Narrative Production in Children With Autism Spectrum Disorder (ASD) and Children With Attention-Deficit/Hyperactivity Disorder (ADHD)

Kuijper, Sanne J. M.; Hartman, Catharina A.; Bogaerds-Hazenberg, S. T.; Hendriks, Petra

Published in:
Journal of Abnormal Psychology

DOI:
10.1037/abn0000231

Journal of Abnormal Psychology
2017, Vol. 126, No. 1, 63–75

0021-843X/17/$12.00 http://dx.doi.org/10.1037/abn0000231

Narrative Production in Children With Autism Spectrum Disorder (ASD) and Children With Attention-Deficit/Hyperactivity Disorder (ADHD): Similarities and Differences

Sanne J. M. Kuijper
University of Groningen

Catharina A. Hartman
University Medical Center Groningen

Suzanne T. M. Bogaerds-Hazenberg and Petra Hendriks
University of Groningen

The present study focuses on the similarities and differences in language production between children with autism spectrum disorder (ASD) and children with attention-deficit/hyperactivity disorder (ADHD). In addition, we investigated whether Theory of Mind (ToM), working memory, and response inhibition are associated with language production. Narratives, produced by 106 Dutch-speaking children (36 with ASD, 34 with ADHD, and 36 typically developing) aged 6 to 12 during ADOS assessment, were examined on several linguistic measures: verbal productivity, speech fluency, syntactic complexity, lexical semantics, and discourse pragmatics. Children were tested on ToM, working memory, and response inhibition and parents filled in the Children's Communication Checklist (CCC-2). Gold-standard diagnostic measures (Autism Diagnostic Observation Schema [ADOS], Autism Diagnostic Interview Revised [ADI-R], and the Parent Interview for Child Symptoms [PICS]) were administered to all children to confirm diagnosis. Regarding similarities, both clinical groups showed impairments in narrative performance relative to typically developing children. These were confirmed by the CCC-2. These impairments were not only present on pragmatic measures, such as the inability to produce a narrative in a coherent and cohesive way, but also on syntactic complexity and their production of repetitions. As for differences, children with ADHD but not children with ASD showed problems in their choice of referring expressions and speech fluency. ToM and working memory performance but not response inhibition were associated with many narrative skills, suggesting that these cognitive mechanisms explain some of the impairments in language production. We conclude that children with ASD and children with ADHD manifest multiple and diverse language production problems, which may partly relate to their problems in ToM and working memory.

General Scientific Summary

This study on narrative production shows that children with autism spectrum disorder (ASD) and children with attention-deficit/hyperactivity disorder (ADHD) manifest multiple and diverse language production problems, which may partly relate to their problems in Theory of Mind and working memory. The results of the present study emphasize the need to investigate language abilities not only of children with ASD, but also of children with ADHD.

Keywords: autism spectrum disorder, ADHD, narrative production, theory of mind, working memory

Supplemental materials: http://dx.doi.org/10.1037/abn0000231.supp

Autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) are among the most frequently diagnosed psychiatric disorders in children, with prevalence rates of about 1% for ASD and 5% for ADHD (Baird et al., 2006; Polanczyk, De Lima, Horta, Biederman, & Rohde, 2007). ASD and ADHD frequently co-occur (Russell, Rodgers, Ukoumunne, & Ford, 2014; Simonoff et al., 2008). Overlap between ASD and ADHD has been found in various domains, including social and cognitive functioning (Johnson, Gliga, Jones, & Charman, 2015; Nijmeijer et al., 2010; Rommelse, Geurts, Franke, Buitelaar, & Hartman, 2011). There are also similar-

This article was published Online First November 28, 2016.

Sanne J. M. Kuijper, Center for Language and Cognition Groningen, University of Groningen; Catharina A. Hartman, University Medical Center Groningen; Suzanne T. M. Bogaerds-Hazenberg and Petra Hendriks, Center for Language and Cognition Groningen, University of Groningen.

Sanne J. M. Kuijper is now at Faculty of Behavioural and Social Sciences, University of Groningen. Suzanne Bogaerds-Hazenberg is now at UiL OTS, Utrecht University.

This research was financed by a grant from the Netherlands Organisation for Scientific Research, NWO, awarded to Petra Hendriks (Grant 277-70-005). We thank Accare University Center of Child and Adolescent Psychiatry Groningen for additional support for this study.

Correspondence concerning this article should be addressed to Sanne J. M. Kuijper, Faculty of Behavioural and Social Sciences, University of Groningen, Grote Rozenstraat 38, 9712 TJ, Groningen, the Netherlands. E-mail: s.j.m.kuijper@rug.nl

ities between ASD and ADHD in language and communication problems, as was found in several studies using a Parental Questionnaire (Children's Communication Checklist (CCC); Bishop & Baird, 2001; Geurts et al., 2004; Geurts & Embrechts, 2008; Helland, Biringer, Helland, & Heimann, 2012). The present study extends this work by studying narratives produced by children with ASD and children with ADHD to investigate the similarities and differences in narrative production between these two groups. To unravel similarities and differences between children with ASD and ADHD, we examine narrative skills per clinical group.

In children diagnosed with ASD, persistent deficits in pragmatics and social communication are among the core criteria (*DSM–5*; American Psychiatric Association [APA], 2013). In contrast to ASD, language impairments are not part of the *DSM* criteria of ADHD. Nonetheless, language problems are among the ADHD criteria (e.g., "often talks excessively" or "often interrupts others"; *DSM–5*; APA, 2013). Children with ADHD also frequently show pragmatic deficits (for an overview, see Green, Johnson, & Bretherton, 2014). Although less well investigated, problems in other linguistic areas, such as syntax and semantics, have also been reported (Eigsti, Bennetto, & Dadlani, 2007; Kjelgaard & Tager-Flusberg, 2001). These seem less prominent and less consistent than problems in pragmatics.

Narratives are a widely used measure for communicative abilities in typically developing (TD) children as well as children with developmental disorders (e.g., Diehl, Bennetto, & Young, 2006; Miniscalco, Hagberg, Kadesjö, Westerlund, & Gillberg, 2007; Tager-Flusberg, 1995). They provide a direct measure of children's communicative abilities, as opposed to the indirect measure of parental report. Like parental report, the ability to produce an appropriate narrative is related to children's daily social communication (Luo & Timler, 2008). By investigating narratives, different aspects of language use can be tapped very precisely: from structural components, such as lexical diversity, syntactic complexity, and sentence length, to more pragmatic components (e.g., the way sentences are linked together or referential dependencies between words; Botting, 2002; Norbury & Bishop, 2003; Tager-Flusberg & Sullivan, 1995). Such precise information is difficult to retrieve from parental questionnaires.

Studies examining narrative skills in children with ASD showed that they exhibit more deficits in explaining causal relations, have difficulties in organizing their stories in a coherent way, and use more ambiguous referring expressions than TD children. On the other hand, children with ASD generally perform similarly to TD children with respect to verbal productivity and syntactic complexity (e.g., Diehl et al., 2006; Losh & Capps, 2003; Suh et al., 2014; Tager-Flusberg & Sullivan, 1995), although some studies found deficits in syntactic complexity (Banney, Harper-Hill, & Arnott, 2015; Capps, Losh, & Thurber, 2000; Norbury & Bishop, 2003). Narrative skills of children with ADHD have been investigated less extensively. Most studies focused on pragmatic skills and narrative organization (Luo & Timler, 2008; Purvis & Tannock, 1997; Renz et al., 2003; Tannock, Purvis, & Schachar, 1993). Children with ADHD exhibited problems in producing an organized, accurate, and cohesive narrative, and they had difficulties in describing goal-directed actions. One study investigating syntactic skills in the narratives of children with ADHD in their narratives reported no differences between children with ADHD and TD children (Parigger, 2012).

Although based on small sample sizes, two studies have compared the narrative skills of children with ASD and children with ADHD. Miniscalco et al. (2007) (five children with ASD, eight with ADHD, and eight children with late developing language, but without neuropsychiatric disorder; no TD children) investigated sentence length, number of subordinate clauses and the amount of relevant information in story retelling, but did not find differences between the three groups. Rumpf, Kamp-Becker, Becker, and Kauschke (2012) studied narratives of 11 children with Asperger syndrome (AS), nine children with ADHD, and 11 TD children. They found that both children with AS and children with ADHD showed problems in pointing out the core aspects of the story. Children with AS had additional difficulties: They produced shorter narratives, used fewer cognitive terms (such as *think* or *know*), and used more explicit forms to refer to the characters than the TD group, whereas the ADHD group did not differ from both groups.

Thus, although studies using Parental Questionnaire report overlap in language and communication problems between ASD and ADHD, much less is known about children's narrative performance. Based on studies that included either ASD or ADHD or that had very small samples, a preliminary conclusion is that shared impairments in ASD and ADHD are in the field of pragmatics, such as organizing and telling a coherent story. On the other hand, verbal productivity and syntactic complexity appear to be relatively unimpaired in both groups. The present study will extend the work on differences and similarities in narrative skills between children with ASD and children with ADHD by including substantial numbers of children with ASD, children with ADHD, and TD children and examine a broad spectrum of narrative skills, varying from pragmatic measures to syntactic and semantic measures.

