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ORIGINAL PAPER

Language Abilities of Russian Primary-School-Aged Children with Autism Spectrum Disorder: Evidence from Comprehensive Assessment

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Abstract

The purpose of the present research was to comprehensively assess the language abilities of Russian primary-school-aged children with Autism Spectrum Disorder (ASD), varying in non-verbal IQ, at all linguistic levels (phonology, lexicon, morphosyntax, and discourse) in production and comprehension. Yet, the influence of such non-language factors as children's age, the severity of autistic traits, and non-verbal IQ on language functioning was studied. Our results indicate a high variability of language skills in children with ASD (from normal to impaired) which is in line with the previous studies. Interestingly, the number of children with normal language abilities was related to the linguistic levels: according to more complex morphosyntax and discourse tests, fewer children with ASD were within the normal range unlike the results in simpler phonological and lexical tests. Importantly, we found that language abilities were best predicted by non-verbal IQ but were independent from age and the severity of autistic traits. The findings support the claim that formal language assessment of children with ASD needs to include all linguistic levels, from phonology to discourse, for helping speech-language therapists to choose an appropriate therapy target.

Keywords Language abilities · Autism Spectrum Disorder · Language production · Language comprehension · Russian

Introduction

Autism Spectrum Disorder (ASD) is a group of neurodevelopmental disorders which are characterized by abnormal functioning in reciprocal social interaction, communication, and the presence of stereotyped and repetitive behaviors and restricted interests (World Health Organization, 2016). Although language impairment is not a core symptom of ASD, it has been shown that about 75% of children with ASD have comorbid language difficulties (Kjelgaard & Tager-Flusberg, 2001; Lindgren et al., 2009). However, detailed knowledge of language abilities in individuals with autism is limited. To fill this gap, we comprehensively assessed the language abilities in a large group of Russian children with ASD. Specifically, we addressed their language profiles across different domains (expressive/receptive) and linguistic levels (phonological, lexical, morphosyntactic, and discourse) and additionally investigated, which non-language factors (such as age, the severity of autistic traits, and non-verbal IQ) are associated with language abilities in ASD.

It has been shown that language abilities are highly heterogeneous in children with ASD, ranging from non-verbal to superior language skills (Tager-Flusberg, 1985, 2006). While the deficit in pragmatic aspects of verbal communication is considered as universal in these children (Lord & Paul, 1997; Volden et al., 2009), numerous studies on

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language functioning in ASD have demonstrated impairments at various linguistic levels in both production and comprehension (e.g., Bishop et al., 2004; Kjellmer et al., 2018; Loucas et al., 2010; Modyanova et al., 2017; Nevill et al., 2019).

At the phonological level, several studies have detected impairments in phonological awareness and different aspects of speech sounds processing (Bishop et al., 2004; Loucas et al., 2010; Tager-Flusberg, 2015; Williams et al., 2013; Wolk et al., 2016). For example, in Tager-Flusberg's study (2015) four groups of children (ASD with language impairments (ALI), ASD without language impairments (ALN), children with Specific Language Impairment (SLI), and typically developing children (TD)) were compared on performance in the *nonword repetition* task which is traditionally considered as a measure of verbal working memory (Dispaldro et al., 2013; Dollaghan & Campbell, 1998). The results revealed the difference in scores between ALI and ALN/TD groups (ALI group had lower scores than ALN and TD), but no difference between ALI and SLI groups. Thus, according to this study, a subgroup of children with ASD have the same phonological processing abilities as children with SLI. However, a study by Williams et al. (2013) did not support the overlapping phenotypes idea, showing that, although children with ASD had problems with nonword repetition, the mechanisms of the impairment had another etiology than in children with SLI. Importantly, these results also demonstrated that stimulus length influenced repetition accuracy in ASD group only when items consisted of 4 or more syllables, which is in line with the conclusion on reduced working memory and particularly phonological short-term memory in children with ASD (Habib et al., 2019; Wang et al., 2017).

