Disorganized speech in autism spectrum disorder: part of the problems in social pragmatic communication and verbal intelligence

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Abstract

Background & Aims: Disorganized speech (DS) refers to the failure to communicate coherently. Children with autism spectrum disorder (ASD) show disorganized speech, such as abrupt topic changes. Disorganized speech can be explained by 1) social pragmatic communication difficulties (SPCD) or 2) social cognition problems (SCP). **Methods:** We tested whether children with ASD and severe disorganized speech differed from those with mild or no disorganized speech, using parent's report on SPCD and tested SCP (i.e., Theory of Mind; ToM). A total of 62 children with ASD (aged 7-12 years) were included, 12 with severe disorganized speech, 32 with mild, and 18 with no disorganized speech. The disorganized speech was assessed using the Kiddie-Formal Thought Disorder Rating Scale (KFTDS). SPCD was measured using the parent-reported Children's Communication Checklist (CCC). SCP was measured using a first-order false-belief task.

Results: Children with severely disorganized speech showed significantly more inappropriate initiations and less coherence. No significant group differences were found in the false belief task, even after included verbal IQ as a covariate in multivariate analysis. **Conclusions:** These findings may contribute to the conceptualization of autistic communication difficulties which may guide intervention optimizations.

Implications: Furthermore, we may consider offering children with ASD and disorganized speech interventions that stimulate and train broader social pragmatic communication skills, social cognition, and verbal ability (i.e., conversational skills).

Introduction

Disorganized speech refers to the degree to which transmission of meaning fails because of incoherent communication, such as abrupt topic changes. Disorganized speech entails verbal signs of illogical thinking and loose associations (Andreasen, 1979). Studies reported elevated levels of disorganized speech in children with autism spectrum disorder (ASD) as compared to typically developing children (Norbury, Gemmell, & Paul, 2014; Solomon, Ozonoff, Carter, & Caplan, 2008; Swineford, Thurm, Baird, Wetherby, & Swedo, 2014). Disorganized speech in ASD has formerly been explained as a manifestation of social cognitive problems and as a potential precursor of psychosis (Andreasen, 1979; Caplan, Guthrie, Fish, Tanguay, & David-Lando, 1989; Liddle et al., 2002). However, a previous study suggested that disorganized speech may rather be a part of the broader developmental difficulties in social pragmatic communication (SPC) (Eussen et al., 2015). In other words, learning how to communicate logically and coherently to meet the listener's needs (how to attune one's communication to the social context) is a developmental process that might be delayed or altered in autistic children with ASD.

Below we will first give some theoretical background that backs up this hypothesis, and that we will formulate more specific hypotheses that will be tested in this study.

Disorganized speech as a part of SPCD

Coherent communication in typically developing (TD) children can be explained in terms of developmental aspects of children's disorganized speech as described by Caplan, Guthrie, Tang, Komo, and Asarnow (2000). Before the age of 7, typically developing children may still have difficulty maintaining a topic of discourse. For instance, instead of providing only relevant topic information, they often still make abrupt topic changes. This behavior can be regarded as displaying signs of disorganized speech which is referred to as loose associations (LA) and illogical thinking (ILL). Around the age of 7, these large unannounced topic shifts (LA's) tend to diminish, but smaller unannounced topic shifts (ILL's) may still appear. By the age of 9, most typically developing children have learned to organize their speech and barely display any signs of disorganized speech.

In contrast, at the age of 9, children with ASD have difficulty maintaining an ongoing topic of conversation, which is a signal of developmental delay in social pragmatic communication. As they get older, their development of social pragmatic communication is improved (Norbury et al., 2014; Simmons, Paul, & Volkmar, 2014). Based on the work by Hale and Tager-Flusberg (2005), we suggest that disorganized speech reflects the difficulties that children with ASD display in maintaining coherent communication with others. These difficulties are a signal of developmental delay in the development of social pragmatic communication skills, i.e., engaging in reciprocal social communication in such a way that the listener's needs are met.

Are social cognition problems associated with disorganized speech?

