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RESEARCH REPORT

Comparing narrative storytelling ability in individuals with autism and fetal alcohol spectrum disorders

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Abstract

Background: Narrative discourse, or storytelling, is used in daily conversation and requires higher-level language and social communication skills that are not always captured by standardised assessments of language. Many autistic individuals and individuals with fetal alcohol spectrum disorders (FASD) have difficulties with both social communication and language skills, and narrative discourse analysis offers an ecologically relevant approach to assessing those challenges.

Aims: This study investigated narrative discourse in individuals with autism and FASD, as well as an age- and sex-matched comparison group.

Methods and Procedures: Narratives from 45 adolescents and adults, 11 with autism, 11 with FASD and 23 age- and sex-matched comparison participants were elicited using a wordless storybook. They were then transcribed orthographically, formatted to the Systematic Analyses of Language Transcript (SALT) convention and scored based on the SALT Narrative Scoring Scheme (NSS), a standardised language analysis protocol. In addition to the NSS total score, which assesses the overall structure and cohesion of the narratives produced, local and global measures of language ability were also employed. The local language measures included the number of mental state and temporal relation terms produced, while the global language measures included mean length of utterance, total different words, total words, total utterances, rate of speech, the number of mazes (e.g., repetitions, 'um', 'uh' or self-corrections) per total word and the NSS total score.

Outcomes and Results: Using the SALT *Language Sample Analysis* tool, our results revealed that on global language measures, group differences were found on rate of speech, number of mazes per total words and the description of conflict/resolution in the narratives produced. The autism group produced significantly more mazes per total word and scored higher on the NSS conflict/resolution category score compared to the FASD and comparison groups. Both the autism and FASD groups spoke at a lower rate than the comparison group. On local language measures of narrative production, all groups were comparable, on average.

Conclusions and Implications: While many aspects of narrative discourse in the autism and FASD groups were similar to each other and to the comparison group, we observed group differences on global measures of narrative production and significant individual variability within groups, suggesting that narrative abilities considered at an individual level may provide important clinical information for intervention planning. Future research should also consider additional variables that influence narrative discourse, such as motivation, distractibility or decision-making of individual participants.

KEYWORDS
autism, FASD, language ability, narrative ability, narrative storytelling

What this paper adds

What is already known on the subject

- Narrative discourse, or storytelling, is used in daily conversational interactions and reveals higher-level language skills that may not be well captured by standardised assessments of language. Many autistic individuals and individuals with fetal alcohol spectrum disorders (FASD) show difficulty with pragmatic and expressive language skills.

What this paper adds to existing knowledge

- We found that many aspects of the narratives produced by the adolescents/young adults in the autism and FASD groups were comparable to each other and to the neurotypical group. However, the groups differed on three global measures of narrative production: rate of speech, number of mazes per total words and the description of conflict/resolution in the narratives produced. Also, significant variability was observed within groups, suggesting that narrative abilities should be considered at an individual level as opposed to their clinical groups.

What are the potential or actual clinical implications of this work?

- This study showed that narrative discourse is an appropriate task that can be added to routine clinical assessments of language abilities in autistic adolescents/young adults as well as those with FASD or typical development and has the potential to reveal higher-level, real-world language skills. An important clinical implication of this study is that narrative language abilities should be considered at an individual level and individual-tailored interventions based on ability level due to the variability observed across individuals.

INTRODUCTION

Narrative discourse, or storytelling, is a form of communication aimed at constructing a shared experience between the storyteller and listeners. As such, it is important for making social-emotional connections with others, for sharing personal perspectives and interests, and for building a common ground of shared knowledge in a

social network. Successfully constructing these shared experiences requires speakers to have adequate language and social communication skills. As a result, narrative discourse is often challenging for neurodiverse individuals who have impairment in social communication and language, such as those with autism (e.g., Barnes & Baron-Cohen, 2012; Colle et al., 2008; Losh & Gordon, 2014) and fetal alcohol spectrum disorders (FASD; Coggins et al., 2007; Ganthous et al., 2017).

Autism is characterised by persistent deficits in social communication functioning accompanied by restricted, repetitive patterns of behaviour, interests or activities (American Psychiatric Association, 2013) and language impairment affects up to 63% of autistic individuals (Levy et al., 2010). It is estimated that 1 in 100 people around the world are diagnosed with autism with variability across sociodemographic groups (Zeidan et al., 2022). In the United States, the prevalence is estimated to be 1 in 36 children (Maenner et al., 2023).

Fetal Alcohol Syndrome (FAS) is a permanent birth defect caused by exposure to the teratogen ethyl alcohol during pregnancy. FAS is characterised by significant central nervous system (CNS) abnormalities, growth deficiency and a unique cluster of three minor facial anomalies—small eyes, thin upper lip and a flat philtrum (Astley, 2004). Most children impaired by prenatal alcohol exposure will not receive a diagnosis of FAS (Astley, 2010) and will instead receive a diagnosis of one of a variety of FASD diagnoses with FAS representing the most severe end of this spectrum. If the degree of CNS dysfunction is used to characterise FASD diagnoses, the term 'Static Encephalopathy, Alcohol Exposed (SE/AE)',—can be used to indicate a significant CNS dysfunction in the context of prenatal alcohol exposure, and the term 'Neurobehavioural Disorder, Alcohol Exposed (NB/AE)'—to indicate a mild-to-moderate CNS dysfunction in the context of prenatal alcohol exposure (Astley, 2004; see also Cook et al., 2016; Hoyme et al., 2016 for examples of other diagnostic nomenclature designed to capture the range of disorders falling under the umbrella of FASD). According to Lange et al.' meta-analysis of 24 unique studies (2017), approximately 8 in 1000 children and youth in the general population worldwide have FASD. In the United States, an estimated 1%–5% of the population have FASD (Center for Disease Control and Prevention, 2023). Past studies of FASD have shown difficulty with both expressive and receptive language skills (Aragón et al., 2008; McGee et al., 2009). Indeed, language impairment is one of the more commonly reported outcomes in FASD. For example, Hemingway et al. (2019) found that among 402 individuals with FASD 6 years of age and older, more than three-quarters of individuals with more severe FASD diagnoses (FAS and static encephalopathy) and a quarter of individuals with milder diagnoses (neurobehavioural disorder) presented with significant impairment in language. Many individuals with FASD also struggle with social communication and interpersonal communication (Coggins et al., 2003; Terband et al., 2018; Thorne & Coggins, 2016).

Social communication is typically measured through two approaches: standardised assessment of language use for social purposes (e.g., Test of Pragmatic Language; Phelps-Terasaki & Phelps-Gunn, 2007) and parent/caregiver report. However, prior studies have identified limitations with these assessment methods such as difficulty in using standardised testing for children with autism due to lack of motivation (Koegel et al., 1997) or the presence of bias in caregivers' reports of the child's language (Tomasello & Mervis, 1994). Thus, narrative discourse offers an ecologically valid method of assessing real-world language skills and social communication in autistic individuals (e.g., Levinson et al., 2020) and individuals with FASD (e.g., Proven et al., 2014; Thorne, 2017).