Although the lexical level, according to several research, is the least affected linguistic level in children with ASD, most of those children have difficulties in single-word production and comprehension (e.g., Arunachalam & Luyster, 2016, 2018; Kjelgaard & Tager-Flusberg, 2001). Luyster et al. (2007) used *MacArthur-Bates Communicative Developmental Inventory* to assess early lexical development in a group of 93 children with ASD and showed that both word production and comprehension were delayed in comparison to TD children. A similar pattern was shown in Kover et al. (2013) in which the *Peabody Picture Vocabulary Test* (PPVT) and the *Expressive Vocabulary Test* (EVT) were used to compare the lexical abilities of autistic children with TD children. Interestingly, nouns are produced and comprehended more accurately than verbs by children with ASD (Swensen et al., 2007), which is consistent in general with the stages of typical language acquisition.

At the level of morphosyntax, the results showed that most of the children with ASD have difficulties in morphological and syntactic processing (e.g., Eigsti et al., 2007; Wittke et al., 2017). For example, in Huang and Finestack's (2020) study, children with ASD with language disorder (LD-ASD) were compared to a group of children with SLI/Developmental Language Disorder (DLD) in their performance on the *Structured Photographic Expressive Language Test—Third Edition* and the *Index of Productive Syntax*. Overall, the authors did not find any difference between morphosyntactic profiles of two groups of children, and concluded that children with ASD had severe difficulties with sentence production. Kover et al. (2014) also found delayed sentence comprehension in school-aged boys with ASD in comparison to TD children, using the *Test for Reception of Grammar—Second Edition*.

At the high order discourse level, several studies have found impaired production and comprehension in children with ASD (e.g., Coderre et al., 2018; Kuijper et al., 2017; Schuh et al., 2016). In a narrative production task, Kuijper et al. (2017) compared children with ASD to the groups of TD children and children with Attention Deficit Hyperactivity Disorder (ADHD). The authors showed that both clinical groups produced shorter and less complex utterances and also made more errors than TD children. In Nuske and Bavin (2010) study, children with and without ASD were asked to read short stories and answer the questions about the main ideas and the details of the stories. The authors have found that children with ASD did not differ from TD children in the ability to comprehend the main ideas of the stories. However, children with ASD were less able to answer the questions regarding the details of the stories in comparison to TD children, which was explained by the Weak Central Coherence theory of autism (Frith, 2008).

Some studies, which assessed language abilities of children with ASD across different linguistic levels, also investigated the non-language factors that influenced language performance in these children (Kjelgaard & Tager-Flusberg, 2001; Kjellmer et al., 2018; Nevill et al., 2019). For example, Kjelgaard and Tager-Flusberg (2001) found a significant association between non-verbal IQ and language abilities, suggesting that non-verbal IQ, at least partly, accounted for the heterogeneity in language functioning in children with ASD. However, the association was not perfect: some children with lower IQ had language skills within the normal range, and, on the contrary, some children with high IQ had impaired language skills. Kjelgaard and Tager-Flusberg (2001) concluded that language skills may be more important in understanding the current general functioning of children with autism than non-verbal IQ.

Among more recent studies, Nevill et al. (2019) investigated a group of very young children with ASD ($N = 104$, age range 1–3) for profiling them and understanding what non-language factors, such as non-verbal IQ, early communicative behaviors, and autism symptoms, predicted language scores measured with different assessment tools. They showed that language development was strongly associated with non-verbal IQ, early vocalizations, and joint attention, whereas other ASD symptoms (usage of gestures, play, and imitation) were not associated with language scores. In another recent work, Kjellmer's et al. (2018) investigated the language abilities of a large group ($N=83$) of preschoolers with ASD (4–6-year-old) without intellectual disability (IQ ≥ 70). Although non-verbal IQ was found to be one of the main predictors of language development in autism, their profiling demonstrated that about 60% of children with ASD without intellectual disability had severe language problems, including expressive and receptive processing deficit and, in particular, phonological impairments.

All in all, available studies reported a high heterogeneity in language functioning in autism. Non-verbal IQ was associated with this heterogeneity, but could not fully account for the developmental level of either expressive or receptive language domains.

Table 1 Demographic information, $M \pm SD$ (range)

	ASD ($N=71$)	TD ($N=25$)	*p* value
Age (years)	9.6 ± 1.4 (7.01–11.10)	9.1 ± 1.0 (7.09–10.11)	0.88
AQ score[a]	85.2 ± 17.7 (45–120)	54.7 ± 15.2 (25–83)	< 0.001*
IQ score[b]	83.1 ± 20.5 (40–125)	30.8 ± 3.4 (23–36)[c]	–

We run *t*-test to compare ASD and TD groups of children

[a]AQ is available in 51 out of 71 ASD and in 24 out of 25 TD groups of children

[b]IQ is available in 66 out of 71 ASD and in all TD groups of children. Because non-verbal IQ was measured with different tools, we do not provide the direct comparison between groups

[c]All TD children were within the normal range, according to Raven's Colored Progressive Matrices. We used cut-off values presented in the original publication for each age-group (i.e. 22 for 7–7.5-year-olds, 23 for 7.5–8-year-olds, etc.)