In a study by Wimmer and Perner (1983), typically developing children and children with ASD were tested in experiments on false beliefs which is an index for Theory of Mind (ToM). The result revealed a strong developmental age trend: 57% of the children aged 4 to 5 years old passed the (first-order) ToM task, while almost all 6 to 9 years old children (86%) passed this test. In contrast, children with ASD aged from 10:11 to 15:10 years passed the first-order false belief task. Clearly, for children with ASD, the first-order mental state attribution is acquired much later (Baron-Cohen, Leslie, & Frith, 1985; Frith, 2012). Thus, this study is important for taking the developmental perspectives on the theory of mind in autism.

This has led researchers to believe that individuals with ASD may have a specific developmental delay in ToM that can also cause problems with the acquisition of social pragmatic language (Baren-Cohen, 1989; Cummings, 2013; Tager-Flusberg, 2007). We hypothesize that this delay in ToM may be related to the significant problems in children's ability to maintain coherent communication, as taking on the perspective of others is needed to understand their communication needs. We based this hypothesis on the assumption of Hale and Tager-Flusberg (2005) that SPCD is the consequence of deficits in ToM. Hale and Tager-Flusberg (2005) found that children with ASD (aged 4–13 years) made significant gains over 1 year in their ability to maintain a topic of conversation that was related to ToM. A significant association was found between understanding the first-order false belief tasks and the ability to maintain a conversation in a meaningful way among children with ASD (Capps, Kehres, & Sigman, 1998; Capps, Losh, & Thurber, 2000).

Our study aims to explore whether disorganized speech 1) is part of the broader social pragmatic communication difficulties (SPCD) that appear in ASD, and 2) can be explained by underlying social cognition problems (SCP). To test this, we examined a) whether children in different disorganized speech groups differed regarding their social pragmatic communication skills as reported by their parents and b) whether the groups differed on ToM performance. We hypothesize that children who have problems in organizing their speech have difficulties to maintain a topic of conversation and have poor social cognitive abilities, i.e., ToM (Eussen et al., 2015).

Methods

Participants and procedure

One hundred forty-two children with ASD participated in this study (de Bruin, Verheij, Wiegman, & Ferdinand, 2007; Eussen et al., 2015) of which 62 were selected for analysis in this article (see Fig. 1). They visited the outpatient clinic at the Department of Child and Adolescent Psychiatry/Psychology of Erasmus Medical Center – Sophia's Children Hospital Rotterdam, Netherlands between July 2002 to September 2004. Inclusion criteria were: (1) meeting the clinical diagnosis of Diagnostic and Statistical Manual of Mental Disorders(DSM-IV-TR; American Psychiatric Association, 2000) classification of ASD and (2) parents being able to communicate in the Dutch language. The exclusion criteria in this study were (1) children aged below 7 years old because cut-off points of ILL and LA were not available for children younger than 7 years, (2) the presence of severe neurological or physical problems, such as epilepsy or muteness. The total group (n = 62) children had a mean age of 9.41 years (SD = 1.65 years). 84% of the participants were boys (n = 52). All children with complete data on Kiddie Formal Thought Disorder Scale (KFTDS), the Children's Communication Checklist (CCC), and the first-order ToM task were included in the analyses.

The clinical diagnostic assessment was obtained by a multi-disciplinary team that consisted of a parental interview on the child's early developmental history, medical history, and current functioning. Parents of the participating children additionally filled out a questionnaire, e.g., the CCC. The children also underwent psychological assessments e.g., the KFTDS and the ToM task (de Bruin, 2006). Parents of the participants had signed informed consent forms.

The Medical Ethics Committee of the Erasmus Medical Centre approved this study.

Materials

Disorganized speech

Kiddie-Formal Thought Disorder Rating Scale (KFTDS) was used to assess disorganized speech, quantified as the presence of loose associations (LA) and illogical thinking (ILL) (Caplan et al., 1989; Caplan et al., 2000). The validity of these KFTDS scales has been established in children with ASD (Solomon et al., 2008; Van der Gaag, Caplan, van Engeland, Loman, & Buitelaar, 2005). Children were

asked to answer standard questions after listening to two audio-taped stories (i.e., “What did you like about this story?” or “Do you think this a true story?”). Children were then asked to make up his/her own story about one of four given topics (the incredible hulk, a witch, a disobedient child, or an unhappy child). This test took 20 to 30 minutes, and the child’s speech was audiotaped. All stories were scored according to the KFTDS guidelines (Caplan et al., 1989) by summing frequency counts for illogical thinking and loose associations. Total raw scores were corrected for the variability of speech by converting the number of utterances per minute. These continuous KFTDS scores were divided into different ordinal categories as falling above or below the cut-off points, in which a score above the cut-off point indicates a higher likelihood of pathology. Using cut-off points, continuous KFTDS scores become dichotomous as falling above or below the cut-off point. Cut-off points were not calculated for children younger than 7 years old because KFTDS is a reliable measure of disorganized speech in children ages 7–18 years old (Caplan et al., 1989; Caplan et al., 2000).