Producing a narrative requires a range of linguistic skills as well as cognitive and social capacities (Norbury, Gemmell, & Paul, 2014). For example, Theory of Mind (ToM) capacity has been related to narrative skills (Capps et al., 2000; Tager-Flusberg & Sullivan, 1995) and to complex syntax (de Villiers & Pyers, 2002). It has also been proposed that executive functioning (EF; e.g., working memory [WM] or inhibition) is related to narrative skills (Tannock & Schachar, 1996), which is also suggested by neuroimaging studies of narrative production (see the review of Mar, 2004). One study examining this reported no significant relations between EF measures and morphosyntactic errors or narrative organization (Parigger, 2012). Another study reported associations between EF measures and a general narrative measure, but not with specific narrative skills (Friend & Bates, 2014). Also a relation between WM and story length in retelling stories by bilinguals has been reported (Tsimpli, Andreou, Agathopoulou, & Masoura, 2014). Inhibition has been found to relate to repair dysfluencies but not to other dysfluency measures (Engelhardt, Nigg, & Ferreira, 2013; Shao, Janse, Visser, & Meyer, 2014). Furthermore, inhibition has previously been linked to second language acquisition (e.g., Bialystok, Martin, & Viswanathan, 2005; Green, 2013), but whether inhibition also plays a role in first language acquisition is yet unclear, although likely. Hence, the relation between EF measures and narrative abilities needs to be studied more extensively. In the present study, the relation between narrative skills and ToM and EF is investigated.

This study has three aims. First, we provide comprehensive language profiles for children with ASD and children with ADHD with respect to (a) verbal productivity; (b) speech fluency; (c) syntactic complexity; (d) lexical semantics; and (e) discourse pragmatics. We hypothesize that children with ASD have most problems with discourse pragmatics, whereas verbal productivity and syntactic complexity may be relatively unimpaired. We hypothesize that children with ADHD also have problems with discourse pragmatics, although these are expected to be less profound than those of children with ASD. Second, we relate children's scores on linguistic measures to performance on ToM and EF tasks. Two important aspects of EF are focused on WM and response inhibition. In this way, insight is provided in the cognitive mechanisms that are important for narrative abilities. Third, we examine how narrative skills relate to the scores on the CCC-2 questionnaire which has often been used in previous research. This will bridge the separate literatures using questionnaires and using narratives. Our broad approach is aimed at providing insight in the similarities and differences of the narrative abilities of children with ASD and ADHD in relation to typical development, including pragmatic as well as semantic and syntactic abilities. Furthermore, it is aimed at relating their narrative abilities to ToM and EF performance.

Method

Participants

The children in the present study took part in a larger study (n = 127) on language and communication. Only children who were administered the *Tuesday* picture story book (Wiesner, 1991) during the ADOS (Lord, Rutter, DiLavore, & Risi, 1999) were included in the current study (n = 108; 38 with ASD, 34 with ADHD, and 36 TD), ranging in age from 6;1 to 12;10 (M = 9;1, SD = 1;8).

ASD. Children in the ASD group were diagnosed with Autistic disorder (n = 7), PDD-NOS (n = 24), or Asperger's disorder (n = 7) by clinicians on the basis of the *DSM–IV–TR* criteria (APA, 2000). All children had IQ-scores above 75 and were able to produce full sentences (i.e., we did not include nonverbal or low-verbal children). Both the ADI-R (Rutter, Le Couteur, & Lord, 2003) and the ADOS (Lord et al., 1999) were administered by trained psychologists. Children in this study were included in the ASD group if they met the ADOS criteria for autism or ASD and/or the ADI-R criteria for autism or ASD (cf. Risi et al.'s (2006) ASD2 criteria). Two children from the ASD group were excluded from further analysis because they did not meet these criteria, leaving 36 children in the ASD group. PICS (Ickowicz et al., 2006) was additionally administered to assess if children with ASD additionally met the criteria for ADHD. We found that four children in the ASD group scored above the ADHD cut-offs on the PICS. In line with their clinical ASD diagnosis, we included these children in the ASD group.

ADHD. Children in the ADHD group were diagnosed with combined type (n = 18), predominantly hyperactive-impulsive type (n = 10), or predominantly inattentive type (n = 6) by clinicians on the basis of the *DSM–IV–TR* criteria. Furthermore, both the PICS and the Teacher Telephone Interview-IV (TTI; Tannock et al., 2002) were administered by trained psychologists. Six children with ADHD lacked TTI information. Four of them already scored above the cut-off for ADHD based on parent information alone. The remaining two children scored, based on only the PICS, only one point below the cut-off for ADHD. Since these children scored comparable on the PICS to the other children in the ADHD group (for whom TTI scores combined with their PICS scores exceeded the cut-off point), we included them in the analyses. Seven children in the ADHD group scored within ASD criteria on the ADOS or ADI-R. In line with their clinical diagnosis, we included these children in the ADHD group.

TD. Children in the TD group had not been diagnosed with ASD or ADHD. The ADOS, ADI-R, and PICS were administered by trained psychologists in this group as well. None of the children scored above the cut-offs for ASD or ADHD described above.

Procedure

Children and their parents were recruited by brochures at schools and in outpatient clinics for child and adolescent psychiatry in Groningen. Children and parents came to the lab together. All parents of participating children signed for informed consent. Children were tested individually on a single day in a quiet testing room with one experimenter present during the ADOS and two experimenters present during the other tasks. After each task, children had a short break. While their child was tested, the parent filled in the questionnaires in a quiet room adjacent to the testing room.

Materials

Background variables. IQ was assessed by two subtests (Vocabulary and Block Design) of the Dutch Wechsler Intelligence Scale for Children (Kort et al., 2002). Verbal ability was assessed by the Dutch version of the Peabody Picture Vocabulary Test-III (PPVT) (Schlichting, 2005). Group means and standard deviations for age, IQ, PPVT, and clinical interviews (ADI-R, ADOS, PICS) can be found in Table 1.

Narratives. During the ADOS assessment, children were shown the almost wordless picture book *Tuesday* (Wiesner, 1991). The book contains 29 pages. Following the ADOS guidelines, the experimenter introduced the story at page 1 and 2: "Here I have a book with pictures. The story starts at Tuesday evening, around eight o'clock. A turtle is sitting on a rock. He looks surprised. Now you tell what happens." Then the child continued the story at page 3. During the story, the experimenter was allowed to interact with the child. In this way, the narrative elicitation approached a natural setting. When the child did not respond, the experimenter gave prompts, such as "what is happening?" According to the ADOS guidelines, at the end of the story the experimenter must interrupt the child and finish the story in order to see how the child reacts to this interruption. The exact point at which the experimenter interrupts the child is not specified in these guidelines and therefore may differ somewhat per child. Therefore we have chosen to transcribe all narratives until page 21, which is well before any interruptions (see also S.1 in the online supplemental materials).

Story transcription. All stories (blinded for diagnosis) were transcribed independently by two trained transcribers, following the Codes for Human Analysis of Transcripts (CHAT; MacWhinney, 2000). These transcribers also decided on syntactic units and

Table 1
Mean Scores (With SDs) of Age, Clinical Instruments (ADI-R, ADOS, PICS), WISC-III, PPVT, FB Task, N-Back Task, Stop Task Per Group (TD, ASD, ADHD)

Background variables	TD (n = 36)[a] *M* (*SD*)	ASD (n = 36)[a] *M* (*SD*)	ADHD (n = 34)[a] *M* (*SD*)	Group differences (Bonferroni corrected post hoc analyses)
% Male	69	92	82	*n.s.*
Age	8;11 (1;8)	9;4 (1;10)	8;11 (1;7)	*n.s.*
ADI-R[b] Social Interaction	1.61 (2.75)	17.33 (6.00)	4.74 (4.17)	ASD*** > ADHD > TD*
ADI-R[b] Communication	1.28 (1.45)	13.56 (4.33)	4.09 (2.73)	ASD*** > ADHD > TD**
ADI-R[b] Stereotyped Behavior	.31 (.67)	4.92 (2.69)	1.41 (1.56)	ASD*** > ADHD > TD*
ADI-R[b] Behavior < 3 yr	.14 (.42)	3.03 (.94)	1.50 (1.56)	ASD*** > ADHD > TD***
ADOS[c] Communication	.50 (.78)	2.94 (1.60)	1.12 (.91)	ASD*** > ADHD,TD
ADOS[c] Social interaction	1.39 (1.66)	8.14 (3.42)	2.47 (1.76)	ASD*** > ADHD,TD
ADOS[c] Com + Soc	1.89 (1.92)	11.08 (4.65)	3.59 (2.38)	ASD*** > ADHD,TD
ADOS RRB	.17 (.45)	1.19 (1.37)	.29 (.58)	ASD*** > ADHD,TD
ADOS Social Affect	1.53 (1.83)	10.00 (4.67)	2.76 (2.12)	ASD*** > ADHD,TD
ADOS SA + RRB	1.69 (2.00)	11.19 (5.29)	3.06 (2.15)	ASD*** > ADHD,TD
PICS[d] Inattention	.08 (.37)	2.31 (2.10)	3.71 (2.21)	ADHD** > ASD > TD***
PICS[d] Hyperactivity/impulsivity	.28 (.57)	2.06 (1.96)	5.26 (2.51)	ADHD*** > ASD > TD***
WISC-III Block Design standard scores (PRI subtest)	11.28 (3.28)	9.06 (3.46)	8.26 (3.10)	ASD*, ADHD** < TD
WISC-III Vocabulary standard scores (VCI subtest)	11.86 (2.57)	8.58 (3.49)	9.44 (1.99)	ASD***, ADHD** < TD
WISC-III Estimated IQ	109.52 (13.83)	93.09 (17.58)	93.04 (12.81)	ASD, ADHD < TD***
PPVT WBQ	108.72 (10.94)	104.61 (15.90)	100.06 (11.32)	ADHD < TD*
False Belief Task (Proportion correct FB1)	.94 (.11)	.86 (.22)	.90 (.10)	*n.s.*
False Belief Task (Proportion correct FB2)	.77 (.29)	.53 (.40)	.57 (.34)	ASD, ADHD < TD*
N-Back Task (Numbers correct 2-back)	41.68 (5.35)	38.82 (7.92)	38.94 (5.98)	*n.s.*
Stop-Signal Task (SSRT)	257.44 (79.06)	259.99 (90.04)	248.08 (85.88)	*n.s.*

