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Here's the Story: Narrative Ability and Executive Function in Autism Spectrum Disorder

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Abstract

Background: Difficulties with narrative have been reported in individuals diagnosed with autism spectrum disorder (ASD), but the role of executive function on narrative ability has not been examined in ASD. In this study, we aimed to (1) examine whether narrative abilities of ASD children differed from neurotypical (NT) children who did not differ in age, sex, and IQ; and (2) investigate relations between executive function and narrative ability in ASD children.

Method: Narratives were elicited from 64 ASD children and 26 NT children using a wordless picture book and coded to derive several aspects of narrative ability such as propositions, evaluative devices, and self-repairs. Executive functions (specifically, inhibition and working memory) were measured using both experimenter-administered assessment and parent-report measures.

Results: Compared to NT children, ASD children produced fewer propositions but did not differ in their use of evaluative devices and self-repairs during narrative production. Greater inhibitory challenges related to more self-repairs involving repetition of story elements, whereas working memory did not relate to any of the measures of narrative ability among ASD children.

Conclusions: This study revealed that narratives by verbally fluent ASD children were shorter and less complex than those by NT children but did not differ in the specific features of narratives. Furthermore, although ASD children did not make more self-repairs than NT children, difficulty with inhibition was related to more self-repairs, indicating more dysfluent narrative production in ASD children, which has implications for intervention.

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Gabriella Greco: conceptualization, methodology, investigation, writing – original draft **Boin Choi:** conceptualization, formal analysis, writing – original draft **Kasey Michel**: methodology, investigation, writing – review and editing **Susan Faja**: conceptualization, methodology, formal analysis, writing – review and editing, supervision

Conflict of Interest

The authors declare no conflict of interest.

Introduction

Pragmatic and Narrative Ability in ASD

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social interaction and social communication as well as restricted and repetitive behaviors (American Psychiatric Association, 2013). In addition to its core features, ASD presents with a heterogenous landscape of language abilities and difficulties (Kim et al., 2014; Tager-Flusberg, 2016; Tager-Flusberg et al., 2005). For example, while some children on the autism spectrum exhibit average to above-average language skills, approximately one-third of ASD children are minimally verbal, with no to limited spoken language (Tager-Flusberg & Kasari, 2013). Among ASD children, difficulties in the domain of pragmatics have been found universally, however (see Baixauli et al., 2016; Naigles & Tek, 2017; Tager-Flusberg et al., 2005 for reviews). Pragmatics – the study of the meaning of language *in context* – encompass uses of language in social settings including conventions and rules for communicating with others (Diehl et al., 2006; Geurts & Embrechts, 2010). More social and complex forms of communication, such as narrative and discourse, for which there is a heavier reliance on pragmatics, are particularly affected in ASD individuals. For instance, ASD individuals demonstrate reduced use of language for social purposes, with studies showing that, even among older verbal children with ASD, language is rarely used to explain or describe events in a conversational context (Ziatas et al., 2003) and consists of more ambiguous pronominal references that may be obscure to the listener (Banney et al., 2015; Suh et al., 2014).

The use of narrative, or storytelling, is a good measure of pragmatic ability, because it involves knowledge of conventions for social use of language and coordination of the sequential details of the story for the benefit of the listener (Capps et al., 2000). Narrative production requires the storyteller to understand that the listener does not have contextual or background information or may not understand certain aspects of the story unless they are explained. It is also important that only information that is relevant to the story at hand be told, as to not confuse the listener (Landa & Goldberg, 2005). Further, telling a story to another person requires the storyteller to understand and attribute thoughts, emotions, and intentions (Losh & Capps, 2003). In short, good narrative communication requires that events be pieced together in a meaningful way so that individuals may convey a particular point of view for the benefit of the listener, thereby requiring that the storyteller both holds information about their intended message and adjusts language to fit their listener's needs.

So far, a clear picture of narrative language use by ASD individuals has been elusive (see Baixauli et al., 2016 and Stirling et al., 2014 for reviews). Regarding the length and complexity of narrative, several studies have reported that narratives of ASD children are shorter and less syntactically complex than neurotypical (NT) children (Capps et al., 2000; Carlsson et al., 2020; King et al., 2013; Peristeri et al., 2017; Thurber & Tager-Flusberg, 1993). By contrast, others have found no group differences in story length and syntactic complexity between ASD and NT children (Diehl et al., 2006; Losh & Capps, 2003; Norbury & Bishop, 2003; Young et al., 2005). Mixed results have also been reported regarding the use of different evaluative devices by ASD individuals and NT individuals.

Evaluative devices refer to strategies or comments that a speaker makes in order to maintain audience involvement in their description of the evaluative dimension of narrative, such as affective and mental states of characters and causal explanations for events (Labov & Waletzky, 1967). Whereas some studies have reported difficulties narrating stories, especially revolving around the mental and affective states, in ASD children (Lee et al., 2018; Losh & Capps, 2003; Rumpf et al., 2012; Siller et al., 2014), others did not find any group difference in the use of narrative devices between ASD children and NT children (Banney et al., 2015; Beaumont& Newcombe, 2006; King et al., 2013; Norbury et al., 2014; Suh et al., 2014).