Narrative abilities in autistic individuals

Past studies of language abilities in autistic individuals show that the use of natural language samples provides additional information beyond standardised language assessments (Barokova & Tager-Flusberg, 2020; Charman, 2004; King & Palikara, 2018; Manolitsi & Botting, 2011; Peristeri et al., 2017; Tager-Flusberg et al., 2009). For instance, Manolisi and Botting (2011) found that although autistic children did not show expressive language deficits on standardised tests, narrative assessment revealed difficulty with storytelling and referencing. King and Palikara (2018) further note that despite the fact that many autistic adolescents may score within the average range on standardised assessments, difficulty with higher-level language skills may not be revealed by these assessments. Similarly, as standardised testing often misses important differences that are evident in naturalistic settings, Lee et al. (2018) found the use of computational linguistics in analysing narrative skills to be effective in distinguishing adolescents and adults with autism from comparison participants without autism.

In past studies of narrative discourse, autistic individuals were found to produce shorter and less complex sentences and stories (Banney et al., 2015; Eigsti et al., 2007; King et al., 2014; Tager-Flusberg & Sullivan, 1995), score lower on local language measures by

producing fewer personal pronouns, temporal expressions, referential expressions (Colle et al., 2008; King et al., 2014; Novogrodsky, 2013), mental states and causal statements (Siller et al., 2014; Tager-Flusberg & Sullivan, 1995). Some autistic individuals were also found to produce stories that were biased toward local details (Barnes & Baron-Cohen, 2012). For example, during a narrative task describing a film, autistic participants were more likely to describe the details in a visual scene, such as a computer in the background instead of the overall setting such as a hospital or an office building, as was typically described by the control group (Barnes & Baron-Cohen, 2012). These global details are needed to capture the 'big picture' of the story, which provides meaningful answers to each story element. Thus, autistic individuals may provide details about the setting or characters but may leave out significant information that helps a listener glean meaning from the information (Barnes & Baron-Cohen, 2012).

However, there are still many aspects of narrative abilities in autistic individuals that are not well understood due to inconsistent findings in past literature. Past research has mostly focused on autistic children and adolescents with fewer studies conducted in adults (e.g., Colle et al., 2008; Geelhand et al., 2020; McCabe et al., 2013). Furthermore, many past studies on narrative discourse have included heterogeneous samples, including autistic individuals across a wide range of age, intellectual and/or language abilities. There have been several reports that when groups are matched on age and cognitive abilities, fewer differences between narratives produced by autistic individuals and neurotypical comparisons are observed (e.g., Colle et al., 2008; Diehl et al., 2006; Losh & Capps, 2003; Losh & Gordon, 2014; Tager-Flusberg & Sullivan, 1995). Moreover, while some past literature reports shorter and less complex narratives (Banney et al., 2015; Tager-Flusberg, 1995), other studies find that the narratives produced by autistic individuals are comparable to comparison participants (Losh & Capps, 2003; McCabe et al., 2013; Sah & Torng, 2015). Similarly, while some past studies report that narratives produced by autistic individuals have fewer cohesive devices (Hilvert et al., 2016), others found minimal to no differences in cohesion compared to a matched control group (Kauschke et al., 2016). Colle et al. (2008) found that pragmatic skills in highly verbal autistic adults did not differ from age-, sex- and IQ-matched comparison groups; however, a narrative discourse task revealed specific challenges in autistic individuals such as using fewer personal pronouns, temporal expressions and referential expressions. Many of these previous studies; however, had small sample sizes and differences in how the study participants were matched to the autistic group, which further complicates the picture (Harvey et al., 2023).

Narrative abilities in individuals with fetal alcohol spectrum disorders

Although there are comparatively more studies on narrative discourse in autistic individuals, several studies have similarly explored the utility of narrative discourse as a language assessment method in individuals with FASD (e.g., Thorne, 2017; Thorne et al., 2007; Vega-Rodríguez et al., 2020). Thorne et al. (2007) analysed stories produced by children 8–11 years of age with FASD for semantic elaboration and reference strategy and found that the rate of ambiguous nominal reference was a marker that distinguished children with FASD from age-matched children without FASD. This finding indicated that errors in referential cohesion, which refers to the failure to introduce and maintain references in an organised way that allows the listener to recognise references and follow the story, may be harder for neurodiverse individuals. In addition to referential cohesion, a study by Ganthous et al. (2017) found difficulties with both global and local measures of narratives, including managing structural elements of the story as well as the ability to use diverse vocabulary, to produce appropriately complex sentences. Difficulty avoiding grammatical errors during narrative production may also be common in FASD (Thorne, 2017).

Present study

Since prior studies have noted difficulties in language and social communication for both individuals with FASD and autism (Bishop et al., 2007; Stevens et al., 2013), the approach taken in the current study is to compare the narrative discourse of adolescents and adults across the two groups, as well as an age- and sex-matched comparison group, to better understand the relationship between narrative discourse and language ability across these three groups. With the limited number of studies available, there is a need for more research on narrative discourse in individuals with FASD. Moreover, while there are numerous studies demonstrating difficulty producing cohesive narratives in autistic children, fewer have included adolescents or adults (Beaumont & Newcombe, 2006; Colle et al., 2008; Geelhand et al., 2020). Thus, the specific goal of the present study is to characterise the similarities and differences in the narrative discourse between adolescents and adults from autism, FASD, and neurotypical groups.

We adopted the *Systemic Analysis of Language Transcript* (SALT) convention for the narrative analysis (Miller & Iglesias, 2020) and the Narrative Scoring Scheme (NSS). The NSS total score is meant to serve as an overall assessment of an individual's ability to produce a structurally sound and coherent narrative with a scoring rubric of

seven categories: introduction, character development, mental states, referencing, conflict/resolution, cohesion and conclusion (see Methods section for further details). The SALT software and language analysis approach standardises the process of transcribing and analysing language samples, allowing for comparison to past studies. Besides the NSS total score, SALT includes two categories of measures: local and global. The local aspect of a narrative demonstrates the speaker's ability to integrate and form cohesive connections at the utterance level (within and across sentences) while the global aspects of a narrative demonstrate the speaker's general facility with language across the length of the narrative. Following SALT conventions, the local measures employed in this study include the use of temporal relation and mental state words. The global measures include the mean length of utterance, semantic measures of the number of used word roots, length of narrative (total words), the total number of utterances produced, rate of speech, mazes per total words as well the NSS total score for each story (Miller & Iglesias, 2020). All variables were measured using SALT's built-in tool—*Language Sample Analysis*, that provided a quick and accessible process for transcribing, coding and analysing the language samples. With detailed protocols, minimal coding and utilising computer analyses, SALT standardised the process of analysing language samples, thus giving consistent and reliable measures of narrative language (see Miller et al., 2015).

The overarching question addressed in this study is whether there are differences in the local and global structure of narratives produced by participants in the autism, FASD and comparison groups. Using a matched pairs research design in combination with random and opportunity sampling techniques to recruit age- and sex-matched comparison participants to the autism and FASD group, we asked the following questions:

> **Question 1**: Are there group differences between local structure variables? To address this question, we quantified the number of temporal relations and mental states produced and compared them across autism, FASD, and comparison groups. Based on findings from prior studies, we hypothesised that participants with autism and FASD would perform worse on the local measures in comparison to the group. We further hypothesised that the FASD group would score higher on the local measures than the autism group.