Note. TD = typically developing; ASD = autism spectrum disorder; ADHD = attention-deficit/hyperactivity disorder; ADI-R = Autism Diagnostic Interview—Revised; ADOS = Autism Diagnostic Observation Schema; Com + Soc = total score on communication domain and social domain; RRB = restricted and repetitive behavior domain; SA + RRB = total score on social affect domain and restricted and repetitive behavior domain; PICS = Parent Interview for Child Symptoms; WISC-III = Wechsler Intelligence Scale for Children, 3rd ed.; PRI = perceptual reasoning index; VCI = verbal comprehension index; PPVT WBQ = Peabody Picture Vocabulary Test-standard score; FB1 = first-order false belief; FB2 = second-order false belief; SSRT = Stop Signal Reaction Time.
[a] Number of participants may vary per task, since some children did not finish all tasks (see Procedure). [b] Five children in the ADHD group scored above the cut-off for ASD on the ADI-R (on the basis of Risi et al.'s criteria; Risi et al., 2006). [c] Two children in the ADHD group scored above the ADOS criteria for ASD. [d] Four children in the ASD group scored within our criteria for ADHD on the PICS (above or one point below the cut-off on the PICS). [e] Chi-square analysis.
* $p < .05$. ** $p < .01$. *** $p < .001$.

on the presence of pauses, retracings, and repetitions (see below for a detailed description of these categories). A third transcriber checked for discrepancies between the two transcripts, and in case of a discrepancy made a decision based on the audio-recordings.

Transcripts were divided into syntactic units, following Norbury and Bishop's (2003) guidelines. A syntactic unit was defined as a main clause and all subordinate clauses belonging to this main clause, if any. For example, complex sentences with a subordinate clause (e.g., "The man was scared, because he saw frogs") were counted as one syntactic unit. Coordinated clauses (e.g., "The frog was flying away and the dog followed him") were counted as two syntactic units. We coded coordinated sentences with a null subject in the second clause as two syntactic units too (e.g., "The frog was flying away and Ø left the dog behind"). Utterances only consisting of "hmm", "yes", or "no" were excluded from analyses (Johnston, 2001).

Coding categories. We investigated children's narrative skills with respect to five categories of linguistic performance. We started with the global category of verbal productivity, assessed by the basic measures of story length and sentence length. Another global category is speech fluency, which comprises children's production of pauses, repetitions, and retracings. At the sentence level, we investigated children's syntactic abilities. The fourth category dealt with the semantics of words and contained measures of lexical diversity. Finally, we examined discourse pragmatics: the way children combine their sentences into larger discourses. Thus, we examined narrative ability in five main categories: (a) verbal productivity; (b) speech fluency; (c) syntactic complexity; (d) lexical semantics; and (e) discourse pragmatics. By coding these five linguistic categories, we can provide a broad profile of the narrative abilities of children with ASD and children with ADHD. Below we discuss how we investigate each category using specific measures. See supplemental Table S1 in the online supplemental materials for examples of each category.

Verbal productivity. Verbal productivity was measured in two ways: First, we counted the total number of syntactic units per child. Second, we calculated the MLU (mean length of utterance) in words by dividing the total number of words by the number of syntactic units.

Speech fluency. To produce coherent stories and correct sentences, speakers need to plan and monitor their sentences. Pauses may reflect syntactic, lexical, and other cognitive decisions (e.g., Guo, Tomblin, & Samelson, 2008). We checked for both filled and unfilled pauses. Filled pauses are pauses in which the child says something like "uh" or "um", while unfilled pauses are clear silent moments. In addition, we calculated the number of repetitions

(e.g., "the . . . the frog flies"; or "the frog . . . the frog flies"), which also reflect syntactic and lexical decisions (Guo et al., 2008; Rispoli, 2003). Furthermore, we counted the number of retracings. These occur when the child stops during his utterance and then restarts with a different continuation (e.g., "and then they wanted . . . they went to the town").

Syntactic complexity. For each child the total number of simple clauses (main clause without subordinate clause(s)) and complex clauses (main clause with subordinate clause(s) or a coordination of main clauses) was counted. Furthermore, of all complex clauses, we also counted the number of tensed complements (e.g., "the man thought that he was dreaming"), which are hypothesized to relate to ToM (de Villiers & Pyers, 2002). Furthermore, we counted the number of morphosyntactic errors.

Lexical semantics. We calculated for each child the Guiraud Index (Guiraud, 1960), a measure of lexical diversity that takes into account story length, which is calculated by dividing the number of different words by the square root of the total number of words.

In addition, for each child the total number of emotional and cognitive terms (ECTs) was counted (See supplemental Table S2 online supplemental materials for a list of ECTs). Beause we are particularly interested in the way children can identify and express the feelings of others, we only counted terms referring to an emotion or cognition of the story characters. Thus, expressions that referred to the child's own mental state were not counted.

Discourse pragmatics. We examined children's ability to adequately produce a coherent and cohesive discourse. First we focused on referential coherence: the way children refer to characters during their narrative. We distinguished between two situations: (a) maintenance of reference to a character that is referred to in the previous clause; and (b) (re)introduction of a referent (i.e., either the first introduction of a referent, or the reintroduction of a referent that is not mentioned in the three clauses before). To maintain reference to a character, it is generally expected that less specific forms are used. These may be pronouns (e.g., "he") if the character is highly prominent. However, when more characters are present in the discourse, speakers tend to use more full noun phrases (NPs; e.g., "the frog") to maintain reference compared to when only one character is present (Arnold & Griffin, 2008). For (re)introduction of a referent generally full NPs are used. We calculated the percentage of pronouns for maintaining reference to a character and the percentage of full NPs for (re)introducing a character. Next, we checked for narrative cohesion by counting the number of causal conjunctions (e.g., "because", "therefore"). The use of causal conjunctions is often related to the use of mental states (e.g., Bamberg & Damrad-Frye, 1991). Hence, we additionally checked for each emotional or cognitive expression whether it was related to the previous or following syntactic unit by the use of a causal conjunction. Furthermore, we scored per main clause whether the subject was the same as in the previous clause. Last, we counted the number of interruptions of the story (e.g., "Where did you buy this book?").

Coding. The number of syntactic units, MLU, pauses, retracings, repetitions, lexical diversity, and causal conjunctions were counted automatically in CHAT on the basis of the final transcripts (see also Story Transcription). For the remaining linguistic categories the transcripts (blinded for diagnosis) were coded by a trained coder. A random 10% of these blinded transcripts were coded by a second coder (Sanne J. M. Kuijper). Intraclass coefficients (ICCs) were high (complex clauses [ICC = .99]; morphosyntactic errors [ICC = .95]; ECTs [ICC = .95]; causal conjunctions in relation to ECTs [ICC = 1.00]; maintenance of reference with full NP [ICC = .87]; maintenance of reference with pronoun [ICC = .98]; reintroduction with full NP [ICC = .93]; (re)introduction with pronoun [ICC = .82]; interruptions [ICC = .94]; subject shifts [ICC = .97]), with the exception of tensed clauses, for which the ICC was medium (ICC = .76).

ToM, WM, and response inhibition. To measure performance on ToM, we used a False Belief (FB) task adopted from Hollebrandse, Van Hout, and Hendriks (2014). FB tasks involve the understanding that another person has his or her own beliefs and that these can be different from one's own beliefs (e.g., Baron-Cohen, Leslie, & Frith, 1985). Two dependent measures were calculated: mean accuracy on first-order FB (FB1) and mean accuracy on second-order FB (FB2). WM was tested with an n-back task (Owen, McMillan, Laird, & Bullmore, 2005) including three experimental conditions: 0-back (baseline), 1-back, and 2-back. The total numbers correct on the 2-back condition was calculated as a measure of WM. Response inhibition was tested with a Stop Task adopted from Van den Wildenberg and Christoffels (2010). The Stop Signal Reaction Time (SSRT) derived from the Stop Task (Band, van der Molen, & Logan, 2003) was calculated as a measure of response inhibition. These three tasks to measure children's ToM, WM, and response inhibition are described in Kuijper, Hartman, and Hendriks (2015) and in the online supplemental materials (S.2, S.3, and S.4).