Storytellers also adjust their language while narrating by using self-repairs. Self-repairs may take the form of repetition, pausing to revise word choice or syntax, postponing a thought to provide relevant background information before continuing, or abandoning an idea and starting over (Evans, 1985). Evidence suggests that different forms of self-repairs may serve different purposes (Engelhardt et al., 2017; Lake et al., 2011). For example, repetitions may serve as a way for the speaker to gain additional time to formulate their narrative, whereas revisions or corrections may serve a social purpose, allowing the speaker an opportunity to clarify for the benefit of the listener. In this regard, repetitions have been considered as "speaker-oriented" and corrections as "listener-oriented" disfluencies (Engelhardt et al., 2017; Lake et al., 2011). To date, only a few studies have explicitly investigated the use of self-repairs in ASD individuals. Compared to NT controls, ASD adults engaged in more repetitions of speech but employed fewer revisions (Engelhardt et al., 2017; Lake et al., 2011). Among children on the spectrum, a similar pattern of increased use of repetitions was found (Kuijper et al., 2017; Suh et al., 2014), but more self-corrections were reported compared to the NT group (Suh et al., 2014). These findings suggest that the use of self-repairs may be another useful indicator to evaluate narrative ability in ASD; however, self-repairs have been relatively understudied especially among ASD children.

While ample research has been conducted to investigate narrative ability in ASD, the contradictory findings on narrative length and evaluative devices as well as the limited number of studies on self-repairs require further investigation to enhance our understanding and characterization of narrative language in ASD. Another limitation of prior research is that the sample sizes are small. A meta-analysis of the studies that examined narrative ability in ASD individuals found that the average number of ASD participants across 17 studies was 18, with only seven studies with sample sizes larger than 20 (Baixauli et al., 2016), indicating the need for larger sample sizes in this area of research. An additional factor that could be responsible is the considerable variability in the matching criteria used for ASD and NT comparison groups (Baixauli et al., 2016). Although participant characteristics such as IQ and age have been found to relate to narrative ability in children (e.g., Berman & Slobin, 2013; Thurm et al., 2007), previous studies have differed in whether they matched the groups on verbal and nonverbal abilities and/or age. Further, emerging evidence reported sex differences in narrative ability between girls and boys, finding that ASD girls were more likely to use internal state words or describe intention than ASD boys (Boorse et al., 2019; Conlon et al., 2019; Kauschke et al., 2016). Nevertheless, sex often has been not considered in earlier studies on narrative ability in ASD, leaving open the question of whether ASD children would exhibit differences in narrative skills from NT children when matched on

IQ, age, as well as sex. Taken together, an investigation of narrative ability in ASD, using a larger sample size and carefully matched groups, is warranted to further advance our understanding of narrative ability in ASD children.

Executive Function and Narrative Ability in ASD

Difficulties with executive function (EF) – the ability to maintain an appropriate problem-solving set to attain a goal (Welsh & Pennington, 1988) – are common among ASD children (Craig et al., 2016; Kenworthy et al., 2008). In one of the first reviews of EF and ASD, Pennington and Ozonoff (1996) reported that ASD groups performed significantly worse than control groups on 25 of 32 EF tasks. Similarly, a meta-analysis by Demetriou et al. (2018) found that EF was impaired across all domains for ASD relative to comparison groups. Although the specific link between executive impairment and language in ASD has not yet been clearly conceptualized and evaluated, EF is thought to relate to the communication deficits that are characteristic of an ASD diagnosis, including pragmatic language (Friedman & Sterling, 2019; Kissine, 2012). EF has been linked to narrative ability in NT and clinical conditions such as attention deficit hyperactivity disorder (ADHD) and traumatic brain injury (Engelhardt et al., 2011, 2013; Mortensen et al., 2006; Mozeiko et al., 2011; Schmitter-Edgecombe et al., 2000). In particular, inhibition – the ability to suppress irrelevant or interfering information or impulse (Xiao et al., 2012) – has been linked to repair disfluencies in NT individuals and ADHD adults (Engelhardt et al., 2011, 2013). One explanation for the link between inhibition and narrative production is that narrative relies on a speaker giving relevant information to another individual, thereby requiring the speaker to suppress information that may be possibly irrelevant or confusing to the listener. Similarly, working memory – the ability to maintain information in temporary storage while performing other mental tasks such as comprehension, learning, and reasoning (Baddeley, 1992) — has been found to influence narrative performance (Kormos & Trebits, 2011), as speakers are required to maintain information about what has been said and what will need to be explained during discourse (Landa & Goldberg, 2005).

Although the links between EF and narrative ability have been reported in NT and some clinical populations, it remains less clear whether EF may also provide insight into the narrative ability in ASD individuals. Akbar et al. (2013) and Kuijper et al. (2017) found that working memory was related to pragmatic language ability in ASD children, whereas inhibition was not. Similarly, others reported significant associations of working memory with discourse comprehension (Schuh et al., 2016) and pragmatic competence (Baixauli-Fortea et al., 2019) in ASD youth as well as with sentence production in ASD adults (Engelhardt et al., 2017), but working memory was the only index of EF investigated in these studies. A recent study by Udhnani et al. (2020) also found that EF predicted pragmatic language in ASD youth, but a composite score of EF was utilized instead of the specific EF measures, thereby leaving it unclear which specific domain of EF predicted pragmatics in ASD.