The Present Study

The goal of the present study was to describe the language profiles in 7–11-year-old (primary-school-aged) Russian children with ASD in both expressive and receptive language domains. We used the Russian Child Language Assessment Battery (RuCLAB, Lopukhina et al., 2019), containing 11 tests, *Phoneme detection* test from the Russian Test of Phonological Processing (RuToPP, Dorofeeva et al., 2020), and a custom-made *Word repetition* test. These 13 tests allowed to assess the language abilities of children at all linguistic levels (phonology, lexicon, morphosyntax, and discourse) in production and comprehension.

The advantage of the present study is fourfold. First, our sample of children consisted of only primary-school-aged children whereas most of the studies included children from a broader age range (e.g., 4–14-year-old children in Kjelgaard and Tager-Flusberg (2001); 4–11-year-olds in Kover et al. (2013); or 5–19-year-olds in Jarrold et al. (1997)), so we were able to describe language abilities of a narrow group of primary-school-aged children with ASD. Importantly, numerous studies focused on language functioning in toddlers or preschoolers with ASD and only a few studies investigated school-aged children and adolescents. Second, the ASD group in our study included children varying in non-verbal IQ, so we did not pre-select children with autism in order to get a full picture of language abilities in this population. Third, we aimed to describe language profiles in ASD at all linguistic levels using not parental reports as many studies did (e.g., Luyster et al., 2007, 2008; Weismer et al., 2010) but measuring language abilities directly, i.e., in formal testing. All of these factors might account for inconsistencies found in the previous literature on language abilities in autism.

Method

Participants

A total of 107 native Russian-speaking children participated in the study: 82 children with ASD (65 boys, 17 girls, age range 7.01–11.10 years, $M_{age}=9.11$, $SD=1.5$) were recruited from the Federal Resource Center for Organization of Comprehensive Support to Children with Autism Spectrum Disorders (FRC for ASD, Moscow, Russia) and 25 age-matched TD children as a control group (14 boys, 11 girls, age range 7.09–10.11 years, $M_{age}=9.1$, $SD=1.0$) were recruited from the public schools in Moscow.

The sample of the ASD group had 4:1 boys to girls ratio which is consistent with the epidemiological studies of sex differences in ASD (Fombonne, 2009; Maenner et al., 2020). Note, however, that it is unclear whether this ratio reflects the real number of girls in autism or they are underdiagnosed (e.g., Green et al., 2019). All children with ASD had a clinical diagnosis within the autistic spectrum, according to ICD-10, and 67 out of 82 also were assessed by a licensed psychiatrist with Autism Diagnosis Observation Schedule—Second Edition, ADOS-2 (Lord et al., 2012; Sorokin & Davydova, 2017; Sorokin et al., 2016). Additionally, to confirm the validity of the diagnosis, parents of both ASD and TD groups of children were asked to fill in the Russian version of the Autism Spectrum Quotient: Children's Version, AQ (Auyeung et al., 2008). The results from the AQ questionnaire were in agreement with the clinical diagnosis (see Table 1). Exclusion criteria were the presence of a known chromosomal syndrome (e.g., fragile X syndrome), comorbid neurological disorders (e.g., epilepsy) and/or previous history of hearing and vision problems. According to them, eleven children with ASD were excluded from the further analysis.

The non-verbal intelligence of TD children was screened with the Raven's Colored Progressive Matrices (Raven, 2000, 2004), and the non-verbal IQ of autistic children was measured with the Kaufman Assessment Battery for Children, K-ABC II (Kaufman & Kaufman, 2004), and Wechsler Intelligence Scale for Children—Third Edition, WISC-III (1991), performance IQ score, where possible.

Demographic information for ASD and TD groups is provided in Table 1.