The inter-rater reliability for the total KFTDS score was good, with a kappa of 0.77 (Caplan et al., 1989). The kappa for ILL was 0.78 and for LA 0.71 (Caplan et al., 1989). The validity of the KFTDS has been established in children with schizophrenia spectrum disorders and ASD (Caplan et al., 2000).

In our sample of children aged 7–12 (n = 62), 71% of children scored *above* the cut-off point for ILL (n = 44), while 19.4% of children scored *above* the cut-off point for LA (n = 50). Based on these results, in the next step, we combine these into one integrated/combined grouping variable. A score above the cut-off point indicated a higher likelihood of disorganized speech. By using the cut-off point value, continuous KFTDS scores were dichotomized as falling above or below the cut-off point. Children with a score above the cut-off point for ILL and LA were assigned to the group ‘severe disorganized speech’, children with a score above the cut-off point for ILL and below the cut-off point for LA were assigned to the group ‘mild disorganized speech’, and children below the cut-off point of ILL and LA were assigned to the group ‘no disorganized speech’.

The rationale for dividing the children into three groups is based on the study by Eussen et al. (2015), who found that ILL predicted the severity of autistic symptoms in adolescence, while LA did not. Those findings indicated that children with ASD show ILL from early childhood onwards, while LA deteriorates when they reach the age of 7 years old. In our study, we included children aged between 7 and 12 years and found that 70% of the children scored above the cut-off point for ILL, while 76% of the children scored below the cut-off point for LA. Based on these results, we combined ILL and LA into one integrated/combined grouping variable, as having both LA and ILL is reflective of the presence of more types of disorganized speech than only having one or the other.

Social pragmatic communication difficulties

The Children's Communication Checklist – CCC (Bishop, 1998) was administered to the parents of the included children. The CCC assessed pragmatic aspects of a child’s social pragmatic communication difficulties. The questionnaire consists of 70 multiple choice questions on a 3-point scale (0 = definitely applies, 1 = applies somewhat, 2 = does not apply). The lower the score on the CCC, the more impaired the

child is. The questions are divided into nine subscales; five subscales for social pragmatic communication skills (coherence, inappropriate initiation, stereotyped language, use of context, and conversational rapport), two subscales to measure formal language (speech production and syntax), and the remaining two subscales assess characteristic behaviors of ASD (social relationships and interests). In this study, we used five social pragmatic communication skills subscales. There are 38 social pragmatic communication items in total, with the sum of the five subscales ranging between 88 to 162. The CCC was translated into Dutch using a two-way translation procedure (Hartman et al., 1998). The internal consistency for the Pragmatic Composite Score was 0.76 (Geurts et al., 2009). Meanwhile, the internal consistency in our dataset is .80.

Social cognition problems

Theory of mind (ToM) was measured using a Dutch ToM task which was based on the classic Sally–Anne false-belief task (Baron-Cohen et al., 1985). A child was told the following story: Ben places a bone in a barrel and goes out to play; while he is gone, Max (Ben's brother) takes the bone from the barrel and hides it in another barrel. After telling this story, children were asked a control question (Where is the bone really?). A wrong answer for this question represents an insufficient understanding of the story and understanding is necessary to perform well on the first-order false-belief tasks. One child who answered this question wrong was excluded from the analyses. Then, children were asked a false-belief question (Which barrel will Ben choose?). The child was given a score of 1 for a correct answer and a score of 0 for the wrong answer.