> **Question 2**. Are there group differences between global structure variables? To address this question, we quantified the global features, including mean length of utterance, total different words, total words, total utterances, rate of speech, number of mazes (e.g., repetitions, 'um', 'uh' or self-corrections) per total words and NSS total score and compared across autism, FASD and comparison groups. Despite the inconsistent findings from the literature, based on studies that reported comparable narrative ability of global structures, we hypothesised that participants with autism and FASD would perform similarly on all measures to the neurotypical comparison group.

> **Question 3**. What is the relationship between local and global features of narratives produced? To address this question, we assessed the relationship between each local and global feature.

> **Question 4**. What is the relationship between global features? To address this question, we assessed the relationship between each global feature.

METHODS

Participants

Forty-six individuals participated in the study from three groups: individuals with autism ($n = 12$), individuals with FASD ($n = 11$) and a comparison group ($n = 23$) that were age- and sex- matched to autism and FASD groups (see Table 1 for breakdown of demographic information by groups). Data from one autistic participant was not usable due to poor audio recording quality, resulting in 11 autistic participants being included in the narrative analysis.

Autism group

Twelve participants diagnosed with autism were recruited from a larger longitudinal study of preschool and early school age development conducted at a large university. The original cohort consisted of 72 autistic children initially recruited between 3 and 4 years of age via advertisements in the local community including parent groups, hospital clinics, the University of Washington Autism Center and the University of Washington Infant and Child

TABLE 1 Sample demographic information of autism, FASD and comparison groups.

	Autism	FASD	Comparison
n	11	11	23
Sex			
Female	4 (36%)	6 (55%)	11 (48%)
Male	7 (64%)	5 (45%)	12 (52%)
Age, years			
Mean	21.66	20.60	21.72
Range	20.9-23.16	13.69-47.07	13.16-45.39
SD	0.64	9.86	6.00
Ethnicity			
Not Hispanic or Latino	9 (82%)	8 (73%)	22 (100%)
Hispanic or Latino	1 (9%)	2 (27%)	0
Other/NA	1 (9%)	0	0
Race			
White	7 (64%)	4 (36%)	18 (78%)
Asian	0	0	2 (9%)
Native Hawaiian/Pacific Islander	1 (9%)	0	0
American Indian/Alaskan Native	0	4 (36%)	0
Black or African American	0	2 (27%)	0
More than one race	3 (27%)	0	2 (9%)

Abbreviation: FASD, fetal alcohol spectrum disorders.

Subject Pool (see Dawson et al., 2004 for more details). Diagnoses of autism, according to criteria from the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994), were made at 3 years of age by a licensed clinical psychologist or supervised graduate student using: (1) the Autism Diagnostic Interview-Revised (Lord et al., 1994), (2) the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al., 2000), (3) medical and family history, (4) cognitive test scores and (5) clinical observation and judgement (see Dawson et al., 2004; Emmons et al., 2021 for further details). These participants were evaluated again at 6, 9 and 13–15 years of age. Specific inclusion criteria for this present study included passing an audiometric screening for clinically normal hearing thresholds, being able to speak in three-word phrases, IQ > 80 and having no other health or developmental concerns. Normal hearing is an important criterion since autistic individuals have a higher incidence of hearing loss (e.g., Rosenhall et al., 1999; Szymanski et al., 2012), which could also affect language abilities. Forty-six participants from the original cohort were re-contacted and invited to participate in this current study. The remaining 26 were not contacted because they had been randomly recruited for another study. Of the 46 participants contacted, four had moved out of state, two were not interested in participating, one could not be scheduled, 25 did not respond to phone calls or emails and two did not meet our eligibility criteria of being able to speak in three-word phrases. Twelve autistic participants from the original cohort were enrolled in this study and tested at ages 21–23 years of age (see Table 1 for sample demographic information).

FASD group

Eleven participants diagnosed with FASD were recruited from the Washington State Fetal Alcohol Syndrome Diagnostic & Prevention Network, a database of individuals who have received assessments for FASD. Prenatal alcohol exposure was confirmed through (1) direct observation of drinking, (2) lab tests (blood alcohol) during pregnancy or delivery or (3) full face of FAS. During routine clinic visits, participants were provided with information about the current research study and given the option to participate, if interested. All participants were diagnosed using the FASD 4-Digit Diagnostic Code, which is an interdisciplinary approach to diagnose the full spectrum of outcomes guided by the magnitude of expression of the four features of FAS: growth deficiency, FAS facial phenotype, CNS structural/functional abnormalities and prenatal alcohol exposure (Astley, 2004; see McLaughlin et al., 2019 for more details). There are four diagnoses that fall under the umbrella of FASD: FAS, Partial FAS (PFAS), SE/AE, ND/AE. No participants in the FASD group received an ADOS autism classification. As with

the autism group, inclusion criteria for the FASD group included passing an audiometric screening for clinically normal hearing thresholds, being able to speak in three-word phrases, IQ > 80 and having no other health or developmental concerns. Ten of 11 FASD participants were adolescents and adults between the ages of 13 and 23; however, one 47-year-old female was also included in the study. The FASD group included two individuals with FAS, one with SE/AE and eight with ND/AE.

Comparison group

The comparison group consisted of 23 participants, who were recruited through flyers distributed around the university and the greater Seattle community. For each participant in the autism and FASD group, one age- and sex-matched participant was recruited as a pair-matched comparison participant. Age matching in comparison participants was ±1 year with one exception: a 47-year-old participant in the FASD group was matched to a 45-year-old comparison individual. Participants were also matched on sex to reflect the higher incidence of males with a diagnosis of ASD (Maenner et al., 2023). Comparison group participants all reported no history of cognitive, developmental or other health concerns. Two participants in the comparison group had a diagnosis of attention-deficit/hyperactivity disorder (ADHD) but were included because there were individuals with ADHD in both the autism and FASD groups. No participants in the comparison groups received an ADOS autism classification.

Procedure

The following measures were obtained over the course of several visits and as part of a larger study that included additional neurophysiological and behavioural measures. Written informed consent was obtained from all participants or their legally authorized representative for participants under 16 years of age. All methods were performed in accordance with protocols reviewed and approved by the Institutional Review Board at the University of Washington where the research was conducted. Participants were provided with monetary compensation for their time.

ADOS-2

The ADOS-2 (Lord et al., 2012), a measure of autism symptom severity, was administered to all participants at the time of testing to confirm autistic status in all participant groups. All participants in the autism group received an ADOS classification of autism. No participants in the comparison or FASD groups received an ADOS autism classification.

WASI-II

The Wechsler Abbreviated Scale of Intelligence—Second Edition (WASI-II; Wechsler, 2011), a measure of intellectual ability, was administered to all participants. Four subtests: Block Design, Vocabulary, Matrix Reasoning and Similarities, were administered to compute the WASI-II Full Scale Intelligence Quotient-4 for each participant and provide an overall estimate of intellectual functioning. The Verbal Composite Index score was computed from the Vocabulary and Similarities subtests and the Perceptual Reasoning Index scores were computed from the Block Design and Matrix Reasoning subtests (see Table 2 for score breakdown).

Auditory screening

To ensure clinically normal hearing thresholds in all participants, each participant was required to pass an audiometric screen (≤20 dB hearing level at octave frequencies between 500 and 8000 Hz), a distortion product otoacoustic emission screen, and an auditory brainstem response screen.