This study was approved by the HSE University Committee on Interuniversity Surveys and Ethical Assessment of Empirical Research (for TD group) and the local ethics committee of the Moscow State University of Psychology and Education (for ASD group), and was conducted in accordance with the Declaration of Helsinki. A written consent form was obtained from a parent of each child.

Materials and Procedure

The materials were 13 tests that assess phonological, lexical, morphosyntactic, and discourse levels in both the expressive and receptive domains (1–7 for production, 8–13 for comprehension, see below). All pictures and real words were selected from the Verbs and Nouns Stimuli Database for Russian (Akinina et al., 2014, 2015, 2016) with name agreement for pictures above 85%. The audio stimuli were recorded by a professional native speaker of Russian.

The properties of each test as well as description of materials are given in Table 2.[1]

All tests were programmed in Java SE8 and administered using a Samsung Galaxy Tab A (2016) SM-T585 model on Android 7.0 platform with a screen size 10.1″, 1920 × 1200 px. The stimuli for all tests were presented with the AutoRAT application (Ivanova et al., 2016).

Each child was tested individually in a quiet room at the Federal Resource Center for ASD or at the Center for Language and Brain, HSE University. Prior to each test, participants were instructed and completed 2–3 trials, which were excluded from the analysis. Children had the opportunity to ask questions and get clarification during these trials but they did not receive any feedback during the testing. The order of items and test presentation were the same for all participants. The testing lasted from 35 to 70 min including up to three breaks between tests.

Scoring

In the comprehension tests (8–13), accuracy was registered automatically in the AutoRAT application as correct or not. In the production tests (1–7), participants' vocal responses were analyzed by the examiner offline and scored on the same day.[2]

Analysis

First of all, in order to estimate group differences (ASD vs. TD) in accuracy for each language test and to assess the influence of different psycholinguistic parameters on children's accuracy, we fitted generalized linear mixed-effects models for all phonological and lexical tests, for *Sentence comprehension* and for *Discourse comprehension* tests with the main effect of group (ASD vs. TD) and psycholinguistic parameters each nested within the ASD group and within the TD group separately. We also fitted linear mixed-effects models with nested contrasts for *Sentence repetition* and without this contrasts for *Sentence production*. A simple linear regression model was fitted for *Discourse production*. All models, except for *Discourse production*, included random intercepts for participants and items. Specific features of each model are provided in section 'Results'.

To estimate the influence of non-language factors (such as age, AQ score, and non-verbal IQ) on accuracy in the ASD group, we fitted simple linear models with Accuracy as the dependent variable and three predictors (age, AQ score, and non-verbal IQ) for each language test separately.

Finally, to provide subgroups comparisons we used one-way ANOVAs for each language test. Dependent variable was either age or non-verbal IQ whereas Group (Impaired, Borderline, and Normal) was a predictor.

Numeric variables in all models were centered to avoid multicollinearity. We applied a Bonferroni correction for the total number of fitted models in each set of analyses but reported uncorrected *p*-values. The models were estimated in R (R Core Team, 2019) with *lme4* package (Bates et al., 2015), and the data were plotted with *ggplot2* (Wickham, 2016).

Results

Children Completed Language Tests

All TD children were able to complete the full language assessment. By contrast, not all children from the ASD

[1] Extended information on each test with examples is available online: https://osf.io/uaxrd/.

[2] Detailed information on scoring is available online: https://osf.io/x8hty/.