CCC-2. The CCC-2 (Bishop, 2003; Dutch translation: Geurts, 2007) measures various aspects of communication. It was filled in by one of the parents. For the purpose of this study we used the eight scales that tap linguistic functioning: (a) speech output; (b) syntax; (c) semantics; (d) coherence; (e) inappropriate initiation; (f) stereotyped language; (g) use of context; and (h) nonverbal communication. Hence, we left out the two nonlinguistic scales (Social Relations and Interests). In addition, we calculated the General Pragmatics Score, a composite score of the raw scores on scales E to H. Furthermore, we calculated a second composite score of raw scores on the remaining scales (A–D), which we named *Structural Language Score*. The questionnaire of one TD child was not returned. This child was excluded in analyses including the CCC-2.

Results

Narratives

Group means and statistical test results for the different measures per narrative category are presented in Table 2. To analyze group differences on the linguistic categories derived from the narratives, for each of the linguistic categories we conducted generalized linear model analyses in IBM SPSS Statistics 23, with dummy-coded contrasts between diagnostic groups and controls (ASD vs. TD and ADHD vs. TD) included as predictor in the analysis. To additionally compare the ASD group with the ADHD group, we reran the analyses with dummy-coded contrasts with the ADHD group as reference category (ASD vs. ADHD and TD vs. ADHD). We used a linear model for the variables with normal score distributions (i.e., the variables syntactic units, MLU, and

Table 2
Mean Scores (With Standard Deviations), Estimates (With Standard Errors), and Effect Sizes on the Linguistic Categories Per Group (TD, ASD, ADHD)

		TD	ASD	ADHD	ASD vs. TD		ADHD vs. TD		ASD vs. ADHD	
Linguistic categories	Measures	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	Estimate (*SE*)	Cohen's *d*	Estimate (*SE*)	Cohen's *d*	Estimate (*SE*)	Cohen's *d*
Verbal productivity	Syntactic units	29.14 (10.28)	28.75 (11.84)	32.62 (14.59)	−.39 (2.86)	−.04	3.48 (2.90)	.28	−3.87 (2.90)	−.29
	MLU	5.98 (1.18)	5.38 (.96)	5.43 (1.05)	−.60* (.25)	−.56	−.55* (.25)	−.49	−.05 (.25)	−.05
Speech fluency	Pauses[a]	30.78% (20.88)	28.72% (22.62)	23.65% (17.80)	−.06 (.10)	−.09	−.29** (.10)	−.37	.23* (.10)	.25
	Retracings[a]	15.10% (14.02)	15.45% (11.47)	11.38% (10.78)	−.01 (.12)	.03	−.28* (.13)	−.3	.28* (.13)	.37
	Repetitions[a]	8.44% (7.54)	13.92% (15.82)	11.94% (13.28)	.53*** (.14)	.44	.39** (.14)	.32	.14 (.13)	.14
Syntactic complexity	Complex clauses[a]	43.03% (21.70)	31.49% (17.35)	35.80% (20.44)	−.36*** (.09)	−.59	−.21** (.09)	−.34	−.14 (.09)	−.23
	Morphosyntactic errors[b]	7.60% (7.27)	13.00% (10.30)	10.79% (10.07)	.54*** (.15)	.61	.40** (.15)	.36	.14 (.14)	.22
	Tensed clauses	1.18% (2.17)	.94% (2.24)	1.29% (3.44)	−.36 (.44)	−.11	.02 (.39)	.04	−.38 (.43)	−.12
Lexical semantics	Lexical diversity	6.68 (.81)	6.38 (.84)	6.50 (.97)	−.30 (.20)	−.36	−.19 (.21)	−.2	−.11 (.21)	−.13
	Emotional and cognitive terms (ECT)[a]	6.92% (6.28)	6.34% (5.81)	8.52% (6.60)	.07 (.17)	−.1	.13 (.16)	.25	−.05 (.16)	−.35
Discourse pragmatics	Maintaining reference[b]	71.83% (18.74)	67.15% (20.43)	71.61% (24.38)	−.31 (.16)	−.24	−.16 (.16)	−.01	−.15 (.16)	−.2
	(Re)introduction of referents[c]	87.99% (16.30)	89.05% (13.56)	84.22% (15.45)	−.01 (.25)	.07	−.50* (.22)	−.24	.49* (.23)	.33
	Causal conjunctions[a]	3.02% (4.13)	1.61% (3.63)	1.52% (2.15)	−.60* (.31)	−.36	−.67* (.30)	−.46	.07 (.35)	.03
	Causal conjunctions with ECT[d]	26.91% (38.44)	4.17% (12.30)	3.39% (11.17)	−1.85** (.66)	−.80	−1.97** (.65)	−.83	.12 (.83)	.07
	Interruptions of story[b]	4.51% (6.57)	7.30% (6.78)	5.96% (6.21)	.46* (.20)	.42	.39* (.20)	.23	.07 (.18)	.21
	Subject shifts[a]	49.20% (15.90)	48.24% (10.80)	46.18% (12.65)	.07 (.09)	−.07	−.02- (.09)	−.21	.09 (.09)	.18

Note. TD = typically developing; ASD = autism spectrum disorder; ADHD = attention-deficit/hyperactivity disorder; MLU = mean length of utterance; ECT = emotional and cognitive terms. [a] Percentage of the total number of syntactic units. [b] Percentage of pronoun use for maintained reference. [c] Percentage of full noun phrase use for referent (re)introduction. [d] Percentage of causal conjunctions with emotional and cognitive terms.
* $p < .05$. ** $p < .01$. *** $p < .001$.

lexical diversity). For the remaining linguistic categories all variables were count data and we used a binary response with logit link, with number of syntactic units as trials-variable to correct for interindividual differences in the number of syntactic units.

Furthermore, we transposed the means of the linguistic measures to z-scores, eliciting three language profiles that illustrate the similarities and differences between the groups (see Figure 1). We will present our findings per narrative category.

Verbal productivity. The three groups did not differ in the number of syntactic units. With regard to MLU, we found that children with ASD and children with ADHD produced shorter sentences than the TD group.

Speech fluency. The ADHD group produced fewer pauses and made fewer retracings in their narratives than the ASD group and the TD group. Furthermore, the ASD group and the ADHD group produced more repetitions than the TD group.

Syntactic complexity. With regard to syntactic complexity, we found that the ASD group and the ADHD group used fewer complex clauses than the TD group. Also, both clinical groups made more morphosyntactic errors than the TD group. No differences in the use of tensed complements were found between the groups.

Lexical semantics. No group differences were found regarding lexical measures. Neither lexical diversity nor the number of produced emotional and cognitive terms differed between the three groups.

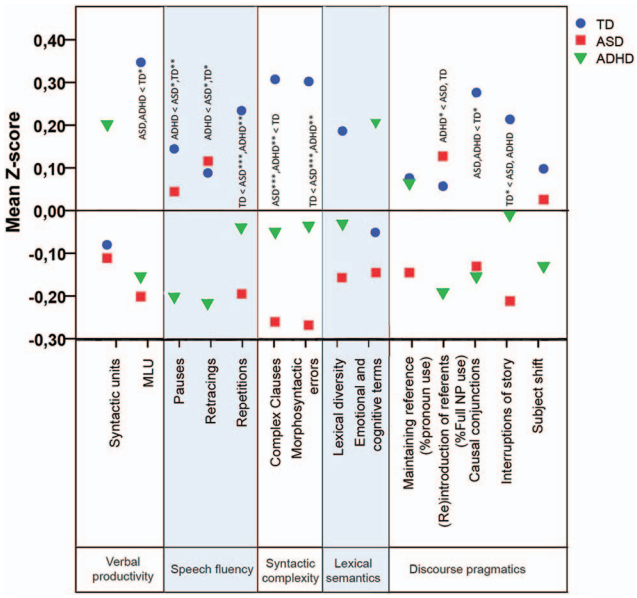

Figure 1. Mean *z*-scores on the linguistic categories per group (TD, ASD, ADHD). Please note that the z-scores of repetitions, morphosyntactic errors, and interruptions of story were reversed to have lower z-scores correspond with more problems. Subcategories Tensed clauses and Causal conjunctions with emotional and cognitive terms were left out to avoid overlap with other categories. TD = typically developing; ASD = autism spectrum disorder; ADHD = attention-deficit/hyperactivity disorder; MLU = mean length of utterance; Full NP = full noun phrase. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. See the online article for the color version of this figure.

Discourse pragmatics. With regard to the use of referring expressions, we found that all three groups mainly used pronouns to maintain reference to a character, while they used more explicit forms for (re)introduction of referents. However, children with ADHD were less specific than children with ASD and TD children when (re)introducing referents. Furthermore, both the ASD group and the ADHD group used significantly fewer causal conjunctions. This effect was even stronger for emotional and cognitive terms: children with ASD and children with ADHD rarely used causal conjunctions to link the emotional and cognitive terms to the context, whereas the TD group used causal conjunctions with one third of all emotional and cognitive terms.[1] We also found that children with ASD and children with ADHD interrupted their stories more often than the TD group. No differences between groups were found in the percentage of subject shift during the story.

