

University of Groningen

## Communication abilities of children with ASD and ADHD

Kuijper, Sanne Joanna Maria

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*

Publisher's PDF, also known as Version of record

*Publication date:*

2016

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*

Kuijper, S. J. M. (2016). *Communication abilities of children with ASD and ADHD: Production, comprehension, and cognitive mechanisms*. [Thesis fully internal (DIV), University of Groningen]. Rijksuniversiteit Groningen.

**Copyright**

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

**Take-down policy**

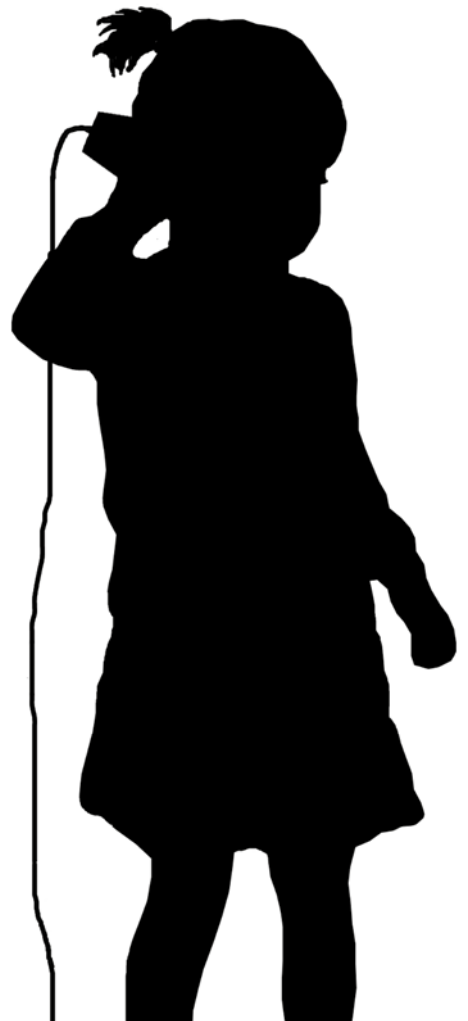
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

# 3

## Narrative production in children with ASD and children with ADHD: similarities and differences

This chapter has been submitted as:  
Kuijper, S. J. M., Hartman, C. A., Bogaerds-Hazenberg, S. T. M., & Hendriks, P. (2015).  
Narrative production in children with ASD and children with ADHD: similarities  
and differences



## Abstract

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). Additionally, we investigated whether Theory of Mind (ToM), working memory, and response inhibition are associated with language production. Narratives, produced by 108 Dutch-speaking children (38 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 (ADOS, ADI-R, and 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.

## Introduction

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 similarities 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 in order to investigate the similarities and differences in language production between these two groups. We are the first to study narrative performance in substantial numbers of TD children, children with ASD, and children with ADHD who all received thorough diagnostic assessment.

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). Such precise information is difficult to retrieve from parent 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 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) (5 children with ASD, 8 with ADHD, and 8 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), 9 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, and used more explicit forms to refer to the characters than the TD group, while the ADHD group did not differ from both groups.

Thus, while 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 studies 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 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 working memory and story length in retelling stories by bilinguals has been reported (Tsimpli, Andreou, Agathopoulou, & Masoura, 2014). However, 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. Second, we relate children's scores on linguistic measures to scores on ToM and EF tasks. Two important aspects of EF are focused on, namely working memory 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.

## Methods

### 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 Autism Diagnostic Observation Schema (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 verbal communication skills. Both the Autism Diagnostic Interview Revised (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. The Parent Interview for Child Symptoms (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 (WISC-III-NL) (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 wordless picture book *Tuesday* (Wiesner, 1991). The experimenter first introduced the book and the child then had to continue telling the story, until the experimenter finished the story. Since this endpoint was not the same for all children, we analyzed all stories until page 18 of the picture book. The experimenter was sitting next to the child, and interaction was allowed between the child and the experimenter. In this way, the narrative elicitation approached a natural setting.