Covariates

Individual factors were taken into consideration as possible confounding variables. First, sex may have influenced the result because females were usually more verbally oriented (Walker, 2005). Despite both sex have similar social understanding difficulties, males showed less restricted, repetitive patterns of behaviors (Lai, Lombardo, Auyeung, Chakrabarti, & Baron-Cohen, 2015). Intelligence Quotient (IQ) was taken into account as a possible covariate based on Van der Gaag et al. (2005), who found a significant negative correlation between Total IQ with illogical thinking and loose association on the KFTDS. A lower IQ is also associated with more difficulties in social pragmatic communication (Schirvar, 2013) and false-belief task (Baren-Cohen, 1989). In this study, IQ was measured using the Wechsler’s Intelligence Scale for Children-Revised version (WISC-R). Finally, age was taken into account as a covariate because developmental aspects play a vital role in the manifestation of DS and therefore scores could be correlated with age. Age also affects social pragmatic communication (Norbury et al., 2014; Tager-Flusberg, Paul, & Lord, 2005) and ToM (Wimmer & Perner, 1983). The older the child is, the better his/her social pragmatic communication skills are, both for TD children and children with ASD (Simmons et al., 2014).

Statistical analyses

Of the 142 children recruited, 89 children had complete KFTDS data, while 53 children had incomplete KFTDS data. Six children were younger than 7 years and three children with high LA and low ILL scores were excluded from the analyses. The group of children with scores above the cut-off point of LA and below the cut-off point of ILL was too small to be included separately in the analyses. *n* = 18 children who did not have complete data on the outcome measures, i.e., SPCD and SCP, were also excluded from the analyses (Fig. 1).

Figure 1 Sample description

The effects of potential attrition (sex, age, and IQ) were checked for the group with complete data (N = 89) versus the group with incomplete data (N = 53). Then, the descriptive characteristics (sex, age, and IQ) of the children were provided for the total group (*n* = 62) and compared between three subgroups i.e., children with severe (n = 12), mild (n = 32) and no DS (n = 18).

Then, assumptions of normality, independence, and homogeneity of variance were checked for the CCC scores. Also, the assumptions of Fisher-Freeman-Halton Exact test were checked for the ToM data. Pearson correlations were used to estimate the influence of covariates (age and IQ) concerning the main variables (KFTDS groups, CCC and ToM). A Spearman correlation was performed to investigate the influence of sex to KFTDS groups, CCC and ToM. In case one of the covariates showed a significant correlation with both the predictor and the outcome variable, we included this covariate in the subsequent analysis of covariance (ANCOVA) and logistic regression analysis for ToM.

A one-way analysis of variance (ANOVA) was used to explore between-group differences for CCC. We examined whether the groups differed significantly on the subscales, i.e., inappropriate initiation, coherence, stereotyped language, use of content, and rapport (Aim 1). Post hoc pairwise tests were carried out to compare between two groups. In this study, we chose Games-Howell procedure as it remains accurate when sample sizes are unequal (Field, 2009). To examine whether disorganized speech influenced their first-order false-belief task (Aim 2), the study used a Fisher-Freeman-Halton Exact Test. We looked at the cross-tabulation and observed the number of children with disorganized speech pass the first-order false-belief task in each group.

In this study, a p-value of < .05 (confidence interval of 95%) is considered to be significant. The statistical analyses have been performed using IBM SPSS Statistics 21.

Results

Descriptive

Sixty-two children with a mean age of 9.41 years, SD = 1.65 years; Boys 84%; mean Total IQ 94.35, SD = 19.47 were included in the analyses. An attrition analysis was performed. An independent sample t-test showed no statistically significant differences between children with complete data (*n* = 62) and children with missing data (*n* = 80) on age, sex, and intelligence (total, verbal, and performance).

Descriptive statistics were provided for the total group and the subgroups (i.e., children with severe, mild and no disorganized speech) as shown in Table 1. No differences were found for the distribution of sex between the three groups, F (2, 59) = .006, p = .98. Age was also not significantly different between the groups, F (2, 59) = 2.15, p = .13. Significant differences on Total, Verbal, and Performance IQ were found amongst the groups (respectively F (2, 59) = 6.90, p = <.01; F (2, 59) = 6.60, p = < .01; F (2, 59) = 4.46, p = .02). Post hoc analyses were performed to check the pair-wise differences between groups (See Table 1).