The Current Study

In summary, difficulties with narrative ability have been found in ASD children, but past research is limited by small sample sizes and varying group matching criteria. Furthermore, the role of the specific EFs in narrative ability of ASD children remains relatively unknown. The current study seeks to fill in these gaps by addressing the following specific aims. First, we examined whether narrative ability of ASD children differed from that of NT children using a larger sample size than previous studies and carefully matching groups on age, IQ, and sex (Study 1). We specifically evaluated narrative length and complexity, evaluative devices, and repairs. Second, we investigated associations between EF and narrative ability within a larger and more representative sample of ASD children (Study 2). We focused on inhibition and working memory as the indices of EF based on previous work (e.g., Baixauli-Fortea et al., 2019; Engelhardt et al., 2013). In these ways, we aim to enhance understanding of the cognitive factors associated with narrative performance in ASD and inform the design of targeted language interventions for individual ASD children.

Methods

Participants

Participant characteristics are provided in Table 1. To address our first research aim of comparing narrative ability in ASD children and their NT peers, 42 autistic children and 26 NT children were included in Study 1. These 64 children were selected from a larger sample of participants across two different research protocols because they met the cognitive and diagnostic eligibility criteria (described below) and had available data including the ADOS-2 (for coding narrative) and executive function measures. As shown in Table 1, ASD and NT children did not differ in age, IQ, and sex at the group level. Age of the children ranged from 7 years 0 months to 11 years 6 months. There were 37 boys and 5 girls in the ASD group and 25 boys and 1 girl in the NT group, χ^2 (1) = 1.30, $p = .255$. The ASD and NT groups did not differ in verbal, nonverbal, or full-scale IQ measured using the Weschler Abbreviated Scale of Intelligence, Second Edition (WASI-II; Wechsler, 2011) or Differential Ability Scales, Second Edition (DAS-2; Elliott, 2007)[1]. To address our second research aim, an additional 22 ASD children were included to examine relations between EF and narrative ability within the ASD group in Study 2. The full ASD group ($n = 64$) ranged in age from 6 years 0 months to 11 years 6 months and included 54 boys and 10 girls. There were no differences in characteristics of the subset of ASD children and NT children for between-group analyses and the full ASD sample for within-group analyses, although the full ASD group tended to be younger with lower cognitive abilities (Table 1).

Inclusion criteria included an IQ of 80 or above, ability to complete child and parent measures in English, and either NT development or an existing diagnosis of ASD. For the ASD group, diagnosis was made using DSM-5 criteria (American Psychiatric Association, 2013), with information obtained from the Autism Diagnostic Observation Schedule-Second Edition (ADOS-2; Lord et al., 2012) and Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994). Exclusion criteria included presence of seizures, significant injuries

[1]Two different IQ measures (WASI and DAS) were used in this study, as children were recruited from two separate research protocols for this project, and they used different methods for assessing cognitive functioning. In Study 1, four children completed the DAS and 64 completed the WASI; in Study 2, 16 children completed the DAS and 48 completed the WASI. While previous studies have used both WASI and DAS as cognitive tests similar to this study and have found no significant differences in IQ scores among ASD individuals (Duncan & Bishop, 2013), it would be more ideal to use one type of IQ assessments for future research until the concurrent validity for the WASI and DAS is established in an ASD population.

or illnesses affecting neural development, and significant sensory or motor impairment. For the NT group, exclusion criteria further included a family history of ASD, birth or developmental abnormalities, or current or past history of psychiatric or neurological disorders.

Of note, given the high comorbidity between ASD and ADHD (Hours et al., 2022) and focus of the current study on EF, we collected the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) and utilized the cutoff for clinically significant ADHD symptoms (≥ 65) to determine the children who exhibited significant co-occurring ADHD symptoms. In Study 1, CBCL data were unavailable for 5 children. In the ASD group, 19 children had significant co-occurring ADHD symptoms and 18 did not. None of the NT children scored in the clinical range on the CBCL. In Study 2, CBCL data were available for 47 children. Of these, 23 scored above the clinical cutoff and 24 scored below.

Procedure and Measures

The study was approved by the Institutional Review Boards at University of Washington and Boston Children's Hospital. Families were first screened by phone to determine eligibility for the study. Then, eligible children completed an in-person assessment of IQ using the WASI-II or DAS-2 and narrative ability (described below). Children in the ASD group completed the ADOS-2 and their caregivers completed the ADI-R to inform the diagnosis of ASD using DSM-5 criteria. Written, informed consent was obtained from all families and all children provided assent.

Narrative Ability.—A sample of narrative language was obtained using the Telling a Story from a Book Task of the ADOS-2 Module 3. Telling a Story from a Book involves generating a story from a wordless picture book and communicating to the examiner. In the present study, the book *Tuesday* (Wiesner, 1991) was used to elicit narrative production by children similar to previous studies of narrative assessment in ASD (Banney et al., 2015; Kuijper et al., 2017; Rumpf et al., 2012; Suh et al., 2014). ASD participants completed the full ADOS-2 assessment, whereas the NT group completed only select subtests (Telling a Story from a Book, Cartoons, Conversation). Narratives were transcribed from the video recordings of the Telling a Story from a Book Task and coded to derive measures of narrative ability such as propositions, use of narrative devices, and self-repairs, each of which is defined and described below.

Propositions.: A proposition is defined as a verb and its arguments and has been used to quantify the length and complexity of the stories in prior research (Beaumont & Newcombe, 2006; Capps et al., 2000; Kauschke et al., 2016; Reilly et al., 1990; Rumpf et al., 2012). An example of a proposition is, "The frogs flew on their lily pads." The number of propositions was one of the dependent variables in the current study and used to control for the length and complexity of narratives.