Elicitation of narratives

The 24-page wordless book, *Frog, Where Are You?* (Mayer, 1969), was used to elicit narrative language samples. This story has been used in previous research with both children and adults (Colle et al., 2008) and does not require any prior descriptions or specific prompts from the examiner. This wordless picture book requires the narrator to connect and organise different actions from the protagonists and events into a coherent story, providing a measure of temporal expressions. Because the story does not provide verbal cues, the participants have the freedom to explore the characters' inner states by taking the perspective of the characters and communicating them to the listener. The story is about a young boy and his dog in search of his lost pet frog. The protagonists' search involves numerous events and encounters with secondary characters. Throughout the story, the two characters engage with these secondary characters in developing the story to finally find the lost pet frog.

Each participant was assessed individually, and each narration was audio recorded for transcription and

TABLE 2 Sample characteristics: WASI-II score, story length by autism, FASD and comparison groups.

		Autism	FASD	Comparison
WASI-II FSIQ-4	*M*	102.36	97.00	119.91
	SD	(14.33)	(19.89)	(6.30)
WASI-II VCI	*M*	98.27	98.70	116.05
	SD	(23.44)	(19.56)	(8.25)
WASI-II PRI	*M*	104.91	95.50	119.09
	SD	(8.99)	(17.49)	(9.34)
Story length	Range	0:49–5:02	1:45–4:59	0:57–2:59
(min:s)	*M*	3.07	2.74	1.80

Abbreviations: FASD, fetal alcohol spectrum disorders; FSIQ-4, Full Scale Intelligence Quotient-4; PRI, Perceptual Reasoning Index; VCI, Verbal Composite Index; WASI-II, Wechsler Abbreviated Scale of Intelligence–Second Edition.

analysis. Participants were presented with a copy of the wordless book *Frog, Where Are You*? A divider was placed between the examiner and the participant so that the examiner was unable to see the pictures in the book while the participant was telling the story. The examiner instructed the participants to review the pictures in the book to become more familiar with the story and then they were asked to use the pictures as a visual prompt to tell the best story that they could. After the participant looked through the book, the examiner confirmed that they were ready and had them turn back to the first page of the book to start recording the story. The participant went through each page of the book and told the story without any prompts provided. The examiner did not intervene during the narration. However, when necessary, the examiner was permitted to provide a verbal prompt to help the participant get started (e.g., 'I will help you get started, once upon a time there was . . . ') or encourage the participant throughout the storytelling (e.g., 'What happened next?'). This procedure ensured that the participants did not memorise the story and emphasised the storytellers' ability to anticipate the listener's informational needs. After the participants finished telling the story, the examiner stopped the recording and praised the participants for their storytelling skills.

Transcription of narratives

Narratives were transcribed orthographically and formatted according to SALT conventions. Transcripts were segmented into *Communication units* (C-units). A C-unit is an independent clause with its modifiers, which includes one main clause with all subordinate clauses attached to it (Miller & Iglesias, 2020). As subordinate clauses depend on the main clause to make sense, they cannot be separated from the main clause, whereas the main clause can stand alone and can be segmented into C-units. Mazes, such as filled pauses, repetitions and revisions, along with unintelligible utterances, and irrelevant comments were marked and included in the transcription. Using SALT software (Miller & Iglesias, 2020), the transcribed narratives, including the C-units and marked mazes, were later used to analyse structural language properties of the transcription including mean length of utterance, total utterances, total different word roots, total words, rate of speech, mazes (e.g., word repetitions or 'um', 'uh') per total words and the overall NSS total score. Details of the transcription can be found on the SALT Training Website (Salt Software, n.d.).

Coding of narratives

The transcribed narratives were entered into the SALT software (Miller & Iglesias, 2020), which aids the process of analysing words, morphemes, utterances and discourse, and were used to code and analyse structural language properties. Codes from SALT was used to calculate the mean length of utterance, total utterances, total different word roots, total words, rate of speech, mazes (e.g., word repetitions or 'um', 'uh') per total words and the overall NSS total score. Additional codes were created to measure the use of mental state and temporal relation words. Two coders were trained on transcription and SALT coding, including the NSS total score and the identification of mental state and temporal relation words using two separate training stories. They were required to achieve over 80% agreement for both transcription and coding with a third experienced coder on the training stories before moving on to the actual data set.

Temporal Relations. The total number of temporal expression terms, excluding mazes, were counted to assess if participants with autism and FASD could organise events in sequential order. Temporal relation terms included temporal adverbs and conjunctions such as 'last night', 'yesterday', 'now' and 'meanwhile'.

Mental States. The total number of mental state terms, excluding mazes, were counted, which included the emotional state of a character in the story (e.g., 'The boy

is *angry* at the dog') and any reference to a mental state, including emphasising the character to explore their inner thoughts, beliefs, intentions (e.g., 'The boy *thought* the frog ran away').

NSS Score. Each of the narrative stories was then coded using the NSS total score as described in the SALT Training Website (n.d.). The NSS total score assesses the individual's ability to produce a structurally sound and coherent narrative. The scoring guideline included many features of story grammar including cohesiveness, connection of story events, consideration for characters' thoughts and behaviours and referencing. Each story was graded on a rubric of seven categories with a grading scale of 0–5: introduction, character development, mental states, referencing, conflict/resolution, cohesion and conclusion. Categories that could not be scored received a score of zero or N/A. Scores of zero were given for the target speaker errors (e.g., not following the protocols or telling the wrong story), and a mark of non-applicable (N/A) was given for the examiner errors (e.g., interference with the speaker's story or recording issues). For each section, a score of 1 indicated minimal/immature performance, a score of 3 indicated emerging skills and the highest score of 5 indicated proficient characteristics. Scores of 2 and 4 were undefined and given based on the examiner's judgment with justification. The scores for each section were then combined to give a total narrative score with the highest possible score of 35. For more details on scoring and guidance using the NSS, see the SALT training website (n.d.).

Interrater agreement

To ensure the reliability of the data, a systematic process of transcription and scoring was designed to prepare all narratives from recorded sourced files by two researchers. The secondary researcher was not informed of the group identity or diagnosis of the narrator. Interrater reliability was calculated for all measures with 93% agreement on words and 89% agreement on C-units in terms of transcription and 96% agreement on all categories of the NSS total score. Percent agreement on words and C-units was calculated based on the number of differences in terms of the numbers of words and C-units. Percent agreement on the NSS total score was determined for each of the seven category scores independently. In each category, the score had to be within ±1 point for the primary and secondary coders to be considered in agreement. The percent agreement between the primary and secondary coder was high across categories; introduction: 93%, character development: 98%, mental states: 96%, referencing: 91%, conflict/resolution: 100%, cohesion: 100% and conclusion: 96%. Since a high percent agreement was achieved, the scores determined by the secondary coder were used to avoid the first coder's biases, who is an author on the manuscript.

Statistical analysis

Pair matching was conducted during the recruitment of the comparison group participants to achieve a balance in age and sex between the study groups. A two-tailed Fisher's exact test revealed a reasonably balanced gender profile across groups ($p = 0.53$; see Table 1 for more details). A Kruskal–Willis test, used due to unequal variance between the groups, revealed no significant difference in the age distribution across groups ($c^2 = 2.29$, $df = 2$, $p = 0.32$; see Table 1 for more details). Thus, this pair matching was not maintained in the statistical analyses because preliminary analyses conducted detected no significant group differences in age or gender.