### Story transcription

All stories were transcribed by two trained transcribers who were blind for diagnosis, following the Codes for Human Analysis of Transcripts (CHAT) (MacWhinney, 2000). A third transcriber checked the stories for differences between the two transcribers, while listening to 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  $\emptyset$  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



**Table 1** Mean scores (with standard deviations) of age, clinical instruments (ADI-R, ADOS, PICS), WISC-III, PPVT, FB task, N-back task, Stop task per group (TD, ASD, ADHD)

	ASD (n = 36) <sup>a</sup>		ADHD (n = 34) <sup>b</sup>		TD (n = 36) <sup>a</sup>		Group differences (Bonferroni corrected post hoc analyses)
	M	(SD)	M	(SD)	M	(SD)	
% Male	92		82		69		
Age	9;4	(1;10)	8;11	(1;7)	8;11	(1;8)	n.s.
ADI-R <sup>b</sup> Social Interaction	17.33	(6.00)	4.74	(4.17)	1.61	(2.75)	ASD***>ADHD>TD*
ADI-R <sup>b</sup> Communication	13.56	(4.33)	4.09	(2.73)	1.28	(1.45)	ASD***>ADHD>TD**
ADI-R <sup>b</sup> Stereotyped Behavior	4.92	(2.69)	1.41	(1.56)	0.31	(0.67)	ASD***>ADHD>TD*
ADI-R <sup>b</sup> Behavior < 3 yr	3.03	(0.94)	1.50	(1.56)	0.14	(0.42)	ASD***>ADHD>TD***
ADOS <sup>c</sup> Communication	2.94	(1.60)	1.12	(0.91)	0.50	(0.78)	ASD***>ADHD,TD
ADOS <sup>c</sup> Social interaction	8.14	(3.42)	2.47	(1.76)	1.39	(1.66)	ASD***>ADHD,TD
ADOS <sup>c</sup> Com+Soc	11.08	(4.65)	3.59	(2.38)	1.89	(1.92)	ASD***>ADHD,TD
ADOS <sup>c</sup> RRB	1.19	(1.37)	0.29	(0.58)	0.17	(0.45)	ASD***>ADHD,TD
ADOS Social Affect	10.00	(4.67)	2.76	(2.12)	1.53	(1.83)	ASD***>ADHD,TD
ADOS SA+RRB	11.19	(5.29)	3.06	(2.15)	1.69	(2.00)	ASD***>ADHD,TD
PICS <sup>d</sup> Inattention	2.31	(2.10)	3.71	(2.21)	0.08	(0.37)	ADHD***>ASD>TD***
PICS <sup>d</sup> Hyperactivity/impulsivity	2.06	(1.96)	5.26	(2.51)	0.28	(0.57)	ADHD***>ASD>TD***
WISC-III Block Design	9.06	(3.46)	8.26	(3.10)	11.28	(3.28)	ASD*, ADHD**<TD
WISC-III Vocabulary	8.58	(3.49)	9.44	(1.99)	11.86	(2.57)	ASD***, ADHD**<TD
WISC-III Estimated IQ	93.09	(17.58)	93.04	(12.81)	109.52	(13.83)	ASD, ADHD<TD***
PPVT WBQ	104.61	(15.90)	100.06	(11.32)	108.72	(10.94)	ADHD<TD*
False Belief Task (Proportion correct FB1)	0.86	(0.22)	0.90	(0.10)	0.94	(0.11)	n.s.
False Belief Task (Proportion correct FB2)	0.53	(0.40)	0.57	(0.34)	0.77	(0.29)	ASD, ADHD<TD*
N-Back Task (Numbers correct 2-back)	38.82	(7.92)	38.94	(5.98)	41.68	(5.35)	n.s.
Stop-Signal Task (SSRT)	259.99	(90.04)	248.08	(85.88)	257.44	(79.06)	n.s.

<sup>a</sup> Number of participants may vary per task, since some children did not finish all tasks (see Procedure). <sup>b</sup> 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)). <sup>c</sup> Two children in the ADHD group scored above the ADOS criteria for ASD. <sup>d</sup> 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).