Our groups differed on IQ and although lower IQ is inherent to ADHD and ASD compared to TD children (see also Dennis et al., 2009), we checked post hoc if found differences between ASD, ADHD and TD remained if IQs were comparable among the groups. This was done by selecting part of our TD-group ($n = 25$) to match the IQs of both other groups. (See supplemental Table S3 in the online supplemental materials for characteristics of the IQ-matched subsample). Effects remained highly similar although, due to reduced statistical power, p values were somewhat higher. Most differences between groups remained significant (i.e., six out of 10 remained significant; four effects lost significance: number of morphosyntactic errors [$p = .09$], reintroduction of referents [$p = .07$], interruptions of story [$p = .07$], and number of causal conjunctions [$p = .15$]). The highly similar magnitudes of the estimated effects in this post hoc analysis suggest that findings were not driven by IQ differences between groups, with the exception of causal conjunctions, for which this appeared partly the case.

Correlations of Narrative Skills With ToM, WM, and Response Inhibition

Next, for each of the five linguistic categories we summed the z-scores on the different measures per category. Pearson correlations were calculated to study the association between the scores on the five linguistic categories and performance on the ToM task, the WM task, and the inhibition task (see Table 3).

ToM, and more specifically second-order FB, was associated with all linguistic categories. Children with higher scores on the ToM task produced longer and more complex sentences, had fewer speech fluency problems, used more different words, and scored higher on the discourse pragmatic measures. WM was positively associated with verbal productivity, syntactic complexity, and discourse pragmatics. Performance on the inhibition task was associated with none of the linguistic categories.

[1] Please note that 21 children who did not use any emotional and cognitive terms were excluded from this analysis (nine TD, 10 ASD, and two ADHD).

Table 3
Correlations of Linguistic Categories With Theory of Mind Scores, Working Memory Scores, Inhibition Scores, and With the Two Composite Scores on the CCC-2

Linguistic categories	FB1	FB2	WM	SSRT	CCC-2 StructLS	CCC-2 GenPS	Estimated IQ[a]
Verbal productivity	.167	.247*	.265**	−.139	−.138	−.210*	.195*
Speech fluency	.103	.237*	.179	−.123	.011	−.193*	.128
Syntactic complexity	.261**	.223*	.213*	−.082	−.446**	−.374**	.386***
Lexical semantics	.210*	.221*	.178	−.136	−.010	−.085	.161
Discourse pragmatics	.285**	.229*	.325**	−.147	−.210*	−.213**	.282**

Note. FB1 = first-order false belief; FB2 = second-order false belief; WM = working memory; SSRT = response inhibition (Stop Signal Reaction Time); CCC-2 = Children's Communication Checklist-2nd version; StructLS = structural language score (scale A-D); GenPS = general pragmatic score (scale E-H).
[a] Based on two subtests of the Wechsler Intelligence Scale for Children, 3rd ed.
* $p < .05$. ** $p < .01$. *** $p < .001$.

CCC-2

Findings based on the CCC-2 for the three groups are shown in Table 4. To analyze group differences on the CCC-2 scales and composite scores, for each scale and for the two composite scores we conducted generalized linear model analyses, with dummy-coded contrasts between diagnostic groups and controls (ASD vs. TD and ADHD vs. TD) included as predictor in the analysis. To additionally compare the ASD group with the ADHD group, we reran the analyses with dummy-coded contrasts with the ADHD group as reference category (ASD vs. ADHD and TD vs. ADHD). We used a linear model. Furthermore, Pearson correlations were calculated to study the association between the five linguistic categories obtained from the narratives and the two composite scores of the CCC-2 (see Table 3).

On five of the eight scales (Speech Output, Syntax, Semantics, Coherence, and Inappropriate Initiation), the ADHD group and the ASD group significantly differed from the TD group, but not from each other. On the remaining three scales (Stereotyped Language, Use of Context and Nonverbal Communication), all three groups significantly differed from each other, with the scores of the ADHD group in between the scores of ASD group and the TD group.

On the Structural Language Score, both the ASD group and the ADHD group differed from the TD group, but not from each other. In contrast, all three groups significantly differed from each other on the General Pragmatics Score, with highest scores (i.e., more problems) for the ASD group, lowest scores for the TD group, and the ADHD group in between.

Concluding, both the ADHD group and the ASD group differed from the TD group on every scale of the CCC-2 and differed from each other on some of the pragmatic scales and the General Pragmatic Score, with scores indicating most impairments for children with ASD. On the structural language scales, the ASD and ADHD group had more problems than TD children but could not been distinguished from each other.

Correlations of Narrative Skills With CCC-2

Pearson correlations were calculated to study the association between the two composite scores of the CCC-2 and the five narrative categories (see Table 3). Correlations were computed

Table 4
Mean Scores (With Standard Deviations), Estimates (With Standard Errors) and Effect Sizes on the CCC-2 Scales Per Group (TD, ASD, ADHD)

CCC-2 scales	TD *M* (*SD*)	ASD	ADHD *M* (*SD*)	ASD vs. TD		ADHD vs. TD		ASD vs. ADHD	
				Estimate (*SE*)	Cohen's *d*	Estimate (*SE*)	Cohen's *d*	Estimate (*SE*)[e]	Cohen's *d*
A Speech Output	.69 (1.21)	2.14 (2.55)	2.79 (2.90)	1.45** (.55)	.72	2.11*** (.55)	.94	−0,66 (.55)	−.23
B. Syntax	.77 (1.37)	4.14 (3.18)	4.18 (3.86)	3,37*** (.70)	1.37	3,41*** (.71)	1.17	−0,038 (.70)	−.01
C. Semantics	2.34 (2.03)	6.31 (2.64)	6.09 (3.62)	3.96*** (.66)	1.68	3.75*** (.67)	1.27	.22 (.67)	.06
D. Coherence	1.66 (1.68)	7.86 (3.37)	6.68 (3.82)	6.20*** (.72)	2.32	5.02*** (.73)	1.70	1.19 (.73)	.32
E. Inappropriate Initiation	2.40 (2.19)	10.72 (4.60)	9.12 (4.67)	8.32*** (.93)	2.30	6.72*** (.95)	1.84	1.61 (.94)	.34
F. Stereotyped Language	.89 (1.11)	5.61 (2.65)	4.15 (3.21)	4.73*** (.58)	2.32	3.26*** (.59)	1.35	1.46* (.59)	.49
G. Use of Context	1.83 (1.62)	11.36 (4.32)	7.62 (3.78)	9.53*** (.81)	2.92	5.79*** (.82)	1.99	3.74*** (.81)	.92
H. Nonverbal Communication	1.26 (1.74)	9.72 (4.00)	5.74 (3.48)	8.46*** (.76)	2.74	4.48*** (.77)	1.62	3.99*** (.76)	1.06
CCC-2 composite scores									
Structural Language Score (sum scales A–D)	5.45 (4.67)	20.44 (9.01)	19.74 (12.21)	14.99*** (2.14)	2.08	14.28*** (2.17)	1.54	.71 (2.15)	.06
General Pragmatic Score (sum scales E–H)	6.37 (5.19)	37.42 (13.05)	26.62 (13.23)	31.05*** (2.61)	3.12	20.25*** (2.64)	1.18	10.80*** (2.63)	.56

Note. TD = typically developing; ASD = autism spectrum disorder; ADHD = attention-deficit/hyperactivity disorder; CCC-2 = Children's Communication Checklist, 2nd version.
* $p < .05$. ** $p < .01$. *** $p < .001$.

based on data combined across all three groups. (See supplemental Table S4 in the online supplemental materials for the correlations for each of the three groups).

The General Pragmatic Score correlated negatively with verbal productivity, speech fluency, syntactic complexity, and discourse pragmatics. That is, children who showed more pragmatic problems, as reported by their parents, produced shorter sentences and stories, showed more problems with their speech fluency, syntactic complexity, and with producing a cohesive and coherent discourse than children who showed less pragmatic problems on the CCC-2.

The Structural Language Score on the CCC-2 correlated negatively with syntactic complexity and discourse pragmatics. No associations were found of the two CCC-2 composite scores with lexical measures, nor with measures of speech fluency.