Normality plots of age, IQ, and CCC indicated a normal distribution of scores for these variables. The assumption of homogeneity of variance (p > .05) was satisfied for CCC- scores. The first assumption of the Chi-square test, the independence of participants, was confirmed. However, more than 20% of the group cells contained less than 5 participants. Therefore, the Fisher-Freeman-Halton Exact Test outcomes were interpreted (Field, 2009).

Significant correlations between the dependent variables (CCC and ToM) and covariates are shown in Table 2. Therefore, in the main analyses (i.e., groups comparison regarding CCC subscales i.e., coherence and inappropriate initiation and ToM), we included IQ as a covariate in the models.

Aim 1: Disorganized speech as a part of SPCD

Table 3 Analysis of variance showed an association between disorganized speech and social pragmatic communication difficulties as reported by the parents in CCC subscales i.e., coherence F(2,59) = 5.46, p <.01, η^2 = .19 and inappropriate initiation F(2, 59) = 4.14, p =.02, η^2 = .14 with both showing large effect sizes. Post hoc analyses showed that children with severe disorganized speech showed significantly lower scores on these subscales than children with no or mild disorganized speech. There was no significant effect of disorganized speech in other CCC subscales, i.e., stereotyped language, use of context, and rapport.

Due to positive significant differences found in CCC subscales i.e., coherence and inappropriate initiation, analysis of covariance (ANCOVA) were performed with the covariate i.e., the Total, Verbal, and Performance IQ. Only the subscale of 'Inappropriate initiation' shows significant differences between the groups after controlling for Total IQ. After correction for Verbal IQ, both subscales remained significant. However, after controlling for Performance IQ only 'Coherence' remained significant.

Aim 2: Are SCP associated with disorganized speech?

All children who took part in the study correctly answered the control question, which allowed us to conclude that they all knew (and implicitly believed) that the bone was put somewhere else after Ben had left. The cross-tabulation in Figure 2 shows the percentage of children passing/failing the first-order false-belief task for each disorganized speech group. 3.1% (1 out of 32) of the children in the mild disorganized speech group and 5.6% (1 out of 18) of the children in the no disorganized speech group failed the first-order false belief task. By contrast, 25% (3 out of 12) of the children with severe

disorganized speech failed the first-order false-belief task. The differences between the three disorganized speech groups were trend significant (p = 0.08).

Table 2 shows that disorganized speech and Verbal IQ are correlated to scores on the first-order false belief task. A logistic regression analysis was conducted with disorganized speech groups as the predictor, passing/failing the ToM task as the outcome, and VIQ as a covariate. In a model with only disorganized speech as a predictor alone it was not significant (χ^2 (1) = 4.64, p = 0.10), and when VIQ was included as a covariate, disorganized speech was also not significantly predicted passing/failing the ToM task (χ^2 = 8.98, df = 1, p = 0.89).

Discussion

The study aimed to explore whether disorganized speech is part of the broader social pragmatic communication difficulties (SPCD) in children with ASD and whether it might be explained by underlying difficulties in ToM. We hypothesized that disorganized speech is part of the broader social pragmatic communication difficulties seen in children with ASD and can be explained by a limited ability to tune one's communication to the listeners' needs, caused by social cognition problems, i.e., ToM (Capps et al., 2000; Eussen et al., 2015; Kuijper, Hartman, Bogaerds-Hazenberg, & Hendriks, 2015; Norbury et al., 2014; Roberts & Patterson, 1983; Tager-Flusberg et al., 2005). Our results indicated children with profound disorganized speech (ILL + LA) showed more inappropriate initiations and less coherence. This small group (n = 12) also showed more difficulties in ToM and cannot be explained by Verbal IQ.

Disorganized speech is part of social pragmatic communication difficulties (SPCD)

Our analyses revealed that disorganized speech was positively associated with several pragmatic subscales of the CCC, i.e., coherence and inappropriate initiation. Our findings extend previous studies that showed before that pragmatics or the appropriate use of language in social and communicative contexts are seriously impaired in children with ASD (Bishop, 2001; Eussen et al., 2015; Tager-Flusberg, 1996; Volden, Coolican, Garon, White, & Bryson, 2009).