\* =  $p < .05$ ; \*\* =  $p < .01$ ; \*\*\* =  $p < .001$ ; n.s. = non-significant.

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; 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 Appendix 5 for examples of each category.

#### **a) 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.

#### **b) Speech fluency**

In order 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 *ehm*, while unfilled pauses are clear silent moments. Additionally, 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*).

#### **c) 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.

#### **d) 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.

Additionally, for each child the total number of emotional and cognitive terms was counted. Since 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.

#### **e) 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: 1) Maintenance of reference to a character that is referred to in the previous clause; and 2) (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 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?*).

#### **ToM, working memory, 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). Working memory was tested with an n-back task (Owen, Mcmillan, & Laird, 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 working memory (WM). Response inhibition was tested with a Stop Task adopted from Van den Wildenberg and Christoffels (2010). The Stop Signal Reaction Time (SSRT) (Band, van der Molen, & Logan, 2003) was calculated as a measure of response inhibition. These three tasks to measure children's ToM, working memory, and response inhibition are described in the Appendices 1, 3, and 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 six scales that tap linguistic functioning: A) Speech Output, B) Syntax, C) Semantics, D) Coherence, E) Inappropriate Initiation, F) Stereotyped Language, G) Use of Context, H) Nonverbal Communication. Hence, we left out the two nonlinguistic scales (Social Relations and Interests). In addition, we calculated the General Pragmatics Score, a sum of scores on scale E to H. Furthermore, we calculated a second composite score of 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, we conducted generalized linear model analyses, with group (ASD, ADHD, TD) as between subjects factor and with TD group as reference category. To additionally compare the ASD group with the ADHD group, we re-ran the analyses with the ADHD group as reference category. We used a linear model for the variables with normal score distributions (i.e., the variables syntactic units, MLU and 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 inter-individual 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 (Figure 1). We will present our findings per narrative category.

#### **a) Verbal productivity**

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

#### **b) 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.

**Table 2** Mean scores (with standard deviations) and estimates (with standard errors) on the linguistic categories per group (TD, ASD, ADHD)

Linguistic categories	Measures	ASD		ADHD	
		<i>M</i>	<i>(SD)</i>	<i>M</i>	<i>(SD)</i>
Verbal productivity	Syntactic Units	28.75	(11.84)	32.62	(14.59)
	MLU	5.38	(0.96)	5.43	(1.05)
Speech fluency	Pauses <sup>1</sup>	28.72%	(22.62)	23.65%	(17.80)
	Retracings <sup>1</sup>	15.45%	(11.47)	11.38%	(10.78)
	Repetitions <sup>1</sup>	13.92%	(15.82)	11.94%	(13.28)
Syntactic complexity	Complex Clauses <sup>1</sup>	31.49%	(17.35)	35.80%	(20.44)
	Morphosyntactic errors <sup>2</sup>	13.00%	(10.30)	10.79%	(10.07)
	Tensed clauses	0.94%	(2.24)	1.29%	(3.44)
Lexical semantics	Lexical Diversity	6.38	(.84)	6.50	(.97)
	Emotional and Cognitive Terms (ECT) <sup>1</sup>	6.34%	(5.81)	8.52%	(6.60)
Discourse pragmatics	Maintaining reference <sup>2</sup>	67.15%	(20.43)	71.61%	(24.38)
	(Re)introduction of referents <sup>3</sup>	89.05%	(13.56)	84.22%	(15.45)
	Causal conjunctions <sup>1</sup>	1.61%	(3.63)	1.52%	(2.15)
	Causal conjunctions with ECT <sup>4</sup>	4.17%	(12.30)	3.39%	(11.17)
	Interruptions of story <sup>2</sup>	7.30%	(6.78)	5.96%	(6.21)
	Subject shifts <sup>1</sup>	48.24 %	(10.80)	46.18%	(12.65)

<sup>1</sup>Percentage of the total number of syntactic units; <sup>2</sup>Percentage of pronoun use for maintained reference;

<sup>3</sup>Percentage of full noun phrase use for referent (re)introduction; <sup>4</sup>Percentage of causal conjunctions with Emotional and Cognitive Terms

\* =  $p < .05$ ; \*\* =  $p < .01$ ; \*\*\* =  $p < .001$ .