Discussion

The first aim of this study was to provide a profile of the narrative abilities of children with ASD and children with ADHD. Starting with the similarities between the two clinical groups, both the ASD group and the ADHD group produce shorter utterances than the TD group, although they are as productive as the TD group in their number of utterances. This corroborates earlier findings of Rumpf et al. (2012), who also found lower MLUs in ADHD and ASD and similar verbal productivity for ADHD and TD. Contrary to our results, Rumpf et al. reported shorter stories in their ASD group compared to their TD group. However, most other studies on ASD did not find differences in story length, which is in line with the present findings (e.g., Banney et al., 2015; Diehl et al., 2006; Losh & Capps, 2003; Norbury & Bishop, 2003; Suh et al., 2014). Furthermore, both clinical groups produce less complex utterances and make more morphosyntactic errors than the TD group (cf. Banney et al., 2015; Capps et al., 2000; Norbury & Bishop, 2003; Tager-Flusberg, 1995, but contrary to Diehl et al., 2006; Losh & Capps, 2003). We also find a reduced use of cohesive devices in the ASD group and the ADHD group: Both groups are less inclined to explicitly express causal relations in their narratives than the TD group, which is even stronger when expressing causal relations with emotional or cognitive terms (cf. Tager-Flusberg & Sullivan, 1995). The limited use of causal conjunctions by children with ASD and ADHD suggests that not only children with ASD (cf. Capps et al., 2000; Tager-Flusberg, 1995), but also children with ADHD have difficulties in explaining relationships between events in a narrative. A final similarity between children with ASD and children with ADHD is that both groups produce more repetitions than the TD group, which is thought to reflect difficulties in retrieving lexical items and producing syntactic structures (Guo et al., 2008). Summarizing, children with ASD and children with ADHD show comparable deficits in narrative production, not only on pragmatic measures, but also on measures of language structure.

In addition to the similarities between ASD and ADHD, there are also differences between the two groups. Children with ADHD are less specific when (re)introducing referents, while children with ASD do not differ from the TD group. This finding in children's spontaneous speech corresponds with findings in a controlled referential elicitation study with short stories in the same group of children (Kuijper et al., 2015). In the present study, we found that even in longer and more complex discourses, children with ASD make the same referential choices as TD children, while children with ADHD use less specific referring expressions. Another important difference between the two clinical groups is that children with ADHD produce fewer pauses and fewer retracings than the ASD group and the TD group, whereas the latter two groups perform similarly. Pauses are regarded as reflecting lexical and syntactic decisions (e.g., Guo et al., 2008; Rispoli, 2003) and more pauses are associated with longer and syntactically more complex sentences (Rispoli & Hadley, 2001). Our findings thus suggest that children with ADHD spend less time making syntactic and lexical decisions in narratives. This may be the cause of the amount of morphosyntactic errors and the reduced syntactic complexity that was found in the ADHD group.

Repetitions are also often viewed as reflecting syntactic and lexical decisions (e.g., Engelhardt et al., 2013; Guo et al., 2008). However, the results of our study suggest that the production of pauses and the production of repetitions may have a different origin: Although children with ASD and children with ADHD produce more repetitions than TD children, children with ASD do not differ from TD children in the number of pauses, and children with ADHD even produce fewer pauses than the TD group. We propose that linguistic repetitions may be indicative of repetitive behaviors in general, and do not reflect lexical or syntactic decisions. In support of this idea, post hoc analysis indicated a positive correlation between the ADI-R subscale of repetitive behavior and the proportion of repetitions ($r = .31$, $p = .001$) and between the ADOS subscale of repetitive behavior and the proportion of repetitions ($r = .20$, $p = .04$). There were no significant associations between these two repetitive behavior subscales and the proportion of pauses.

In sum, with regard to our first aim, our results show that not only in children with ASD, but also in children with ADHD, deficits in language production are present. These deficits are present on pragmatic measures such as relative impairment in producing a cohesive and coherent narrative, as we hypothesized. In addition, both groups also show deficits on syntactic measures and speech fluency measures. Children with ASD seem to have most problems with syntactic complexity and also frequently interrupt their stories, while children with ADHD have most problems in their choice of referring expressions and speech fluency (which may reflect lexical and syntactic decisions). This extensive linguistic profile gives insights in the specific language problems for both clinical groups, adding to a growing literature on the overlap and differences between both disorders.

The second aim of our study was to provide insights into the cognitive processes relevant for the appropriate production of narratives. We find that ToM is associated with all five narrative categories. Previous studies reported relations between ToM and the ability to tell a coherent story (Capps et al., 2000), the use of tensed complements (de Villiers & Pyers, 2002), and the use of emotional and cognitive terms (Capps et al., 2000; Tager-Flusberg & Sullivan, 1995). Our study is consistent with these findings and additionally shows that ToM is also associated with speech fluency and with structural linguistic components, such as verbal productivity and measures of syntactic complexity. Important to note is that the ToM task used in this study is a verbal task. It is clear that language and ToM are associated, although the meaning of the relation is unclear. Some researchers argue that language plays a causal role in the development of ToM (e.g., De Villiers & Pyers,

2002) or, reversely, that ToM is needed for language development (e.g., Sabbagh & Baldwin, 2001). A meta-analysis of Milligan et al. (2007) showed evidence for relations in both directions. The design of our study does not enable us to determine the direction of the associations between the linguistic abilities and ToM performance.

With regard to EF, there are associations between narrative skills (verbal productivity, syntactic complexity, and discourse pragmatics) and WM, but none between narrative skills and inhibition. WM has previously been related to language comprehension processes (see the meta-analysis of Daneman & Merikle, 1996), but little is known about the relation between WM and language production, although associations have been found between WM and choice of referring expression (Almor, Kempler, Macdonald, Andersen, & Tyler, 1999; Kuijper et al., 2015). The present study shows that WM is associated with language production at different levels simultaneously at sentence level (syntactic complexity), discourse level (discourse pragmatics), and narrative level (verbal productivity). To establish relations between the utterances in the story, speakers need to remember the previous discourse while planning the next utterance. Furthermore, to produce longer and more difficult sentences, speakers need sufficient WM. Our findings indicate that children with lower WM capacity tend to produce shorter and simpler sentences and stories and are less able to establish a coherent and cohesive discourse. Inhibition is not related to any of the narrative skills. It could be that it is not motor response inhibition (which we measured by use of the SSRT in the Stop Task) that is relevant for narrative ability, but rather cognitive inhibition (interference control). When producing a sentence, a speaker should make lexical and syntactical choices, thereby inhibiting competing words and syntactic structures. This inhibition of competing words and structures may more resemble performance on an interference control task than on a motor response inhibition task. In support of this idea, a relation between interference control and verbal fluency has previously been found, but not between response inhibition and verbal fluency (Engelhardt et al., 2013; Shao, Janse, Visser, & Meyer, 2014). Whether other narrative skills also relate to interference control remains to be investigated.

Our third aim was to relate children's narrative abilities to their communicative functioning as reported by their parents on the CCC-2. We find that on CCC-2 scales that tap problems with language structure, the ASD and ADHD group cannot be distinguished from each other, whereas on scales that measure pragmatic problems (Use of Stereotyped Language, Use of Context and Nonverbal Communication) they can. Our findings on the CCC-2 corroborate most findings of Geurts and Embrechts (2008) and Helland et al. (2012), with group differences even more outspoken in the present study and found on every scale in comparison to the control group. This may relate to the rigorous diagnostic assessment by gold-standard diagnostic measures in our study (ADOS, ADI-R, and PICS; all applied to the ASD, ADHD, and TD groups), which is more valid than clinical diagnosis only, as was the case in both previous studies. Furthermore, children in our study were slightly younger than in Geurts and Embrechts' study, which may account for more reported problems with the structural aspects of language, as was the case in their sample of preschoolers (Geurts & Embrechts, 2008).

With regard to the relation between children's narrative abilities and their CCC-2 scores, we find that the composite score General Pragmatics is associated with measures of verbal productivity, speech fluency, syntactic complexity, and discourse pragmatics, whereas the composite score Structural Language is associated with measures of syntactic complexity and discourse pragmatics. No associations are found between the General Pragmatics Score or the Structural Language Score and measures of lexical semantics or speech fluency. Note that the significant correlations between narratives and CCC-2 composite scores are modest (r varies between .2 and .4). This confirms that narratives give different information about children's linguistic performance than what parents observe in their children. The strength of narratives above parental reports is that they provide a direct and more objective measure of children's language abilities than the more subjective report of parents and can add valuable information, particularly on more implicit aspects of children's communication capacities. Furthermore, detailed examination of children's narratives may measure more precisely the different aspects of children's language than parental questionnaires.

One limitation of this study may be that the number of syntactic units produced per child (28–30) is relatively small. In some other studies, children produced about 40 utterances each (Capps et al., 2000; Norbury & Bishop, 2003; Rumpf et al., 2012), although other studies were also based on 25–28 utterances per child (Banney et al., 2015; Diehl et al., 2006; Suh et al., 2014). Because some of the scored measures are relatively rare, it is possible that longer narratives give more accurate estimates and may yield higher correlations between the linguistic categories and ToM, WM, and the CCC-2 scores. Although detailed manual transcriptions are time-consuming, recent developments in (semi-)automatic transcription contribute to faster collection and analysis of spontaneous data (e.g., Strik & Cucchiarini, 2014). This yields future opportunities for research and perhaps even for the use of narratives for diagnostic purposes in clinical practice. Given that the standard diagnostic assessment of the ADOS provides valuable information on children's linguistic difficulties (our study as well as Banney et al., 2015; Rumpf et al., 2012; Suh et al., 2014), we propose that storytelling during the *Cartoon* activity in the ADOS can be added to the *Tuesday* narratives to collect longer transcripts.