According to the parents' reports, children with profound disorganized speech showed more inappropriate initiations than children with mild or no disorganized speech. Children who demonstrate inappropriate initiation show impairments in reciprocal communication, no interest in others, and talk about subjects that are outside the interest of the listener (Baird & Norbury, 2015; Visser & Tops, 2017). Consequently, the listener is not able to follow their story. Also in another study, children with ASD were found to initiate less in their conversations with peers than the typically developing group (Jones & Schwartz, 2009). In line with our hypothesis, severely disorganized speech, as tested with the KTFDS, was associated with more difficulties in social pragmatic communication among children with ASD. In our study, other aspects of social pragmatic communication skills did not show associations with disorganized speech, such as rapport. Rapport can be considered as mainly relying on nonverbal cues of social communication such

as eye contact, facial expressions, or gestures. The KFTDS does not measure these nonverbal communication aspects. Therefore, these findings need to be confirmed by research using clinical observation as well as parent reports.

Are social cognition problems associated with disorganized speech?

Our second aim was to examine the differences in performance on the first-order false-belief task between groups. The hypothesis that poor ToM is associated with profound disorganized speech was not confirmed, as we only found a trend association if no corrections were made. Yet, after taking into consideration Verbal IQ as a covariate, groups of disorganized speech also showed not a significant predictor of performance on the ToM task. Children with severely disorganized speech showed more difficulties with social cognition as compared to children with mild or no disorganized speech, but this difference was mainly explained by their differences in Verbal IQ.

This can potentially be explained by the observation that some children with ASD seem to ‘imitate’ other people’s verbal behavior and therefore appear more verbally intelligent than they in fact are. In other words, their speech production appears better (i.e. abundant speech production with rich vocabulary) than their language perception is (i.e., in terms of semantics and syntaxis) which might alter the actual meaning of what is being said (McCann, Peppe, Gibbon, O'Hare, & Rutherford, 2007). Underlying language difficulties can lead to poor performance on ToM tasks (McCann et al., 2007), which would explain the current findings.

Methodological considerations

The current study has several limitations that should be considered when interpreting the results. Firstly, a small and unequal number of children were included in each group of disorganized speech (n = 12, n = 32, n = 18), which might have biased our findings (non-representative/selective inclusion). Secondly, our study compared three groups of children with ASD i.e., severe, mild, and no disorganized speech amongst each other, while previous studies compared children with ASD to typically developing children and/or other disorders (Kuijper et al., 2015; Norbury et al., 2014). In other words, children in our sample were more similar in diagnosis to each other as compared to the groups compared in other studies. Finally, our social pragmatic communication measurement was based on parents’ report only and not on direct observations of the children which may create bias in reporting about their child (i.e., under-or over report of problems based on the behaviors that parents observe mainly in the home context). However, Eussen et al. (2015) also showed associations between disorganized speech and social communication problems as observed with the ADOS-2.

Recommendations for future research

Since the current sample size was small for cross-tabulations, future research with bigger sample size is recommended. Second, the current findings show that disorganized speech seems to be associated with

some aspects of social pragmatic communication skills and ToM. Longitudinal studies are also recommended because these could give more insight in the development of disorganized speech over time and associations with developing ToM.

Conclusion and Implications of the research findings for practice

In conclusion, the presence of disorganized speech in children with ASD should not be considered a pre-psychotic sign (see Eussen, et. al., 2015) but rather, disorganized speech should be considered as a specific problem with social pragmatic communication. Moreover, severe disorganized speech (i.e., showing loose associations as well as illogical reasoning/abrupt topic shifts) may be related to difficulties with theory of mind, but mainly to Verbal IQ.

Although these findings are preliminary and should thus be replicated and considered in the light of the limitations of our study, readers could consider offering children with ASD and disorganized speech interventions that stimulate and train broader social pragmatic communication skills, social cognition, and verbal ability (i.e., conversational skills). An evidence-based intervention that meets these requirements is the *Children Friendship Training* (CFT; Frankel et al., 2010). This intervention is designed for children in the age range of 6 to 12 years old. CFT explains rules of social skills explicitly which creates clear and concrete handles for children with ASD and disorganized speech. Children are encouraged to reflect on the perspectives of others and actively participate in social situations, which could help to generalize the obtained skills in social cognition and communication to other contexts. Differences in Verbal IQ may need to be considered as a moderator of treatment outcome.

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Tables

Table 1. Descriptive information of the total sample of (n = 62) on covariates.