Evaluative devices.: Evaluative devices provide information about the narrator's interpretation of events and evaluate the ability to maintain audience interest and the details of the unfolding the story (Labov & Waletzky, 1967). Coding for the evaluative devices followed the scheme originally proposed by Reilly et al. (1990) and has been previously adapted and used in the ASD literature (e.g., Capps et al., 2000; King et al., 2013). The coding system yields counts for affective states, character speech/onomatopoeia/sound effects, audience hookers, emphatic markers, mental states, negatives, inferences/causality, and hedges (see Table 2). Totals for each type of the evaluative devices were calculated and combined to give a total number of evaluative devices. In addition to the total number of evaluative devices, references to affective and mental states of characters were also of interest in the present study.

Self-repairs.: Self-repairs are corrections of errors in speech without external prompting, which occur shortly after the error was made (Evans, 1985; Postma, 2000). Following self-repair literature, four forms of self-repairs were coded in the present study: repetition, correction, abandonment, and postponement. Repetition occurs when the same word(s) are repeated without making a change to the grammar or meaning of the utterance. Correction refers to the replacement of a word or words to improve clarity by adjusting syntax, word choice, or prosody of the statement. Abandonment involves discarding an utterance for an entirely new thought. Finally, postponement occurs when a thought is interrupted and clarifying information is interjected before the speaker returns to their initial thought. All four types of repairs have been found in the communicative monitoring of young children (Evans, 1985) and allowed for a thorough investigation of monitoring during the narrative tasks at hand. Given accumulating evidence from studies that indicate different patterns of usage between repetition and other types of speech dysfluencies (Engelhardt et al., 2017; Lake et al., 2011; Suh et al., 2014), we examined repetitions and other types of self-repairs separately. That is, the total number of corrections, abandonments, and postponements were collapsed into a single variable: spontaneous corrections. Repetitions were examined separately to reduce the potential conflation of stuttering, which would not count as a repair, as it does not imply the same metacognitive or social awareness of wanting to change what has been said to better communicate with the listener.

Reliability.: The first and last authors first created the coding scheme for the present study based on previous research and established initial reliability on the categories described in the preceding paragraphs. Then, four independent coders (blind to participant diagnosis) were trained on the coding scheme, became reliable with the first author (kappa > .8), and independently coded the rest of the narratives. To assess inter-rater reliability, at least of 10% of the narratives Telling a Story from a Book were selected at random and coded by two separate coders.

Executive Function.—Inhibition and working memory were chosen as the specific indices of EF *a priori* based on the findings from previous work reporting that they are associated with narrative ability (e.g., Akbar et al., 2013; Baixauli-Fortea et al., 2019; Engelhardt et al., 2011, 2013; Kuijper et al., 2017; Schuh et al., 2016). Both parent report and standardized assessment measures of EF were selected for use with this age range. In addition, parent report of EF was used because we were interested in understanding how real-world EF skills related to narrative performance.

Inhibition.: Standardized T-scores from the Inhibit scale of the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000) were used as a measure of inhibition. The BRIEF is a parent report of a child's EF abilities across settings and demonstrates good psychometric properties (Roth et al., 2014). Parent report of inhibition was used because we were interested in understanding how real-world exec Lower BRIEF scores represent fewer EF challenges (e.g., better inhibition).

Working memory.: Standardized T-scores from the BRIEF Working Memory scale were used as a measure of working memory. In addition, verbal working memory was measured using the Numbers subset of the Children's Memory Scale (CMS; Cohen, 1997). The CMS Numbers subtest includes a forward and backward portion, which are thought to capture short-term memory and working memory, respectively. Given our interest in working memory, we used raw scores from the backward portion of the CMS Numbers subtest. Of note, scaled scores for working memory are age adjusted whereas our narrative scores were not, so we used the CMS Numbers raw scores in our analyses to compare performance on the working memory task independent of age. Raw scores for the digit span are often reported in previous studies (Giofre et al., 2015; Pisoni et al., 2012).

Statistical Analyses

Differences between groups were examined using t-tests and analysis of covariance (ANCOVA). Prior to computing results, data were inspected for normality. Measures of narrative ability (i.e., specific evaluative devices and self-repairs) were log transformed after first adding 1 to each score to correct for skewness. Homogeneity of variance was also examined via Levene's test and corrected when variances differed between groups. For examination of within-groups effects, correlation analyses were first computed to determine whether the continuous variables of participant characteristics (i.e., age, IQ) were associated with narrative ability. To examine whether sex was associated, we directly compared boys and girls on the measures of narrative ability given its categorical nature. Then, regressions were computed to determine the contribution of EF on narrative ability of ASD children while controlling for potential confounding variables.