In conclusion, both children with ASD and children with ADHD have deficits in language production, not only as rated by parents, as has been shown before, but also in the narratives the children tell. Both pragmatic and syntactic components of their language are impaired, whereas semantic components are unimpaired in comparison to TD children. Children with ADHD differ from children with ASD in that they have more difficulties in speech fluency and the choice of referring expressions. Furthermore, ToM and WM performance but not response inhibition are associated with many narrative skills, suggesting that impairments in these cognitive mechanisms may partly explain impairments in language production. Our study provides broad profiles of the language abilities of children with ASD and children with ADHD, with strengths and difficulties in narrative production for both groups. The results of the present study emphasize the need to investigate

language abilities not only of children with ASD, but also of children with ADHD.

References

Almor, A., Kempler, D., MacDonald, M. C., Andersen, E. S., & Tyler, L. K. (1999). Why do Alzheimer patients have difficulty with pronouns? Working memory, semantics, and reference in comprehension and production in Alzheimer's disease. *Brain and Language, 67,* 202–227. http://dx.doi.org/10.1006/brln.1999.2055

American Psychiatric Association (APA). (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

American Psychiatric Association (APA). (2000). *Diagnostic and statistical manual of mental disorders* (4th ed. Text Revision). Washington, DC: Author.

Arnold, J., & Griffin, Z. M. (2008). The effect of additional characters on choice of referring expression: Everyone counts. *Journal of Memory and Language, 56,* 521–536. http://dx.doi.org/10.1016/j.jml.2006.09.007

Baird, G., Simonoff, E., Pickles, A., Chandler, S., Loucas, T., Meldrum, D., & Charman, T. (2006). Prevalence of disorders of the autism spectrum in a population cohort of children in South Thames: The Special Needs and Autism Project (SNAP). *The Lancet, 368,* 210–215. http://dx.doi.org/10.1016/S0140-6736(06)69041-7

Bamberg, M., & Damrad-Frye, R. (1991). On the ability to provide evaluative comments: Further explorations of children's narrative competencies. *Journal of Child Language, 18,* 689–710. http://dx.doi.org/10.1017/S0305000900011314

Band, G. P. H., van der Molen, M. W., & Logan, G. D. (2003). Horse-race model simulations of the stop-signal procedure. *Acta Psychologica, 112,* 105–142. http://dx.doi.org/10.1016/S0001-6918(02)00079-3

Banney, R. M., Harper-Hill, K., & Arnott, W. L. (2015). The Autism Diagnostic Observation Schedule and narrative assessment: Evidence for specific narrative impairments in autism spectrum disorders. *International Journal of Speech-Language Pathology, 17,* 159–171. http://dx.doi.org/10.3109/17549507.2014.977348

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21,* 37–46. http://dx.doi.org/10.1016/0010-0277(85)90022-8

Bialystok, E., Martin, M. M., & Viswanathan, M. (2005). Bilingualism across the lifespan: The rise and fall of inhibitory control. *The International Journal of Bilingualism, 9,* 103–119. http://dx.doi.org/10.1177/13670069050090010701

Bishop, D. V. M. (2003). *The Children's Communication Checklist-version-2 (CCC-2)*. London, UK: Psychological Corperation.

Bishop, D. V. M., & Baird, G. (2001). Parent and teacher report of pragmatic aspects of communication: Use of the Children's Communication Checklist in a clinical setting. *Developmental Medicine & Child Neurology, 43,* 809–818. http://dx.doi.org/10.1017/S0012162201001475

Botting, N. (2002). Narrative as a tool for the assessment of linguistic and pragmatic impairments. *Child Language Teaching and Therapy, 18*(1), 1–21. http://dx.doi.org/10.1191/0265659002ct224oa

Capps, L., Losh, M., & Thurber, C. (2000). "The frog ate the bug and made his mouth sad": Narrative competence in children with autism. *Journal of Abnormal Child Psychology, 28,* 193–204. http://dx.doi.org/10.1023/A:1005126915631

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin & Review, 3,* 422–433. http://dx.doi.org/10.3758/BF03214546

Dennis, M., Francis, D. J., Cirino, P. T., Schachar, R., Barnes, M. A., & Fletcher, J. M. (2009). Why IQ is not a covariate in cognitive studies of neurodevelopmental disorders. *Journal of the International Neuropsychological Society, 15,* 331–343. http://dx.doi.org/10.1017/S1355617709090481

de Villiers, J. G., & Pyers, J. E. (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief-understanding. *Cognitive Development, 17,* 1037–1060. http://dx.doi.org/10.1016/S0885-2014(02)00073-4

Diehl, J. J., Bennetto, L., & Young, E. C. (2006). Story recall and narrative coherence of high-functioning children with autism spectrum disorders. *Journal of Abnormal Child Psychology, 34,* 87–102. http://dx.doi.org/10.1007/s10802-005-9003-x

Eigsti, I.-M., Bennetto, L., & Dadlani, M. B. (2007). Beyond pragmatics: Morphosyntactic development in autism. *Journal of Autism and Developmental Disorders, 37,* 1007–1023. http://dx.doi.org/10.1007/s10803-006-0239-2

Engelhardt, P. E., Nigg, J. T., & Ferreira, F. (2013). Is the fluency of language outputs related to individual differences in intelligence and executive function? *Acta Psychologica, 144,* 424–432. http://dx.doi.org/10.1016/j.actpsy.2013.08.002

Friend, M., & Bates, R. P. (2014). The union of narrative and executive function: Different but complementary. *Frontiers in Psychology, 5,* 469. http://dx.doi.org/10.3389/fpsyg.2014.00469

Geurts, H. M. (2007). *CCC-2-NL: Children's Communication Checklist-2*. Amsterdam, the Netherlands: Harcourt Assesment.

Geurts, H. M., & Embrechts, M. (2008). Language profiles in ASD, SLI, and ADHD. *Journal of Autism and Developmental Disorders, 38,* 1931–1943. http://dx.doi.org/10.1007/s10803-008-0587-1

Geurts, H. M., Verté, S., Oosterlaan, J., Roeyers, H., Hartman, C. A., Mulder, E. J., . . . Sergeant, J. A. (2004). Can the Children's Communication Checklist differentiate between children with autism, children with ADHD, and normal controls? *Journal of Child Psychology and Psychiatry, 45,* 1437–1453. http://dx.doi.org/10.1111/j.1469-7610.2004.00326.x

Green, B. C., Johnson, K. A., & Bretherton, L. (2014). Pragmatic language difficulties in children with hyperactivity and attention problems: An integrated review. *International Journal of Language & Communication Disorders, 49,* 15–29. http://dx.doi.org/10.1111/1460-6984.12056

Green, D. W. (2013). Inhibition and control in second language acquisition. *The Encyclopedia of Applied Linguistics, 2,* 2–5.

Guiraud, P. (1960). *Problèmes et méthodes de la statistique linguistique*. Dordrecht, the Netherlands: Reidel.

Guo, L. Y., Tomblin, J. B., & Samelson, V. (2008). Speech disruptions in the narratives of English-speaking children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 51,* 722–738. http://dx.doi.org/10.1044/1092-4388(2008/051)

Helland, W. A., Biringer, E., Helland, T., & Heimann, M. (2012). Exploring language profiles for children with ADHD and children with asperger syndrome. *Journal of Attention Disorders, 16,* 34–43. http://dx.doi.org/10.1177/1087054710378233

Hollebrandse, B., Van Hout, A., & Hendriks, P. (2014). Children's first and second-order false-belief reasoning in a verbal and a low-verbal task. *Synthese, 191,* 321–333. http://dx.doi.org/10.1007/s11229-012-0169-9

Ickowicz, A., Schachar, R. J., Sugarman, R., Chen, S. X., Millette, C., & Cook, L. (2006). The parent interview for child symptoms: A situation-specific clinical research interview for attention-deficit hyperactivity and related disorders. *The Canadian Journal of Psychiatry/La Revue canadienne de psychiatrie, 51,* 325–328.

Johnson, M. H., Gliga, T., Jones, E., & Charman, T. (2015). Annual research review: Infant development, autism, and ADHD—Early pathways to emerging disorders. *Journal of Child Psychology and Psychiatry, 56,* 228–247. http://dx.doi.org/10.1111/jcpp.12328

Johnston, J. R. (2001). An alternate MLU calculation: Magnitude and variability of effects. *Journal of Speech, Language, and Hearing Research, 44,* 156–164. http://dx.doi.org/10.1044/1092-4388(2001/014)

Kjelgaard, M. M., & Tager-Flusberg, H. (2001). An investigation of language impairment in autism: Implications for genetic subgroups.

Language and Cognitive Processes, 16(2–3), 287–308. http://dx.doi.org/10.1080/01690960042000058

Kort, W., Compaan, E. L., Bleichrodt, N., Resing, W. C. M. Schittekatte, M., Bosmans, M., . . .Verhaeghe, P. (2002). *WISC-III NL, Handleiding*. London, UK: The Psychological Corporation.

Kuijper, S. J. M., Hartman, C. A., & Hendriks, P. (2015). Who is he? Children with ASD and ADHD take the listener into account in their production of ambiguous pronouns. *PLoS ONE, 10*(7), e0132408. http://dx.doi.org/10.1371/journal.pone.0132408

Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (1999). *ADOS: Autism Diagnostic Observation Schedule Manual*. Los Angeles, CA: Western Psychological Services.