All analyses were conducted using the same sample size ($N = 46$; autism, $n = 11$; FASD, $n = 11$; comparison, $n = 23$. To test the main hypothesis of whether there were differences in the local and global structure of narratives produced, a one-way analysis of variance (ANOVA) was used to test for statistical differences between the means across all the groups. To assess the relationship between local and global variables, Pearson correlation coefficient (Pearson's r) was used to measure the strength of the linear relationship between the number of temporal relation words produced as well as between mental state words produced and other global measures. Finally, Pearson's r was also used to investigate the relationship between different global measures of the narratives.

RESULTS

Local measures across groups

To address our first research question, Table 3 shows the means and standard deviations for the two measures of local abilities, temporal relation words and mental state words. A one-way ANOVA revealed no statistically significant group differences in the number of mental state words produced (Figure 1b; one-way ANOVA, $F(2,42) = 0.54$, $p = 0.59$, $\eta^2 = 0.02$) or temporal relation words produced (Figure 1a; one-way ANOVA, $F(2,42) = 1.85$, $p = 0.17$, $\eta^2 = 0.08$).

Global measures across groups

Table 4 presents the means and standard deviations for five measures of global abilities including total words produced, rate of speech, number of mazes produced per total words, number of different words produced, mean

TABLE 3 Local measures raw scores: Means, SDs, and one-way ANOVA comparisons between autism, FASD and comparison groups.

Local measures	Autism		FASD		Comparison		$F(2,42)$	η^2
	M	*SD*	*M*	*SD*	*M*	*SD*		
1. Temporal relation words	11.50	7.28	8.09	3.33	8.13	4.30	1.85	0.08
2. Mental state words	6.82	2.71	5.46	3.27	5.83	3.46	0.54	0.02

Abbreviations: ANOVA, analysis of variance; FASD, fetal alcohol spectrum disorders.

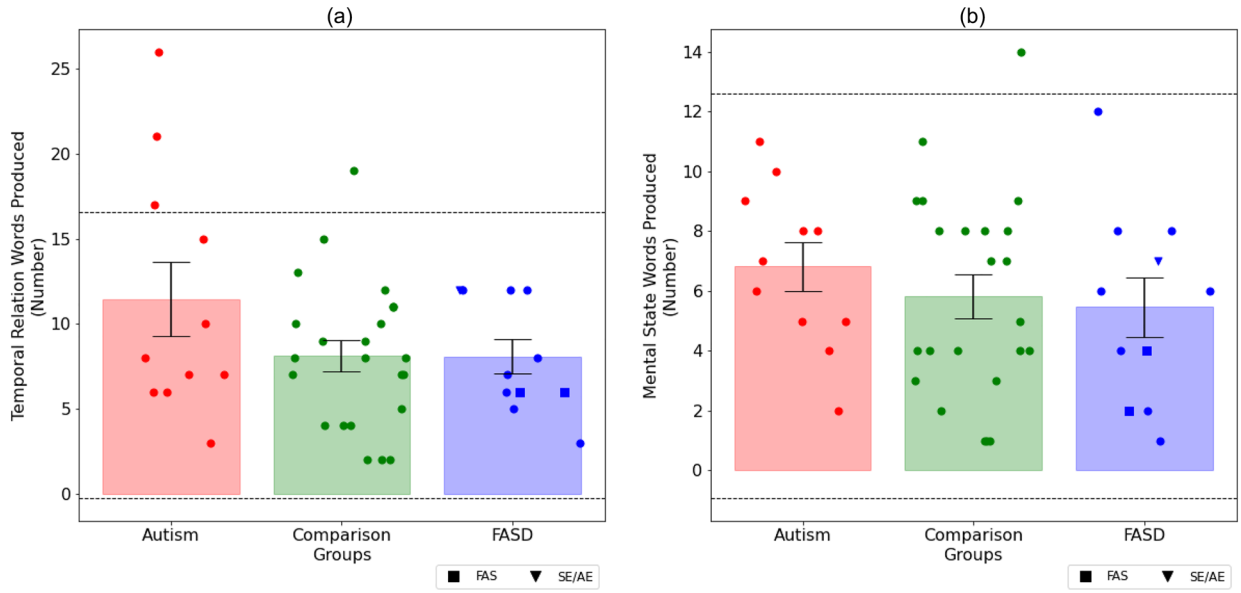

FIGURE 1 Local measures, temporal relation words (a) and mental state words (b), as a function of participant group. Mean ± SE shown with bars. Individual data points shown with solid circles. Dotted lines show ±2 SD of the Comparison group mean as reference. Square marker shows participants with Fetal Alcohol Syndrome (FAS) and triangle marker shows participants with Static Encephalopathy, Alcohol Exposed (SE/AE). No group differences were observed for the number of temporal relation and mental state words produced. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 4 Global measures raw scores: Means, SDs, and one-way ANOVA comparisons between autism, FASD and comparison groups.

Global measures	Autism		FASD		Comparison		$F(2,42)$	η^2
	M	*SD*	*M*	*SD*	*M*	*SD*		
1. Total words with mazes	381.55	125.67	314.09	124.15	283.91	97.31	2.86	0.12
2. Words/minute	128.90	23.07	115.19	28.24	159.04	20.43	15.35**	0.42
3. Mazes/total words	0.12	0.08	0.06	0.05	0.04	0.03	8.82**	0.30
4. Total different words	119.91	31.04	106.55	27.03	104.57	26.42	1.19	0.05
5. Mean length of utterances	11.26	2.98	9.74	1.72	10.40	1.89	1.38	0.06
6. Total utterances	31.18	12.68	30.82	14.21	25.87	7.09	1.32	0.06
7. NSS total score	24.91	5.30	22.27	6.42	22.74	4.61	0.84	0.04
8. NSS conflict	4.09	1.38	3.09	1.38	3.00	0.85	3.68*	0.15

*$p \leq 0.05$.
**$p \leq 0.001$.
Abbreviations: ANOVA, analysis of variance; FASD, fetal alcohol spectrum disorders; NSS, Narrative Scoring Scheme.

length of utterances in words, total utterances produced and the NSS total score. A one-way ANOVA comparing each of the global measures in the autism, FASD and comparison groups revealed significant differences in the rate of speech and mazes per total words but no significant group differences in total words produced, number of different words produced, mean length of utterance or NSS total score. Of the seven categories that contribute to the

NSS total score, significant group differences were also observed for conflict/resolution,

Rate of speech. The comparison group spoke with a faster rate of speech, measured by the number of words spoken per minute, compared to the autism and FASD groups (Figure 2b). A one-way ANOVA revealed a significant difference across groups in the number of words spoken per minute (one-way ANOVA, $F(2, 42) = 15.35$, $p < 0.001$, $\eta^2 = 0.42$). Post-hoc comparisons using independent sample *t*-tests with Bonferroni correction revealed a lower rate of speech in the autism ($M = 128.90$, $SD = 23.07$) and FASD ($M = 115.19$, $SD = 28.24$) groups compared to the comparison group ($M = 159.04$, $SD = 20.43$). However, no significant difference was observed between the autism and FASD groups. Notably, four of the individuals with autism and four from the FASD group (one with FAS) spoke at a rate more than 2 SD slower than the mean of the comparison group (See Figure 2b).