					Pair-wise comparison		
	Severe DS (*n* = 12)	Mild DS (*n* = 32)	No DS (*n* = 18)	*Anova*	No vs mild DS	No vs severe DS	Mild vs severe DS
Sex (% boys)	83	84	83	1.0			
	M (SD)	M (SD)	M (SD)		*p*	*p*	*p*
Age	8.59 (1.27)	9.50 (1.77)	9.81 (1.53)	.13			
IQ:							
- TIQ	77.92 (15.11)	96.28 (18.96)	101.89 (17.30)	**<.01****	<.01	<.01	<.01
- VIQ	79.42 (14.04)	96.34 (19.03)	102.78 (16.72)	**<.01****	.44	<.01	<.01
- PIQ	80.75 (19.43)	97.44 (20.73)	101.50 (17.00)	**.02***	.74	.02	.05

Note: *$p < .05$; **$p < .01$

Table 2. Correlations between outcome variables and covariates

	Coherence	Inapprop.	Stereotype	Context	Rapport	CCC	ToM
Sex[b]	.28*	.16	.09	.19	.12	.23	-.14
Age[a]	.46**	.28*	.19	.27*	.15	.39**	.19
TIQ[a]	.33**	.10	.05	.10	.12	.19	.33**
VIQ[a]	.28*	.01	-.06	.00	.15	.10	.37**
PIQ[a]	.31*	.19	.17	.19	.07	.27*	.23

Note: *: $p < .05$; **: $p < .01$

Subscales of CCC; Inapprop: Inappropriate initiation; Stereotype: Stereotype language; Context: Use of context; CCC: Total Children's Communication Checklist; ToM: Theory of mind; TIQ: Total IQ; VIQ: Verbal

IQ; PIQ: Performance IQ; a: Pearson correlations; b: Spearman correlations.

Table 3. Differences on CCC pragmatic subscales among disorganized speech groups

	Severe DS (n = 12)	*Mild DS (n = 32)*	*No DS (n = 18)*				*No vs mild DS*	*No vs severe DS*	*Mild vs severe DS*
	M (SD)	M (SD)	M (SD)	*F*	*p*	*Partial η²*	*p*	*p*	*p*
Pragmatic subscales:									
Coherence	25.83 (1.59)	28.69 (3.04)	29.44 (3.70)	5.46	**< .01**	.19	.74	**< .01**	**< .01**
Coherence corrected for TIQ				2.95	.06	.09	.88	.07	.11
Coherence corrected for VIQ				3.41	**.04**	.11	.87	**.04**	.08
Coherence corrected for PIQ	22.83 (2.95)	26.13 (4.18)	26.5 (3.29)	3.37	**.04**	.10	.86	**.04**	.09
Inappropriate initiation				4.14	**.02**	.14	.94	**.01**	**.02**
Inappropriate initiation corrected for TIQ				3.42	**.04**	.11	.98	.06	**.05**
Inappropriate initiation corrected for VIQ				4.61	**.01**	.14	.95	**.02**	**.02**
Inappropriate initiation corrected for PIQ				2.8	.07	.09	.99	.10	.09

Note: DS: disorganized speech

Table 4. Results of binary logistic regression of children who pass/fail ToM task

	b (SE)	OR (95% CI)	*p*
Step 1			
DS groups	-1.08 (.69)	0.34(0.09-1.31)	0.12
Step 2			
DS groups	-0.12 (0.82)	0.89(0.18-4.43)	0.89
VIQ	0.11 (0.04)	1.11(1.02-1.21)	0.02*

Note: OR: Odd Ratio; CI: Confidence Interval; DS: Disorganized speech group; VIQ: Verbal IQ