Losh, M., & Capps, L. (2003). Narrative ability in high-functioning children with autism or Asperger's syndrome. *Journal of Autism and Developmental Disorders, 33,* 239–251. http://dx.doi.org/10.1023/A:1024446215446

Luo, F., & Timler, G. R. (2008). Narrative organization skills in children with attention deficit hyperactivity disorder and language impairment: Application of the causal network model. *Clinical Linguistics & Phonetics, 22,* 25–46. http://dx.doi.org/10.1080/02699200701627430

MacWhinney, B. (2000). *The CHILDES Project: Tools for Analyzing Talk* (3rd ed.). Mahwah, NJ: Erlbaum.

Mar, R. A. (2004). The neuropsychology of narrative: Story comprehension, story production and their interrelation. *Neuropsychologia, 42,* 1414–1434. http://dx.doi.org/10.1016/j.neuropsychologia.2003.12.016

Milligan, K., Astington, J. W., & Dack, L. A. (2007). Language and theory of mind: Meta-analysis of the relation between language ability and false-belief understanding. *Child Development, 78,* 622–646. http://dx.doi.org/10.1111/j.1467-8624.2007.01018.x

Miniscalco, C., Hagberg, B., Kadesjö, B., Westerlund, M., & Gillberg, C. (2007). Narrative skills, cognitive profiles and neuropsychiatric disorders in 7–8-year-old children with late developing language. *International Journal of Language & Communication Disorders, 42,* 665–681. http://dx.doi.org/10.1080/13682820601084428

Nijmeijer, J. S., Arias-Vásquez, A., Rommelse, N. N. J., Altink, M. E., Anney, R. J. L., Asherson, P., . . . Hoekstra, P. J. (2010). Identifying loci for the overlap between attention-deficit/hyperactivity disorder and autism spectrum disorder using a genome-wide QTL linkage approach. *Journal of the American Academy of Child & Adolescent Psychiatry, 49,* 675–685.

Norbury, C. F., & Bishop, D. V. M. (2003). Narrative skills of children with communication impairments. *International Journal of Language & Communication Disorders, 38,* 287–313. http://dx.doi.org/10.1080/1368231000010813 3

Norbury, C. F., Gemmell, T., & Paul, R. (2014). Pragmatics abilities in narrative production: A cross-disorder comparison. *Journal of Child Language, 41,* 485–510. http://dx.doi.org/10.1017/S030500091300007X

Owen, A. M., McMillan, K. M., Laird, A. R., & Bullmore, E. (2005). N-back working memory paradigm: A meta-analysis of normative functional neuroimaging studies. *Human Brain Mapping, 25,* 46–59. http://dx.doi.org/10.1002/hbm.20131

Parigger, E. (2012). *Language and executive functioning in children with ADHD* (Doctoral dissertation). University of Amsterdam, Amsterdam, the Netherlands.

Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., & Rohde, L. A. (2007). The worldwide prevalence of ADHD: A systematic review and metaregression analysis. *The American Journal of Psychiatry, 164,* 942–948. http://dx.doi.org/10.1176/ajp.2007.164.6.942

Purvis, K. L., & Tannock, R. (1997). Language abilities in children with attention deficit hyperactivity disorder, reading disabilities, and normal controls. *Journal of Abnormal Child Psychology, 25,* 133–144. http://dx.doi.org/10.1023/A:1025731529006

Renz, K., Lorch, E. P., Milich, R., Lemberger, C., Bodner, A., & Welsh, R. (2003). On-line story representation in boys with attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology, 31,* 93–104. http://dx.doi.org/10.1023/A:1021777417160

Risi, S., Lord, C., Gotham, K., Corsello, C., Chrysler, C., Szatmari, P., . . . Pickles, A. (2006). Combining information from multiple sources in the diagnosis of autism spectrum disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 45,* 1094–1103. http://dx.doi.org/10.1097/01.chi.0000227880.42780.0e

Rispoli, M. (2003). Changes in the nature of sentence production during the period of grammatical development. *Journal of Speech, Language, and Hearing Research, 46,* 818–830. http://dx.doi.org/10.1044/1092-4388(2003/064)

Rispoli, M., & Hadley, P. (2001). The leading-edge: The significance of sentence disruptions in the development of grammar. *Journal of Speech, Language, and Hearing Research, 44,* 1131–1143. http://dx.doi.org/10.1044/1092-4388(2001/089)

Rommelse, N. N. J., Geurts, H. M., Franke, B., Buitelaar, J. K., & Hartman, C. A. (2011). A review on cognitive and brain endophenotypes that may be common in autism spectrum disorder and attention-deficit/hyperactivity disorder and facilitate the search for pleiotropic genes. *Neuroscience and Biobehavioral Reviews, 35,* 1363–1396. http://dx.doi.org/10.1016/j.neubiorev.2011.02.015

Rumpf, A. L., Kamp-Becker, I., Becker, K., & Kauschke, C. (2012). Narrative competence and internal state language of children with Asperger Syndrome and ADHD. *Research in Developmental Disabilities, 33,* 1395–1407. http://dx.doi.org/10.1016/j.ridd.2012.03.007

Russell, G., Rodgers, L. R., Ukoumunne, O. C., & Ford, T. (2014). Prevalence of parent-reported ASD and ADHD in the UK: Findings from the Millennium Cohort Study. *Journal of Autism and Developmental Disorders, 44,* 31–40. http://dx.doi.org/10.1007/s10803-013-1849-0

Rutter, M., Le Couteur, A., & Lord, C. (2003). *ADI-R: Autism Diagnostic Interview Revised manual*. Los Angeles, CA: Western Psychological Services.

Sabbagh, M. A., & Baldwin, D. A. (2001). Learning words from knowledgeable versus ignorant speakers: Links between preschoolers' theory of mind and semantic development. *Child Development, 72,* 1054–1070. http://dx.doi.org/10.1111/1467-8624.00334

Schlichting, L. (2005). *Peabody Picture Vocabulary Test-III-NL*. Amsterdam, the Netherlands: Harcourt Test Publishers.

Shao, Z., Janse, E., Visser, K., & Meyer, A. S. (2014). What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults. *Frontiers in Psychology, 5,* 772. http://dx.doi.org/10.3389/fpsyg.2014.00772

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry, 47,* 921–929. http://dx.doi.org/10.1097/CHI.0b013e318179964f

Strik, H., & Cucchiarini, C. (2014). On automatic phonological transcription of speech corpora. In: J. Durand, U. Gut, & G. Kristoffersen (Eds.), *The Oxford handbook of corpus phonology* (pp. 89–109). Oxford, England: Oxford University Press.

Suh, J., Eigsti, I. M., Naigles, L., Barton, M., Kelley, E., & Fein, D. (2014). Narrative performance of optimal outcome children and adolescents with a history of an Autism Spectrum Disorder (ASD). *Journal of Autism and Developmental Disorders, 44,* 1681–1694. http://dx.doi.org/10.1007/s10803-014-2042-9

Tager-Flusberg, H. (1995). "Once upon a ribbit": Stories narrated by autistic children. *British Journal of Developmental Psychology, 13,* 45–59. http://dx.doi.org/10.1111/j.2044-835X.1995.tb00663.x

Tager-Flusberg, H., & Sullivan, K. (1995). Attributing mental states to story characters: A comparison of narratives produced by autistic and mentally retarded individuals. *Applied Psycholinguistics, 16,* 241. http://dx.doi.org/10.1017/S0142716400007281

Tannock, R., Hum, M., Masellis, M., Humphries, T., & Schachar, R. (2002). *Teacher Telephone Interview for attention-deficit/hyperativity disorder and related disorders: DSM–IV version*. Toronto, Ontario, Canada: The Hospital for Sick Children.

Tannock, R., Purvis, K. L., & Schachar, R. J. (1993). Narrative abilities in children with attention deficit hyperactivity disorder and normal peers. *Journal of Abnormal Child Psychology, 21,* 103–117. http://dx.doi.org/10.1007/BF00910492

Tannock, R., & Schachar, R. (1996). Executive dysfunction as an underlying mechanism of behavior and language problems in attention-deficit hyperactivity disorder. In J. H. Beitchman, N. J. Cohen, M. M. Konstantareas, & R. Tannock (Eds.), *Language, learning and behavioral disorders: Developmental, biological and clinical perspectives* (pp. 128–155). Cambridge, UK: Cambridge University Press.

Tsimpli, I. M., Andreou, M., Agathopoulou, E., & Masoura, E. (2014). Narrative production, bilingualism and working memory capacity: A study of Greek-German bilingual children. In G. Kotzoglou et al. (Eds.), *Proceedings of the 11th International Conference on Greek Linguistics* (pp. 1730–1742). Rhodes, Greece: University of the Aegean.

van den Wildenberg, W. P. M., & Christoffels, I. K. (2010). STOP TALKING! Inhibition of speech is affected by word frequency and dysfunctional impulsivity. *Frontiers in Psychology, 1,* 145.

Wiesner, D. (1991). *Tuesday*. New York, NY: Clarion Books.

Received December 7, 2015
Revision received September 27, 2016
Accepted September 27, 2016 ■