Number of mazes per total words. The number of mazes produced per total words showed that the autism group produced more mazes (e.g., repetition, 'um', 'uh') compared to the FASD and comparison groups (see Figure 2c). A one-way ANOVA revealed a significant group difference in the number of mazes per total words (one-way ANOVA, $F(2,42) = 8.82$, $p < 0.001$, $\eta^2 = 0.30$). Post-hoc comparisons were conducted using independent sample *t*-tests with Bonferroni correction, which revealed a significantly higher number of mazes produced per total words in the autism group ($M = 0.12$, $SD = 0.08$) compared to the comparison group ($M = 0.04$, $SD = 0.03$) and to the FASD group ($M = 0.06$, $SD = 0.05$). However, no significant group difference was detected between the FASD and comparison groups. Notably, the autism group had a much wider variability in the maze words per total words and the mean from the autism group on this measure was more than 2 SD higher than the mean of the comparison group (See Figure 2c).

NSS conflict/resolution. To generate the NSS total score, an estimate of the overall score of whether the story is structurally sound and coherent, each story was graded on a rubric of seven categories. The NSS category score for conflict/resolution showed that the autism group scored higher compared to the FASD and comparison groups (Figure 2h). A one-way ANOVA revealed a significant group difference in the score of conflict/resolution (one-way ANOVA, $F(2,42) = 3.68$, $p = 0.03$, $\eta^2 = 0.15$). Post-hoc comparisons were conducted using independent sample *t*-tests with Bonferroni correction, which revealed a significantly higher score for conflict/resolution in the autism group ($M = 4.09$, $SD = 1.38$) compared to the comparison group ($M = 3.00$, $SD = 0.85$). However, no significant group difference was observed between the autism and FASD groups ($M = 3.09$, $SD = 1.38$) or between the FASD and comparison groups. Notably, six from the autism group and three from the FASD group received the highest possible score on this measure (i.e., a score of 5), where only one individual from the comparison group performed as well (See Figure 2h).

Relationships between local measures and global measures

To investigate the relationship between local and global measures of the narratives, Pearson correlation coefficient (Pearson's r) was used to measure the strength of the linear relationship between the number of temporal relation words produced as well as between mental state words produced and other global measures (see Table 5). This revealed a positive correlation between the NSS total score and the number of temporal relation words (Pearson's r, $r(43) = 0.38$, $p = 0.01$) and between NSS category conflict/resolution and the number of temporal relation words (Pearson's r, $r(43) = 0.49$, $p < 0.001$). The higher the overall NSS score or NSS conflict/resolution, the greater the number of temporal relation words observed. A positive correlation between NSS total score and the mental state words as well as NSS category conflict/resolution was also detected (NSS total score, Pearson's r, $r(43) = 0.63$, $p < 0.001$; NSS conflict/resolution, Pearson's r, $r(43) = 0.47$, $p < 0.001$). The higher the overall NSS score and its conflict/resolution category, the more mental state words are observed.

Relationships within global measures

To investigate the relationship between different global measures of the narratives, Pearson correlation coefficient (Pearson's r) was also used (see Table 6). A strong correlation between the number of total words produced and the number of mazes produced per total words (Pearson's r, $r(43) = 0.33$, $p = 0.03$) was observed, which indicates a higher number of mazes was observed for longer narratives. The rate of speech was also positively correlated with mean length of the utterances (Pearson's r, $r(43) = 0.36$, $p = 0.01$), which suggests that the longer the length of the utterances, the faster the rate of speech. Additionally, a strong correlation between NSS category conflict/resolution and a few other global measures were also observed, including total words with mazes (Pearson's r, $r(43) = 0.80$, $p < 0.001$), total different words (Pearson's r, $r(43) = 0.79$, $p < 0.001$), mean length of utterances (Pearson's r, $r(43) = 0.35$, $p = 0.02$), total utterances produced (Pearson's r, $r(43)$