Results

Between Group Comparisons of Narrative Ability

While telling the *Tuesday* story, ASD children used significantly fewer propositions (M=29.7*,* SD=10.4) than NT children (M=39.3*,* SD=12.1), $t(66)= -3.49$, p=.001, Cohen's d = 0.85. Children on the autism spectrum also used significantly fewer narrative devices (M=16.9*,* SD=7.1) than NT children (M=23.2*,* SD=13.3), $t(34)= -2.21$, p=.03, Glass's delta = 0.47. However, controlling for propositions (i.e., length of the narrative), ANCOVA revealed that there was no main effect of group on narrative devices, $F(1, 65) = 0.78$, $p = .38$, $\eta_p^2 = .012$. Because they were of specific interest, group differences in affective states and mental states were also examined, and no significant effects were detected for log corrected variables (ts < 1.63 and ps > .11) or via ANCOVA controlling for propositions (Fs < 0.54 and ps > .47). Furthermore, an examination of total self-repairs as well as its two types (repetitions and spontaneous corrections) revealed no effects of group (ts < 0.89 and ps >

.38), and there were no differences detected via ANCOVA, controlling for propositions (*F*s < 0.97 and *p*s > .33).

Relations Between EF and Narrative Ability Within ASD Children

Given previous research on the important role that IQ, age, and sex play in narrative ability (e.g., Berman & Slobin, 2013; Boorse et al., 2019; Thurm et al., 2007), we first examined whether verbal IQ and age were correlated with the measures of narrative ability. Within the full group of ASD children, there was substantial variation in verbal IQ standard scores, ranging from 77 to 160. Nonetheless, verbal IQ was not correlated with the number of propositions, narrative devices, and self-repairs (Table 3), *p*s > .52. In contrast, age was significantly, positively correlated with propositions and evaluative devices (Table 3). No effects of sex were detected, *t*s < .691, *p*s > 49. Given the significant correlations between age and narrative ability, age was included as a covariate in all regression models described below.

To determine whether the specific indices of EF (i.e., inhibition and working memory) were associated with narrative ability in ASD children, we conducted a series of regression analyses predicting the propositions, evaluative devices, and the self-repairs, separately. Table 4 shows the results of regression models predicting the propositions. As shown in Table 4, inhibition and working memory did not predict propositions, controlling for age. Table 5 shows the results of regression models first predicting the evaluative devices and then the self-repairs. Examination of the relation between EF and evaluative devices indicated that inhibition and working memory again did not predict the number of evaluative devices generated, controlling for age and propositions, which was included to account for the overall story length and complexity. In contrast, inhibition was significantly, positively associated with the total number of self-repairs even with age and propositions controlled. As such, we further examined relations between inhibition and the types of self-repairs and found that more difficulty with inhibition was related to more repetitions, *rho*(59) = .273, *p*=.04, and approached significance for the number of spontaneous corrections, *rho*(59) = .256, *p* = .05. Notably, propositions were significantly, positively associated with evaluative devices and self-repairs as shown in Table 5.[2]

Discussion

In this study we sought to examine whether verbally fluent ASD children differed on narrative ability from NT children, who did not differ in IQ, age, and sex, and whether the specific domains of EF were associated with narrative performance in ASD children. Between-groups comparisons revealed that ASD children generated shorter stories and less complex language than NT peers while narrating a wordless picture book. However, ASD children did not differ from NT children in their use of evaluative devices and self-repairs when the differences in the story length was controlled for. Our within-group

[2]Given the high comorbidity between ASD and ADHD and our interest in examining relations between EF (which is impacted in ADHD) and narrative skills, we re-ran the regression analyses and included CBCL ADHD scores in the first step of the regression. All of the regression results were unchanged except that CMS Numbers was significant in the model predicting the number of propositions.

analyses indicated that greater inhibitory challenges were associated with more self-repairs, especially those involving repetition of story elements, whereas working memory was not related to any of the measures of narrative ability. Below we discuss each of these main findings in turn.

Narrative Ability in ASD and NT Children

Consistent with previous findings (Capps et al., 2000; Carlsson et al., 2020; King et al., 2013; Peristeri et al., 2017; Thurber & Tager-Flusberg, 1993), we found that ASD children produced fewer propositions, indicating shorter length and less complexity of language, than NT children while narrating the *Tuesday* story. These findings are also in line with Baixauli et al.'s (2016) meta-analysis that reported that ASD participants showed significantly worse performance on narrative productivity (indicated by length) with a moderate effect size. Given that our ASD and NT groups were comparable on the variables associated with narrative ability in ASD (Berman & Slobin, 2013; Boorse et al., 2019; Conlon et al., 2019; Kauschke et al., 2016; Thurm et al., 2007), these findings add robust evidence to the literature that ASD children exhibit differences in narrative length and complexity from NT children. In addition, these results indicate that the amount or quantity of narrative, defined by the number of propositions, may serve as a useful clinical marker that distinguishes ASD children from NT peers during the ADOS-2 administration. Furthermore, the finding that ASD children did not differ from NT peers on verbal IQ but showed significant differences in the measure of narrative ability, is consistent with the larger literature reporting that pragmatic language is impaired even among verbally fluent ASD children.

We found that ASD children produced fewer total evaluative devices than NT children; however, the group differences were no longer significant once the number of propositions was controlled for. ASD children also did not differ in the use of language referring to affective and mental states of characters from NT children. These results were somewhat surprising based on previous studies reporting group differences in evaluative devices (e.g., Diehl et al., 2006), but similar findings have been reported by others (Capps et al., 2000; Norbury & Bishop, 2003; Tager-Flusberg, 1995). These discrepancies across the studies may be attributed to different stimuli used for eliciting narratives (Banney et al., 2015). For example, the book "*Frog, Where Are You?"* (Mayer, 1969), which was commonly used in earlier studies, centers around the story of a boy searching for his missing pet frog, and most of its pages show the boy with salient facial expressions and discrete emotions (e.g., sad, worried, surprised) that may be easy and familiar to children to recognize and label; by contrast, only four out of 28 pages in *Tuesday* show human characters, thereby potentially providing fewer opportunities for children to comment on human emotions.