Table 2 Language tests and materials

Domain	Test (linguistic level)	Task (# of items)	Controlled variables
Production	1. Nonword repetition (phonology)	Listen to nonwords and repeat them (n = 24)	Length (1, 2, and 3 syllables long) Number of articulatory switches Following phonotactic rules of Russian
	2. Word repetition (vocabulary)	Listen to words and repeat them (n = 24)	Length (1, 2, and 3 syllables long) Number of articulatory switches Age of acquisition Frequency (low, high)
	3. Object naming (vocabulary)	Name object depicted on the picture (n = 24)	*Pictures:* Subjective visual complexity Familiarity Imageability *Words:* Age of acquisition Frequency (low, medium, high)
	4. Action naming (vocabulary)	Name actions depicted on the picture (n = 24)	The same as in 3. Object naming
	5. Sentence repetition (morphosyntax)	Listen to sentences and repeat them (n = 12)	Length (3 or 6 content words in sentence) Frequency of word lemmas (low, high)
	6. Sentence production (morphosyntax)	Describe the picture relying on the provided spoken model (syntactic priming paradigm) (n = 24)	Number of verb arguments (1, 2, and 3) Type of third argument (Instrumental or Prepositional) Semantic reversibility (reversible or irreversible)
	7. Discourse production (discourse)	Produce a story based on the presented picture with exposition, climax, and resolution (n = 1)	–
Comprehension	8. Phoneme detection (phonology)	Listen to a phoneme followed by a word and judge whether the phoneme was presented in the word (n = 24)	Position of target phoneme (beginning, middle, or the end of word)
	9. Phonological discrimination (phonology)	Listen to pairs of nonwords and identify whether they are same or different (n = 24)	Place of contrasting sound Syllable structure Type of vowel Type of consonant
	10. Noun comprehension (vocabulary)	Listen to object words and choose a corresponding picture out of four (word-to-picture matching paradigm) (n = 24)	*Pictures:* Subjective visual complexity Familiarity Imageability *Words:* Age of acquisition Frequency (low, medium, high) Length
	11. Verb comprehension (vocabulary)	Listen to action words and choose a corresponding picture out of four (word-to-picture matching paradigm) (n = 24)	The same as in 10. Noun comprehension
	12. Sentence comprehension (morphosyntax)	Listen to sentences and choose a corresponding picture out of two (sentence-to-picture matching paradigm) (n = 24)	Number of verb arguments (1, 2, and 3) Type of third argument (Instrumental or Prepositional) Word order (canonical SVO or non-canonical OVS) Construction type (simple constructions, subject and object relative clauses, reflexive constructions, prepositional constructions)
	13. Discourse comprehension (discourse)	Listen to story and answer the questions on events/details of story (n_{text} = 1, $n_{question}$ = 16)	*Type of questions*: Relation to the story (mean line or details) Type of information (explicit or implicit)

Table 3 Performance on language tests, ASD group ($N=71$)

Language test	Number of children	*M*	*SD*
Word repetition	70	0.92	0.26
Noun comprehension	70	0.88	0.31
Verb comprehension	68	0.84	0.36
Object naming	69	0.82	0.38
Nonword repetition	70	0.80	0.39
Action naming	60	0.68	0.46
Sentence repetition	60	0.68	0.39
Sentence comprehension	62	0.65	0.47
Discourse production	59	0.63	0.32
Sentence production	50	0.59	0.42
Phonological discrimination	47	0.58	0.49
Discourse comprehension	54	0.55	0.49
Phoneme detection	46	0.53	0.49

group completed all tests. Table 3 provides information on the number of children with autism who were able to complete each test as well as the mean accuracy and standard deviations for each test.

As expected, test complexity was related to the number of children with ASD who were able to complete them. For example, most of the children completed the simple *Nonword repetition* (98.6%) or *Noun comprehension* (98.6%) tests, whereas fewer children completed more difficult *Phoneme detection* (64.8%) or *Sentence production* (70.4%) tests.

In order to estimate the influence of individual characteristics on the children's ability to complete the tests, we fitted a simple linear model which predicted the percentage of completed tests from the full language assessment and used age, AQ score, and non-verbal IQ as predictors. The results showed that there were no associations between the percentage of completed tests and neither age, $\beta=-0.003$, $SE=0.02$, $t=-0.14$, $p=0.88$; nor AQ score, $\beta=-0.001$, $SE=0.001$, $t=-0.97$, $p=0.33$. By contrast, there was a significant relationship between the percentage of completed tests and non-verbal IQ, $\beta=0.005$, $SE=0.001$, $t=4.32$, $p<0.001$. Thus, neither age nor the severity of autism (measured with AQ questionnaire) were related to the ability to complete the language tests, whereas non-verbal cognition accounted for this ability.

Language Abilities Across Linguistic Levels

Here we provide the group comparisons between children with ASD and TD children for each test. Additionally, we estimated the impact of psycholinguistic properties of the stimuli on accuracy scores. We applied a Bonferroni correction, so that the predictors are significant at the $\alpha=0.003$ level (total number of fitted models with the main effect of group = 13).