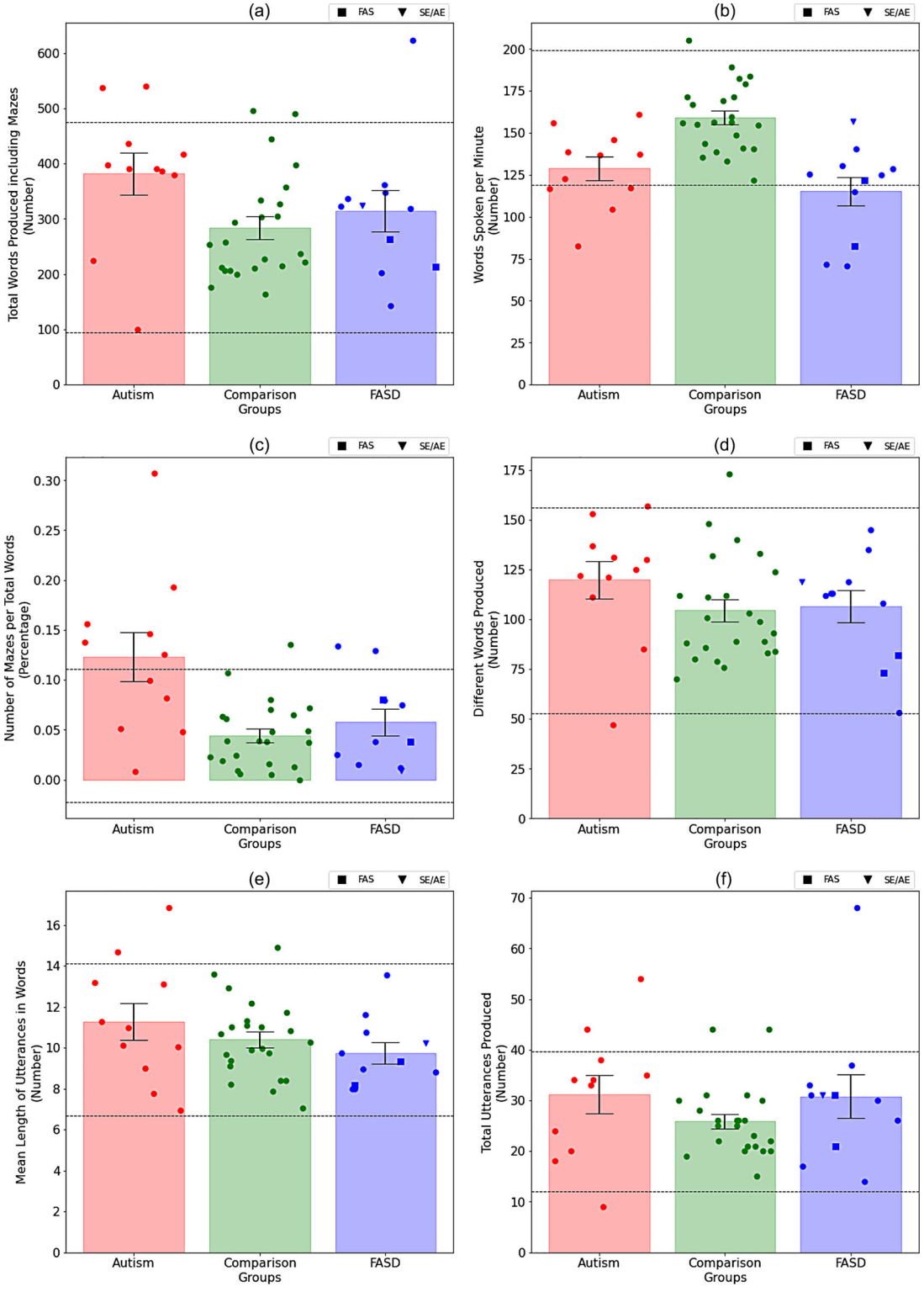

FIGURE 2 Global measures: total words produced (a), words spoken per minute (b), number of mazes per total words (c), different words produced (d), mean length of utterances in words (e), total utterances produced (f), Narrative Scoring Scheme (NSS) total score (g) and NSS conflict/resolution as a function of participant group (h). Mean ± SE shown with bars. Individual data points shown with solid circles. Dotted lines show ±2 SD of the Comparison group mean as reference except in (g) and (h). For (g) dotted lines show NSS total score normative ranges; Proficient: 35–28, Emerging: 14–21, Immature: 0–7. For (h) dotted lines show NSS total score normative ranges; Proficient: 5, Emerging: 3, Immature: 1. Square marker shows participants with Fetal Alcohol Syndrome (FAS) and triangle marker shows participants with Static Encephalopathy, Alcohol Exposed (SE/AE). Group differences were observed for words spoken per minute, number of mazes per total words and NSS category conflict/resolution. [Colour figure can be viewed at wileyonlinelibrary.com]

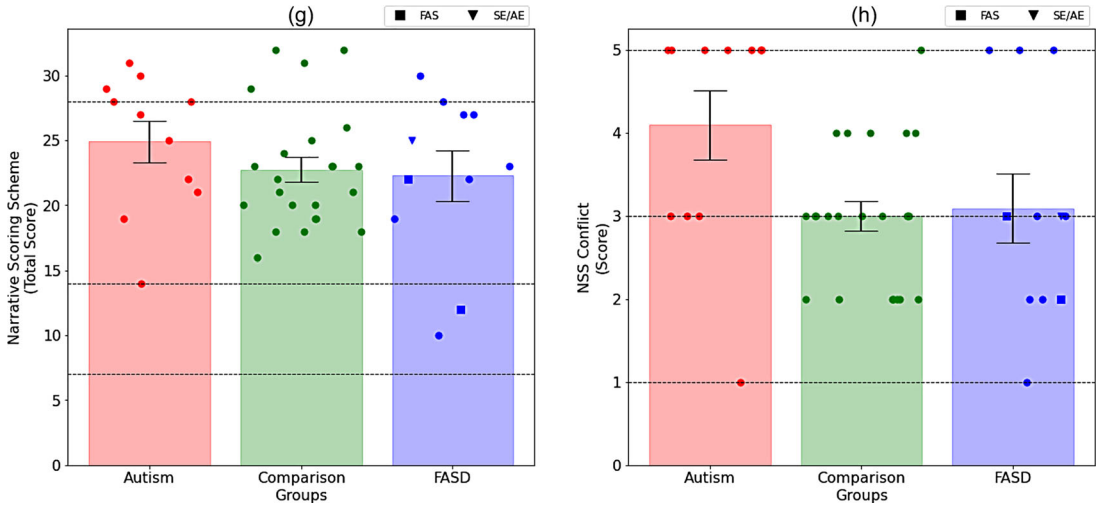

FIGURE 2 Continued

TABLE 5 Correlations between local measures and global measures.

Global variables	Local variables	
	Temporal relation	Mental state
1. Total words with mazes	0.62***	0.60***
2. Words/minute	0.10	0.21
3. Mazes/total words	0.10	0.08
4. Total different words	0.51***	0.66***
5. Mean length of utterances	0.36*	0.44**
6. Total utterances	0.38**	0.40**
7. NSS total score	0.38**	0.63***
8. NSS conflict	0.49***	0.47***

*$p \leq 0.05$.
**$p \leq 0.01$.
***$p \leq 0.001$.
Abbreviation: NSS, Narrative Scoring Scheme.

= 0.63, $p < 0.001$) and NSS total score (Pearson's r, $r(43) = 0.81$, $p < 0.001$).

DISCUSSION

In this study, we elicited narratives using a wordless picture book to investigate narrative discourse abilities in a sample of adolescent and adults with autism, FASD and an age- and sex-matched comparison group. We evaluated both local and global language features of the narratives produced and group differences were observed on three global measures: the number of mazes per total words produced, rate of speech, as well as the conflict/resolution category score that contributed to the NSS total score. Participants in the autism group produced significantly more mazes per total words compared to the FASD and comparison groups, and both the autism and FASD groups spoke at a lower rate of speech compared to the comparison group (i.e., talked slower). Participants in the autism group also scored significantly higher than the FASD and comparison group on the NSS category score for conflict/resolution. No significant group differences were found on local measures, including the number of temporal relation and mental state words produced. While our findings revealed that at the group level, many aspects of global narrative production, including the total number of words including mazes, number of different words, total number of utterances, mean length of utterances, the NSS total score in the autism and FASD groups were comparable to the comparison group, there was notable variability within each group.

The control of local and global aspects of language contributes to successful social communication and narrative discourse as the speakers are required to consider a listener's perspective to construct a cohesive narrative as they organise the story. Our results addressed the broad question: are there differences in the local and global structure

TABLE 6 Correlations between global measures.

Global variables	1	2	3	4	5	6	7
1. Total words with mazes	—						
2. Words/minute	0.04	—					
3. Mazes/total words	0.33*	−0.23	—				
4. Total different words	0.90***	0.13	0.14	—			
5. Mean length of utterances	0.37**	0.36**	0.12	0.58***	—		
6. Total utterances	0.79***	−0.15	0.13	0.60***	−0.23	—	
7. NSS total score	0.73***	0.19	−0.02	0.84***	0.53***	0.45**	—
8. NSS conflict/resolution	0.80***	0.01	0.10	0.79***	0.35*	0.63***	0.81***

*$p \leq 0.05$.
**$p \leq 0.01$.
***$p \leq 0.001$.
Abbreviation: NSS, Narrative Scoring Scheme.

of narratives produced by participants from the autism, FASD and comparison groups? Each of these findings is discussed in more details later.

Local measures

Temporal relations

At group level, there was no significant difference observed in the number of temporal relation words produced by autism, FASD and comparison groups. This finding is in contrast with Colle et al. (2008), who did find a difference between the autism and comparison groups. Additionally, we observed a positive correlation between the NSS total score as well as the NSS category conflict/resolution score and the number of temporal relation words, indicating that the more temporal relation words produced, the more coherent the story and the better the conflict and resolution. A positive correlation between the number of total words (including mazes) and the number of temporal relation words was also observed, which indicates that the number of temporal words produced was proportional to the length of the story itself but may not necessarily tell us about how participants maintained and used temporal references. Given the strong relationship between the number of temporal relation words produced and the NSS total score, the use of temporal relation words may have helped the storytellers produce a more coherent story. Thus, this finding suggests that the number of temporal relation words produced may be a good predictor for the storyteller's overall ability to produce a coherent narrative.