Our finding that the ASD and NT groups did not show differences in the use of self-repairs was also unexpected considering past work reporting the contrary (Engelhardt et al., 2017; Kuijper et al., 2017; Lake et al., 2011; Suh et al., 2014). One explanation for our null finding is that the age of our participants was younger than previous studies, and thus, narrative ability (especially, its specific quality features such as self-repairs) may still be developing in our sample, and between-group differences may have been less apparent. Another possibility is that ASD children may show a relative strength in some measures of the narrative ability during a story generation task, which was utilized in this study, compared to a more demanding tasks such as narration recall. In support of this idea, Losh and Gordon (2014) found that ASD children showed comparable competence as control children during a narration task using a picture book, but they produced narratives reduced in semantic quality during narration recall, suggesting that narrative performance in ASD may vary across contexts with different interpersonal and cognitive demands.

Another explanation for the non-significant group differences is due to the limited statistical power, especially with regards to the small NT group ($n = 26$). Although the ADOS-2 administration is often (and rightfully) prioritized for ASD children in research studies, administrating the part of the ADOS-2 to a large group of NT children will provide important comparison data for ASD children. Regarding an examination of narrative ability, this seems especially feasible given the brief nature of the Telling a Story from a Book Task of the ADOS-2.

Taken together, our findings from the between-group comparisons of narrative ability in ASD and NT children show that while narratives by ASD children were shorter and less complex, the specific features of narratives (i.e., evaluative devices and self-repairs) were comparable to those of NT children when the groups were comparable on age, IQ, and sex. Moreover, these findings indicate that narrative ability among ASD children may be nuanced with some of its aspects impaired while others more intact than previously recognized. Therefore, multiple aspects of narrative should be evaluated using different narrative contexts and task demands to further our understanding of the strengths and weaknesses in narrative production among ASD children.

Associations between Executive Function and Narrative Production in ASD

Among ASD children, EF – particularly, inhibition – was associated with self-repairs while narrating the *Tuesday* story. That is, ASD children who were better at suppressing impulses tended to produce fewer self-repairs, indicating more fluent narrative production. These findings replicate the findings of past studies with NT and ADHD individuals (Engelhardt et al., 2011, 2013; Mortensen et al., 2006; Schmitter-Edgecombe et al., 2000) and expand upon them by revealing the specific association between inhibition and self-repairs in the ASD population. These findings suggest that the inhibition allows individuals to prevent the potential generation of irrelevant content during storytelling, and the ability to inhibit appears to benefit not only NT individuals but also individuals with clinical conditions during narrative production. However, our findings contrast those of past work that did not find the significant association of inhibition with pragmatics in ASD (Akbar et al., 2013; Kuijper et al., 2017). The discrepancies may be attributable to the differences in the tasks to measure pragmatic skills in ASD. For example, we utilized the story generation task, while Akbar et al. (2013) used the Pragmatic Judgment subtest from the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999), which asks participants what they would say or do in a situation that requires pragmatic judgment on the part of the participant (e.g., “Suppose the telephone rings. You pick it up. What do you say?”). Arguably, story generation tasks are more unstructured and may require a greater degree of inhibitory control of competing words and sentences than standardized assessments of pragmatics (e.g., CASL). Another explanation is that inhibition was operationalized differently across the studies. Specifically, motor response inhibition (i.e., a Go/No-go task) was measured in Kuijper et al. (2017), whereas the BRIEF Inhibit scale used in the current study focuses on the real-world behavioral inhibition, impulse control, and interference suppression, and it is possible that our broadband measure of inhibition may capture aspects of inhibition that relate to narrative production. In fact, others have reported significant associations of verbal fluency with inhibitory control, but not with response inhibition (Engelhardt et al., 2013; Shao et al., 2014), lending support to this explanation. Nonetheless, the mixed findings across studies underscore the need for future research to further examine the contribution of inhibition, specifically the role that different types of inhibition may play, in narrative production by ASD individuals.

Although previous studies reported significant associations between working memory and language in ASD (Akbar et al., 2013; Baixauli-Fortea et al., 2019; Engelhardt et al., 2017; Kuijper et al., 2017; Schuh et al., 2016), working memory was not predictive of narrative ability in our sample, whether it was measured using the direct experimenter-administered assessment (CMS) or the indirect parent report (BRIEF). There are a few notable differences between the present study and previous work that may explain the discrepancies across the findings. First, different tasks that are used to elicit language production may rely on working memory capacity to the varying extent. For example, Engelhardt et al. (2017) used a sentence production task, for which participants were instructed to memorize and repeat a complex sentence, whereas we asked participants to tell a story while viewing the fictional book *Tuesday*. Therefore, the task demands were different between the two studies, with the task demands of the former likely being more dependent on working memory capacity for successful performance. Next, different studies have focused on the different directionality of the relations between EF and narrative ability. Akbar et al. (2013), for instance, investigated whether pragmatic language predicted the measures of EF in ASD children, whereas our study examined the reverse direction by studying working memory as a potential predictor of narrative ability. Given that the directionality of the associations between working memory and language in ASD remains unclear (Ellis Weismer et al., 2018; Friedman & Sterling, 2019) and that it may differ across different developmental stages or ability levels (Edmunds et al., 2021), future research should shed more light onto this issue using prospective, longitudinal designs.