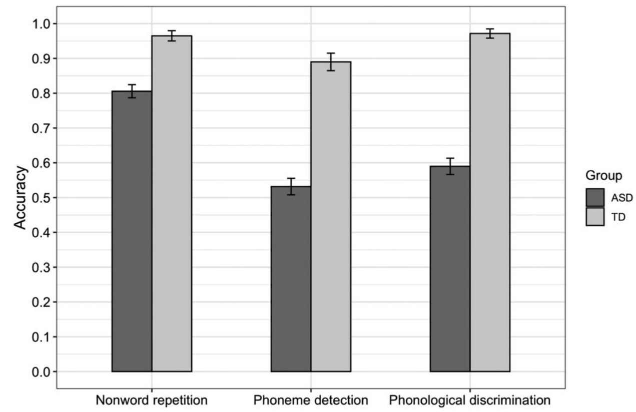

Fig. 1 The comparisons between ASD and TD groups of children in accuracy on phonological assessment tests

Phonology

Phonological processing was assessed with *Nonword repetition*, *Phoneme detection,* and *Phonological discrimination* tests. For each test, we fitted a generalized linear mixed-effects model that estimated participants' accuracy and included the main effect of Group (ASD, TD) and the effect of stimulus Length nested within the ASD group and within the TD group separately as fixed effects and Participants and Items as random intercepts. The analysis revealed the significant main effect of Group for all phonological tests, showing that children with ASD had lower scores than TD children: for *Nonword repetition*, $M_{ASD}=0.80$ ($SD=0.39$) vs. $M_{TD}=0.96$ ($SD=0.18$), $\beta=-1.08$, $SE=0.19$, $z=-5.54$, $p<0.001$; for *Phoneme detection*, $M_{ASD}=0.53$ ($SD=0.49$) vs. $M_{TD}=0.89$ ($SD=0.31$), $\beta=-1.96$, $SE=0.43$, $z=-4.52$, $p<0.001$; for *Phonological discrimination*, $M_{ASD}=0.58$ ($SD=0.49$) vs. $M_{TD}=0.97$ ($SD=0.16$), $\beta=-3.27$, $SE=0.69$, $z=-4.73$, $p<0.001$ (Fig. 1). We did not find significant effects of stimulus length in any of these tests in the ASD or in the TD groups of children.[3]

Lexicon

Lexical processing was assessed with *Word repetition*, *Object naming*, *Action naming*, *Noun comprehension*, and *Verb comprehension* tests. The first set of analyses aimed to reveal the difference between ASD and TD groups of children in accuracy in each of the five tests and the influence

[3] The tables with the model outcomes for all tests are available online: https://osf.io/bcvn8/.

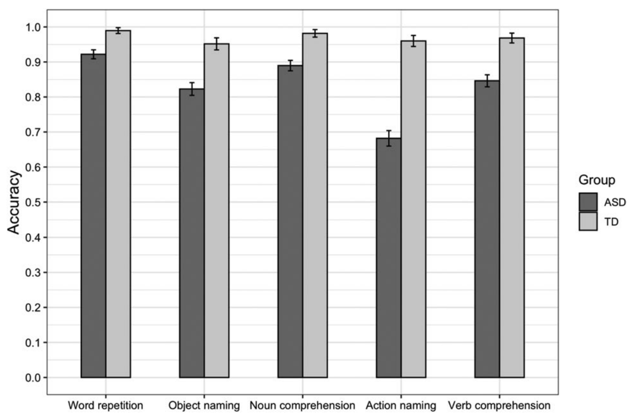

Fig. 2 The comparisons between ASD and TD groups of children in accuracy on vocabulary assessment tests

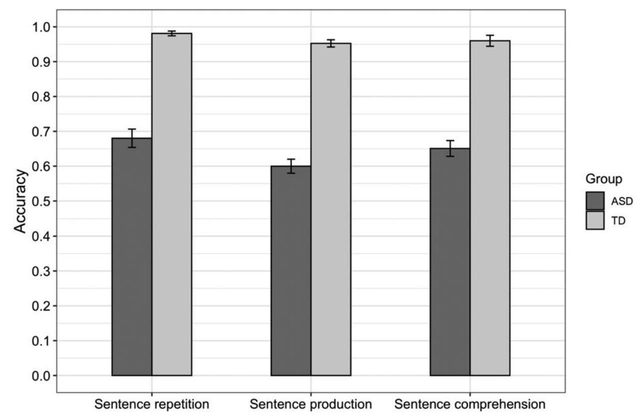

Fig. 3 The comparisons between ASD and TD groups of children in accuracy on morphosyntax assessment tests

