
Comprehension questions		Factual/literal	Inferential	Internal response	Other
1	Who is the story about?	✓			
2	Why did Ana have to stay at home?		✓		✓
3	Why did Ana get bored?		✓	✓	
4	Where did Ana go to find her parents?		✓		✓
5	Why did Ana get scared?		✓	✓	
6	Who found Ana?	✓			
7	What did the policeman do?	✓			
8	Why were Ana's parents happy to see her?		✓	✓	

Appendix B— Four categories of quality of responses, examples of responses and scores.[a]

	Low	Quality of response continuum ⟶		High
Category	D—inadequate or off topic	C—low contingency	B—incomplete	A—expected
Definition	Unrelated to the question or no response	Contains information that is not relevant to the question	Potential justification; may be imprecise or incomplete	Most frequent and contingent response
1. "Who is the story about?"	Goodbye.	The brother.	The girl.	Ana.
2. "Why did Ana have to stay at home?"	He is not allowed to go home.	Because she wanted somebody to play with.	Her mum and dad told her to.	Because she was sick all week.
3."Why did Ana get bored?"	Because she opened the front door.	Because she is not happy at all.	Because she could not do anything.	Because her brother was not playing with her.
4."Where did Ana go to find her parents?"	This is my birthday.	Find the police.	Down the street.	At the beach.
5. "Why did Ana get scared?"	Because she was bored.	She did not like the outside.	She was scared at night.	She could not find her parents.
6. "Who found Ana?"	She can go to the supermarket.	The brother.	Mum and dad.	The police.
7. "What did the policeman do?"	A ship.	He tapped her on the shoulder.	Bring her back.	Took her back home.
8. "Why were Ana's parents happy to see her?"	Because they were happy.	Because they love her.	Because she was back.	Because they thought they had lost her.
Score	0	1	2	3

[a]Based on Filiatrault-Veilleux et al. (2016).