### c) 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.

### d) 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.

TD		ASD vs. TD		ADHD vs. TD		ASD vs. ADHD <sup>1</sup>	
<i>M</i>	<i>(SD)</i>	<i>Estimate</i>	<i>(SE)</i>	<i>Estimate</i>	<i>(SE)</i>	<i>Estimate</i>	<i>(SE)</i>
29.14	(10.28)	-.39	(2.86)	3.48	(2.90)	-3.87	(2.90)
5.98	(1.18)	-.60*	(.25)	-.55*	(.25)	-.05	(.25)
30.78%	(20.88)	-.06	(.10)	-.29**	(.10)	.23*	(.10)
15.10%	(14.02)	-.01	(.12)	-.28*	(.13)	.28*	(.13)
8.44%	(7.54)	.53***	(.14)	.39**	(.14)	.14	(.13)
43.03%	(21.70)	-.36***	(.09)	-.21**	(.09)	-.14	(.09)
7.60%	(7.27)	.54***	(.15)	.40**	(.15)	.14	(.14)
1.18%	(2.17)	-.36	(.44)	.02	(.39)	-.38	(.43)
6.68	(.81)	-.30	(.20)	-.19	(.21)	-.11	(.21)
6.92%	(6.28)	.07	(.17)	.13	(.16)	-.05	(.16)
71.83%	(18.74)	-.31	(.16)	-.16	(.16)	-.15	(.16)
87.99%	(16.30)	-.01	(.25)	-.50*	(.22)	.49*	(.23)
3.02%	(4.13)	-.60*	(.31)	-.67*	(.30)	.07	(.35)
26.91%	(38.44)	-1.85**	(.66)	-1.97**	(.65)	.12	(.83)
4.51%	(6.57)	.46*	(.20)	.39*	(.20)	.07	(.18)
49.20%	(15.90)	.07	(.09)	-.02-	(.09)	.09	(.09)

### e) Discourse pragmatics

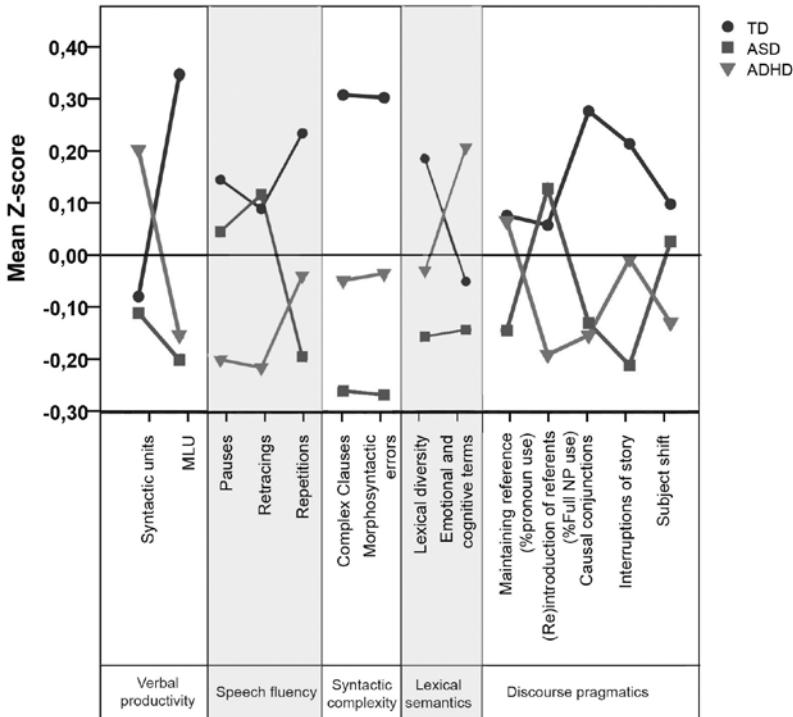
With regard to the use of referring expressions, we found that all three groups mainly used pronouns to maintain reference to a character, while they used more explicit forms for (re)introduction of referents. However, children with ADHD were less specific than children with ASD and TD children when (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, while the TD group used causal conjunctions with one third of all emotional and cognitive terms.<sup>1</sup> We also found that

<sup>1</sup> Please note that 21 children who did not use any emotional and cognitive terms were excluded from this analysis (9 TD, 10 ASD, and 2 ADHD)

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.