A few other findings are worthy of mention. Our correlation analyses indicated that age was significantly related to the measures of narrative ability such that older children used more propositions and evaluative devices than younger children within the ASD group. Age was also positively related to affective and mental states such that older children used more terms on affective and mental states relative to younger children. These findings are not particularly surprising given the developmental trajectories of storytelling skills across childhood (Rathmann et al., 2007; Stadler & Ward, 2005). Critically, our analyses demonstrated that even with these age-related differences controlled, inhibition predicted the use of self-repairs, suggesting that the ability to suppress irrelevant information during storytelling is important for fluent narrative production in ASD children above and beyond the role of development. In contrast, the finding that verbal IQ was not related to narrative ability was surprising in view of prior work showing the contrary (e.g., Capps et al., 2000), but has been also found in other studies (e.g., Losh & Capps, 2003). It is possible that the WASI-II and DAS-2, which were used to assess verbal IQ in our study, may not require longer sentences at this age. Additionally, propositions may account for some of the variance that verbal IQ would account for in our sample. It is also interesting that propositions predicted the use of evaluative devices as well as self-repairs. This means that ASD children who produced more complex language also generated more evaluative devices and self-repairs, suggesting that the amount (quantity) and specific features (quality) of narrative ability are related to one another in ASD children. Finally, this result underscores the importance of including propositions (or another proxy for narrative quantity) as a covariate in analyses and in studies of narrative ability.

By implication, these findings suggest that multiple aspects of narrative should be evaluated in assessments to understand relative strengths and weaknesses of linguistic ability in ASD children and to inform the design of targeted language interventions for individual children. Clinicians should pay particular attention to the length and complexity of narratives (which was indexed by propositions in the current study), as it appears to be a specific area of challenge in ASD children. Further, these results indicate that narratives elicited as part of the ADOS-2 provide a brief, reliable way to differentiate ASD and NT children and could be adapted for use in educational and clinical settings to examine narrative generation. Moreover, our findings highlight the need to assess a variety of EF in relation to narrative ability in ASD children, as it may be useful in designing interventions for improving narrative performance in ASD children.

The strengths of our study are the relatively large sample of children on the spectrum, use of a standardized context for narrative performance, and ASD diagnosis made using both ADOS-2 and ADI-R. In light of the contributions of our study, however, there are several limitations that must be considered. First, there are sample characteristics that might have limited our ability to detect meaningful group differences. While the overall sample size of our study was larger than those of previous studies, the NT group of 26 children was small. Although the variances for both the ASD and NT groups were similar, a larger sample of NT children could have provided more statistical power to detect subtle group differences, if any, in narrative ability between ASD and NT children. Our sample was also predominantly male, which appears to be a common problem in studies on narrative ability in ASD (Baixauli et al., 2016) as well as the ASD literature in general (Cascio et al., 2021). As accumulating evidence suggests important gender differences in pragmatic communication between ASD males and females (Boorse et al., 2019; Conlon et al., 2019; Kauschke et al., 2016), future studies should recruit more representative samples to enhance the generalizability of the findings to the full spectrum of ASD individuals.

In addition, we utilized the parent report of inhibition, which has important value in measuring typical day-to-day functioning of children, but is subject to potential reporting bias (Althubaiti, 2016). Also, ratings of inhibition have shown to have small to modest correlations with performance-based measures, indicating that they may index different aspects of cognitive functioning (Toplak et al., 2012). Thus, future research should consider using more objective measures of EF such as child direct assessments. We also did not have a measure of oral language or language comprehension beyond the administration of verbal IQ measures and do not know whether children had an additional language disorder. Therefore, it is possible that the significant group difference in propositions between ASD and NT groups could reflect broader oral language abilities rather than narrative ability *per se*. Future research utilize specific language assessments to examine language abilities of children in more detail, given that language ability may be closely related to narrative competence. It is also important to note that NT children completed the task in a shorter session (who had to complete the narrative portion of the ADOS only) than ASD children (who completed the full ADOS), and we cannot rule out the potential effect of fatigue on narrative performance of the participants. Finally, while we focused on EF as a potential factor associated with narrative ability, there are other important factors, such as theory of mind and bilingualism, which have been found to relate to narrative production in ASD children (Baixauli-Fortea et al., 2019; Capps et al., 2000; Kuijper et al., 2017; Losh & Capps, 2003; Peristeri et al., 2020; Tager-Flusberg, 1995). Considering how the full range of potential factors uniquely and simultaneously contribute to narrative ability in ASD will be an important avenue for future research.

In conclusion, this study revealed that ASD children produced shorter and less complex narratives than NT children, but the specific features of narrative production, such as the use of evaluative devices and self-repairs, did not differ between the groups, suggesting that narrative production may be more nuanced in ASD children than previously thought. Moreover, better inhibition skills predicted fewer self-repairs and thus more fluent narrative production among ASD children above and beyond children's age and story length. While more research is clearly needed to further examine the associations between EF and narrative ability, these findings indicate the potential utility of supporting EF development to enhance narrative skills among school-aged ASD children. There is growing evidence that targeted EF trainings are effective in improving EF skills in ASD children (Kenworthy et al., 2014; see Pasqualotto et al., 2021 for a review), and it will be an interesting and important avenue for future studies to evaluate whether the positive effects of EF interventions can generalize to other domains of development such as storytelling among ASD children. Given that pragmatic language is closely related to social functioning and emotional and behavioral needs of ASD children (e.g.,Helland & Helland, 2017), it is essential to better understand pragmatic ability and the contribution of its underlying cognitive factors to better support healthy development of ASD children.