Mental states

Our results also did not show any significant differences at group level between the autism, FASD and comparison groups in the production of mental state words. This, however, was not what we predicted. These findings were consistent with some of the results from the narrative discourse of autistic individuals in both adults (Beaumont & Newcombe, 2006; Colle et al., 2008; Suh et al., 2014) and children (Tager-Flusberg & Sullivan, 1995). However, although Tager-Flusberg and Sullivan (1995) showed that autistic children produced a similar quantity of emotional and mental state words, they noted that autistic children were more likely to use expressions with a limited understanding of intentions and internal states of the character and less likely to take into consideration the point of view of the listener. Similarly, Beaumont and Newcombe (2006) found no differences in the number of mental state words produced, but adults with autism were less likely to provide an explanation as to why a character was thinking or feeling in a particular way compared to comparison participants. In short, these children were able to label emotions but did not fully understand the role of the mental state expressions that they used. This finding suggests that although autistic individuals may produce the same number of mental state words as the comparison group, they may show difficulty in comprehension that is not captured by the measures employed in this study.

Nevertheless, a strong correlation between the overall score of NSS as well as its category conflict/resolution and the number of mental state words produced was observed, which indicates that the use of mental state words may help aid in the production of a coherent story.

Global measures

The results showed significant group differences between autism, FASD and comparison participants on the number of mazes per total words, rate of speech and the NSS category score for conflict/resolution. The finding that autistic

individuals produced narratives with greater number of mazes per total words compared to FASD and comparison groups is consistent with past studies that found excessive production of mazes in autistic individuals (Lake et al., 2011; Suh et al., 2014). The slower rate of speech in both autism and FASD compared to the comparison group is also consistent with past studies that found a relationship between low processing speed and communication symptoms in autistic individuals (Haigh et al., 2018; Hedvall et al., 2013; Oliveras-Rentas et al., 2012) and individuals with FASD (Burden et al., 2005; Olson et al., 1998).

Additionally, higher scores on the NSS category score for conflict/resolution of the narratives observed in the autism group revealed the individuals' ability to clearly state all these critical details that help advance the plot of the story (Miller & Iglesias, 2020). These findings are not consistent with past studies that found children with autism produced globally impoverished stories compared to their comparison participants, including a lower score on NSS overall and conflict/resolution specifically (King et al., 2014; King & Palikara, 2018). In our study, participants in the autism group received higher scores compared to the FASD and comparison groups, contrary to our initial expectations.

On other aspects of the global features, the results showed that the autism and FASD groups were comparable to each other as well as the comparison group, including the length of narrative, mean length of utterances, total utterances, total different words produced and the NSS total score. The results on the number of total words produced including mazes are consistent with past studies that found a comparable length of narrative between autism and comparison group (Banney et al., 2015; Colle et al., 2008; King et al., 2014; Suh et al., 2014; Tager-Flusberg & Sullivan, 1995). The results on other measures are consistent with Reindal et al. (2021) as well as Colle et al. (2008)'s findings that autistic children had comparable structural language skills to neurotypical children such as choice of vocabulary. However, since pragmatic language difficulty was found to be more prevalent in autistic children compared to neurotypical children and is an essential component of social communication, pragmatic language skill should be examined in relation to the structural components of narrative discourse.

A particular strength of this study is the multi-group approach, which enabled us to compare the narrative discourse in individuals with autism and FASD. Such examination increases the generalisability of findings to the broader population of adults evaluated for autism and FASD since the literature on narrative discourse in FASD is still limited.

A limitation of this study is that only group-level analyses were conducted due to the small sample size. While our findings suggest strong narrative abilities for the participants in the autism and FASD groups on average in our participant sample, there was also significant variability across individuals. Such heterogeneous results suggest that language abilities need to be considered at the individual level as opposed to the diagnostic category and that our observed results may not generalise to all individuals with autism and FASD. Importantly, individual data with normative reference lines for ±2 SD of the comparison group are presented in Figures 1 and 2 so that one could consider what magnitude of contrast would be clinically meaningful for each subject across diagnostic categories, in addition to what was statistically significant at group level. For the NSS total score and the NSS Conflict/Resolution score, normative ranges were also included in Figure 2 (see figure caption for further details).

In this current study, since we expected heterogeneity in language and intellectual ability in both autism and FASD groups, we measured both verbal and non-verbal intellectual abilities using the WASI—Second Edition (see Table 2). Given the widely distributed performance in both local and global levels of narrative language production, future studies should recruit larger participant numbers and also assess their participants based on their groups' distinctive characteristics or co-occurring conditions such as shape bias in individuals with autism (Abdelaziz et al., 2018) or attention deficit in individuals with autism (Baixauli et al., 2017) and FASD (Nanson & Hiscock, 1990; Rasmussen et al., 2010). Additional variables that influence narrative discourse, such as motivation, distractibility and decision making of individual participants should also be considered.

An additional limitation of this study is that only one storytelling task was obtained, which may not reflect how each individual would perform across different settings in daily social communication situations. It is important to note that although there are aspects of narrative discourse that the participants in this sample did not show difficulty with on this particular task, they may show difficulty with other higher-level language measures. Moreover, the findings reported in this study may not generalise to other individuals with autism and FASD or even other types of narratives within the same participant. Additional tasks and analyses involving narrative discourse would provide useful comparisons between these two groups. Lastly, when context is used to support other structural components of language (e.g., providing temporal relation terms to make a smoother transition between parts of a story or using non-linguistic signals to communicate; Barokova & Tager-Flusberg, 2020), more than just spoken language is used to deliver stories. As such, future studies of narrative discourse in individuals with FASD and autism should be extended to all components of language,

including but not limited to, expressive or pragmatic language skills.

A further limitation of the study is that the majority of the FASD cases were at the moderate end of the spectrum (eight with ND/AE) while only three were at the severe end (two with FAS, one with SE/AE). If the study sample contained only those with FAS/PFAS or SE/AE, we may have identified more significant contrasts. Nonetheless, given the limited number of past studies on the narrative discourse of adolescents and adults with FASD and their shared characteristics with autism (Kippin et al., 2022; Stevens et al., 2013; Terband et al., 2018), this present investigation of narrative discourse will contribute to what we know about the language abilities of individuals with FASD. This study suggests that many aspects of the narrative discourse of individuals with autism and FASD in our particular sample are comparable to the neurotypical comparison participants and each other when considered at the group level. This includes both local and global features. With the comparatively large body of research available in autistic individuals, the results highlighting the similarities between autism and other neurodiverse populations like FASD could lead to more research that is focused on the representations of autistic characteristics in other neurological conditions (e.g., Stevens et al., 2013), and specifically its potential influence on the development of language skills.

Ultimately, the results of this study could aid in the development of clinical tools to best assess language abilities across populations. This understanding could also lead to the development of language support systems that further help individuals advance their language skills and gain self-confidence in daily social communication (Nanson & Hiscock, 1990). Taken together, this current study provided evidence that narrative assessment is an appropriate tool that can be included in routine clinical assessments of language that may reveal important aspects of higher-level language skills required in everyday real-world conversational interactions.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interests.

DATA AVAILABILITY STATEMENT

Data are available from corresponding author upon request.

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