**Summary**

We found the following similarities in narrative ability between children with ASD and children with ADHD: Both the ASD group and the ADHD group had problems in producing a cohesive narrative, showed reduced syntactic complexity, and produced more repetitions than the TD group. We also found differences between the two clinical groups: Children with ADHD showed fewer pauses and fewer retracings than children with ASD and TD children and were less specific than TD children when (re)introducing referents.



**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 in order to have lower z-scores correspond with more problems. Subcategories Tensed clauses and Causal conjunctions with ECT were left out to avoid overlap with other categories

### Correlations of narrative skills with ToM, working memory, and response inhibition

Next, for each of the five linguistic categories we combined 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 working memory 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. Working memory was positively associated with verbal productivity, syntactic complexity, and discourse pragmatics. Performance on the inhibition task was associated with none of the linguistic categories.

**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
Verbal productivity	.167	.247*	.265**	-.139	-.138	-.210*
Speech fluency	.103	.237*	.179	-.123	.011	-.193*
Syntactic complexity	.261**	.223*	.213*	-.082	-.446**	-.374**
Lexical semantics	.210*	.221*	.178	-.136	-.010	-.085
Discourse pragmatics	.285**	.229*	.325**	-.147	-.210*	-.213**

Note. StructLS = Structural Language Score (scale A-D); GenPS = General Pragmatic Score (scale E-H)  
\* =  $p < .05$ ; \*\* =  $p < .01$ ; \*\*\* =  $p < .001$

### CCC-2

Findings based on the CCC-2 for the three groups are shown in Figure 2 and Table 4. Two MANOVAs with group (ASD, ADHD, TD) as between subjects factor were conducted: one with the eight scales and the other with the two composite scores as dependent measures. 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).

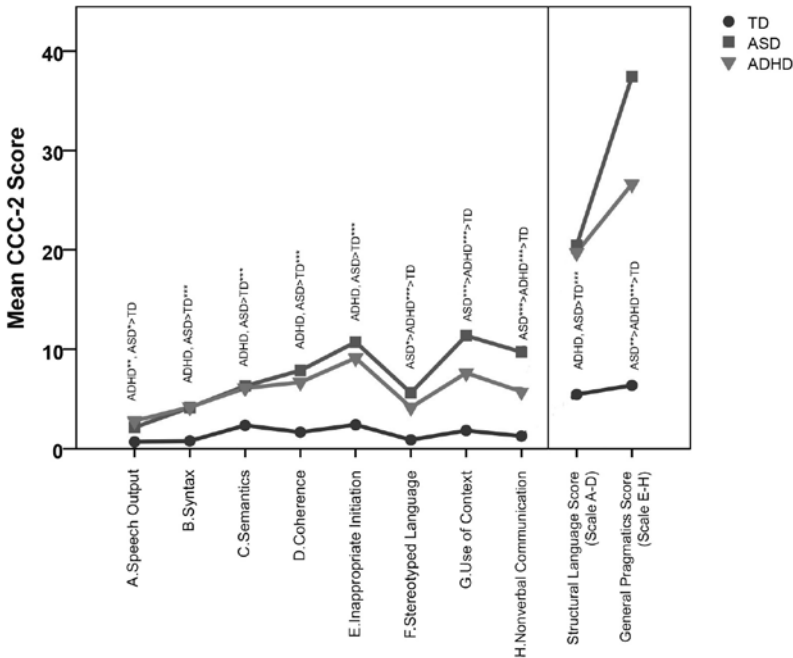
There was a main effect of group ( $Wilk's \Lambda = .30$ ,  $F(16,190) = 9.78$ ,  $p < .001$ ). On six of the eight scales (Speech Output, Syntax, Semantics, Coherence, Inappropriate Initiation, and Stereotyped Language), the ADHD group and the ASD group significantly



differed from the TD group, but not from each other. On the remaining two scales (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.