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Highlights

- Narrative ability and executive function were measured in school-aged children.
- Autistic children produced shorter and less complex stories than neurotypical children.
- Inhibitory challenges related to dysfluent narrative among autistic children.
- Working memory did not relate to any of the measures of narrative ability.
- More work is needed to examine relations between executive function and narrative.

Table 1.

Participant Characteristics

	NT *M (SD)*	ASD Subset *M (SD)*	*ASD* Full *M (SD)*	NT vs ASD Subset *t, p, Cohen's d*	ASD Subset vs ASD Full *t, p, Cohen's d*
N (F:M)	26 (1:25)	42 (5:37)	64 (10:54)	χ^2 = 1.30, 0.26	χ^2 = 0.29, 0.59
Age (in mos.)	117.5	110.0	103.9	1.85, 0.07, 0.46	1.67, 0.09, 0.34
	(16.2)	(16.4)	(19.0)		
	89–143	86–138	77–138		
Verbal IQ	112.0	107.9	104.8	1.28, 0.20, 0.30	0.98, 0.33, 0.19
	(9.4)	(16.7)	(16.1)		
	97–127	79–145	77–160		
Nonverbal IQ	112.7	109.5	104.3	0.83, 0.41, 0.21	1.52, 0.13, 0.30
	(12.3)	(17.2)	(17.2)		
	88–137	79–145	69–145		
Full Scale IQ	114.0	109.2	104.7	1.45, 0.15, 0.38	1.52, 0.13, 0.30
	(10.2)	(14.8)	(15.1)		
	91–130	90–153	80–153		

Table 2.

Coding Scheme for Evaluative Devices (From Reilly et al., 1990)

- **Affective States**: References to the emotional states of characters.
- **Character Speech, Onomatopoeia, & Sound Effects**: Dramatic events used to show, rather than describe, events in a story. The speech is in the manner of the character.
- **Audience Hookers**: These are exclamatory phrases that service to renew or maintain audience attention. Often accompanied by exclamatory prosody, which is the rhythm, stress, and intonation of speech.
- **Emphatic Markers**: This includes intensifiers and repetition, meaning that these aspects of story-telling are meant to emphasize a certain action or description of a character or event.
- **Mental States**: Information about the character’s behaviors; a focus on the internal states of the characters.
- **Negatives**: This device serves to define narrator perspective. Narrator indicates events or behaviors contrary to underlying expectations.
- **Inferences and Causality**: Inferring the cause or motivation for certain events, or making inferences about what is happening in a picture. This classification is for anything not in the aforementioned categories that still infers some sort of state.

Table 3.

Bivariate Correlations between Participant Characteristics (Verbal IQ, Age, and Sex) and Measures of Narrative Ability within the ASD Full Sample

	Verbal IQ	Age	Sex
Propositions	−.01	.35**	.61
Evaluative Devices	.08	.27*	.69
Affective States	.09	.25*	.47
Mental States	.23	.25*	.44
Self-Repairs	.04	.17	.25

Note.

*$p \leq .05$;

**$p < .01$;

Spearman’s rho are reported for Affective and Mental States.

Table 4.

Regression Predicting the Total Number of Propositions

	B	SE B	β	Semi-partial	Semi-partial squared
Age	.128	.074	.250†	.222	.049
BRIEF Inhibit T score	.115	.129	.134	.113	.013
BRIEF Working Memory T score	.001	.130	.001	.001	.000
CMS Numbers Backward Raw Score	.944	.639	.192	.188	.035
R^2, *F*, *p*	R^2 = .11; *F*(1,55) = 6.77, *p* = .012				
R^2 change (when BRIEF and CMS added)	R^2 = .04; *F*(3,52) = 0.90, *p* = .45				

Note. CMS = Children's Memory Scale;

$^{\dagger}p < .1$

Table 5.

Regressions Predicting the Total Number of Evaluative Devices and Self-Repairs

	Evaluative Devices					Self-Repairs				
	B	***SE B***	***β***	***Semi-partial***	***Semi-partial squared***	***B***	***SE B***	***β***	***Semi-partial***	***Semi-partial squared***
Propositions	.503	.072	.714***	.657	.431	.329	.056	.629***	.579	.335
Age	−.021	.040	−.059	−.051	.003	−.051	.031	−.192	−.165	.027
BRIEF Inhibit T-score	.101	.068	.168	.141	.020	.149	.053	.330**	.278	.077
BRIEF Working Memory T-score	−.015	.068	−.023	−.021	.000	.010	.053	.020	.019	.000
CMS Numbers Backward Raw Score	−.277	.341	−.081	−.077	.006	−.248	.265	−.097	−.093	.009
R^2, *F, p*	R^2 =.51; *F*=28.0, *p*<.001					R^2 =.39; *F*=17.2, *p*<.001				
R^2 change (EF variables added)	R^2 =.03; *F*=1.15, *p*=.34					R^2 =.11; *F*=3.78, *p*=.02				

** *p* < .01;

*** *p* < .001