* $p < .05$; ** $p < .01$

Declarations

Competing interests: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Figures

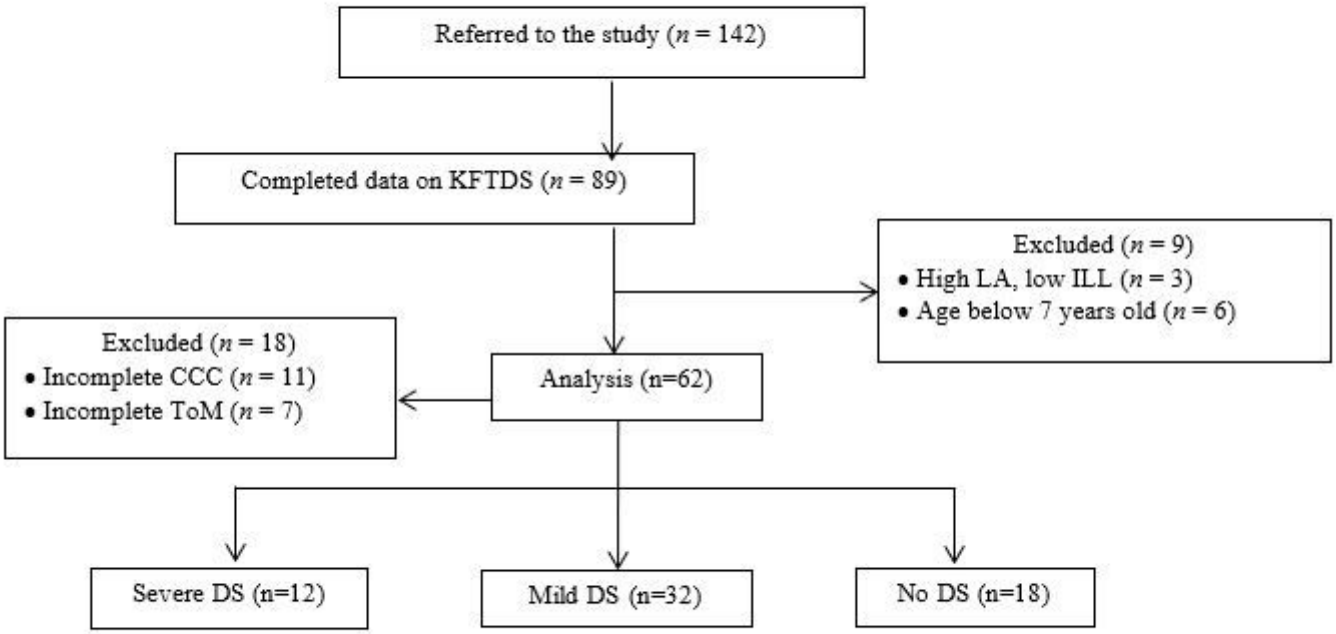

Figure 1

Sample description

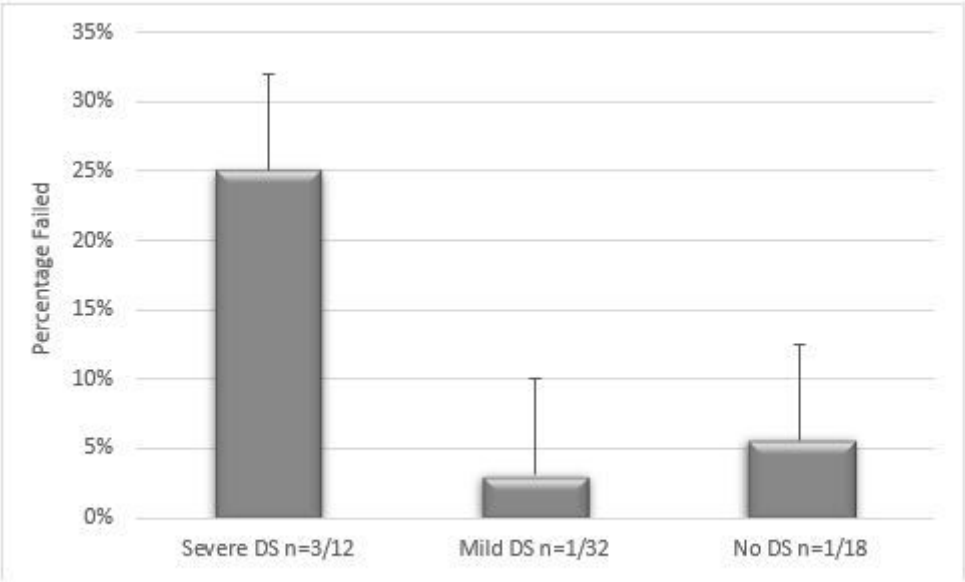

Figure 2

Percentages of children who failed the first-order false-belief task