We also found a main effect of group with both composite scores (the Structural Language Score and the General Pragmatics Score) as dependent measures (*Wilk's  $\Lambda$*  = .39,  $F(4,202) = 30.69, p < .001$ ). 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 be distinguished from each other.



**Figure 2** Mean scores and Bonferroni corrected group comparisons on the CCC-2 scales and composite scales per group (TD, ASD, ADHD).

\* =  $p < .05$ ; \*\* =  $p < .01$ ; \*\*\* =  $p < .001$

**Table 4** Means and standard deviations for CCC-2 raw and composite scores per group (TD, ASD, ADHD)

	ASD		ADHD		TD		Main Group effect		
	Mean	SD	Mean	SD	Mean	SD	F(2,102)	$\eta^2$	
CCC-2 scales									Post hoc
A.Speech Output	2.14	(2.55)	2.79	(2.90)	0.69	(1.21)	7.41	.13	ADHD** , ASD*>TD
B.Syntax	4.14	(3.18)	4.18	(3.86)	0.77	(1.37)	15.00	.23	ADHD, ASD>TD***
C.Semantics	6.31	(2.64)	6.09	(3.62)	2.34	(2.03)	21.74	.30	ADHD, ASD>TD***
D.Coherence	7.86	(3.37)	6.68	(3.82)	1.66	(1.68)	39.93	.44	ADHD, ASD>TD***
E.Inappropriate Initiation	10.72	(4.6)	9.12	(4.67)	2.40	(2.19)	43.13	.46	ADHD, ASD>TD***
F.Stereotyped Language	5.61	(2.65)	4.15	(3.21)	0.89	(1.11)	33.56	.40	ASD*>ADHD***>TD
G.Use of context	11.36	(4.32)	7.62	(3.78)	1.83	(1.62)	68.67	.57	ASD***>ADHD***>TD
H.Nonverbal comm.	9.72	(4.)	5.74	(3.48)	1.26	(1.74)	61.08	.55	ASD***>ADHD***>TD

	ASD		ADHD		TD		Main Group effect		
	Mean	SD	Mean	SD	Mean	SD	F(2,102)	$\eta^2$	
CCC-2 Composite scores									Post hoc
Structural Language Score (Sum scales A-D)	20.44	(9.01)	19.74	(12.21)	5.45	(4.67)	30.05	.37	ADHD, ASD>TD***
General Pragmatic Score (Sum scales E-H)	37.42	(13.05)	26.62	(23.57)	6.37	(5.19)	70.78	.58	ASD***>ADHD***>TD

\* p < .05, \*\* p < .01, \*\*\* p < .001

### **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). 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 the ASD 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, while 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, Nigg, & Ferreira, 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: while 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 not with the proportion of pauses ( $r = -.09, p = .34$ ).

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 the inability to produce a cohesive and coherent narrative, as we hypothesized. Additionally, 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.

Also with regard to EF, there are associations between narrative skills (verbal productivity, syntactic complexity, and discourse pragmatics) and working memory, but none between narrative skills and inhibition. Working memory has previously been related to language comprehension processes (see the meta-analysis of Daneman & Merikle, 1996), but little is known about the relation between working memory and language production, although associations have been found between working memory and choice of referring expression (Almor, Kempler, Macdonald, Andersen, & Tyler, 1999; Kuijper et al., 2015). The present study shows that working memory is associated with language production at different levels simultaneously: at sentence level (syntactic complexity), discourse level (discourse pragmatics) and narrative level (verbal productivity). In order 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 working memory. Our findings indicate that children with lower working memory 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, while 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 & 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 & 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, while 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). Since 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, working memory, 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 & Cucchiari, 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.

Concluding, 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 pragmatics 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 working memory 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.