of stimulus length on accuracy for *Word repetition*. Five generalized linear mixed-effects models included the main effect of Group (ASD, TD) and the effect of stimulus Length nested within the ASD group and within the TD group separately (only for *Word repetition*) as fixed effects and Participants and Items as random intercepts. We found the significant main effects of Group in all the models except for the model for *Word repetition* (Fig. 2): for *Object naming*, $M_{ASD} = 0.82$ ($SD = 0.38$) vs. $M_{TD} = 0.95$ ($SD = 0.21$), $\beta = 1.90$, $SE = 0.51$, $z = 3.70$, $p < 0.001$; for *Action naming*, $M_{ASD} = 0.68$ ($SD = 0.46$) vs. $M_{TD} = 0.96$ ($SD = 0.19$), $\beta = 3.40$, $SE = 0.61$, $z = 5.55$, $p < 0.001$; for *Noun comprehension*, $M_{ASD} = 0.88$ ($SD = 0.31$) vs. $M_{TD} = 0.98$ ($SD = 0.13$), $\beta = 2.19$, $SE = 0.54$, $z = 3.99$, $p < 0.001$; for *Verb comprehension*, $M_{ASD} = 0.84$ ($SD = 0.36$) vs. $M_{TD} = 0.96$ ($SD = 0.17$), $\beta = 1.93$, $SE = 0.51$, $z = 3.72$, $p < 0.001$. Additionally, we did not find the effect of stimulus length on accuracy for *Word repetition* in either group of children.

The next step of analysis estimates the word class effect (nouns vs. verbs) on accuracy in both production (*Object naming*, *Action naming*) and comprehension (*Noun comprehension*, *Verb comprehension*) for ASD and TD groups of children. Two generalized linear mixed-effects models included the main effect of Group (ASD, TD) and the effect of Word class (Nouns, Verbs; intercept corresponding to Nouns) nested within the ASD group and within the TD group separately as a fixed effect and Participants and Items as random intercepts. The models were fitted separately for production and comprehension. In the TD group, we did not find the effect of word class: nouns and verbs were produced and recognized with comparable accuracy. By contrast, in the ASD group, we found a significant effect of word class: children with ASD struggled more with verbs than with nouns in *Production*, $M_{nouns} = 0.82$ ($SD = 0.38$) vs. $M_{verbs} = 0.68$ ($SD = 0.46$), $\beta = -1.18$, $SE = 0.10$, $z = -11.46$, $p < 0.001$; as well as in *Comprehension*, $M_{nouns} = 0.88$ ($SD = 0.31$) vs. $M_{verbs} = 0.84$ ($SD = 0.36$), $\beta = -0.54$, $SE = 0.12$, $z = -4.42$, $p < 0.001$.

Additionally, for *Noun comprehension* and *Verb comprehension* tests we calculated the number of errors of different types (semantic, phonological, and unrelated) in the ASD and TD groups. Although TD children made fewer errors than autistic children, the pattern was the same in both groups: most errors were semantic (61% of the total number of errors in ASD and 90% in TD); phonological errors comprised 23% in ASD and 7% in TD, and unrelated errors comprised 16% in ASD and 3% in TD.

Morphosyntax

The morphosyntactic level was assessed with *Sentence repetition*, *Sentence production*, and *Sentence comprehension* tests. The first set of analyses aimed to reveal the effects of participants' group, frequency and length of stimuli on accuracy. For *Sentence repetition*, we fitted a linear mixed-effects model with the main effect of Group (ASD, TD) and the effects of Frequency and Length each nested within the ASD group and within the TD group separately as fixed effects and Participants and Items as random intercepts; for *Sentence production,* we fitted a linear mixed-effects model with the main effect of Group (ASD, TD) as a fixed effect and Participants and Items as random intercepts; and for *Sentence comprehension* test, we fitted the generalized linear mixed-effects model with the main effect of Group (ASD, TD) as a fixed effect and Participants and Items as random intercepts.

The results showed the significant main effect of group for all models, showing that children with ASD had lower scores in sentence processing than TD children: for *Sentence repetition*, $M_{ASD} = 0.68$ ($SD = 0.39$) vs. $M_{TD} = 0.98$ ($SD = 0.05$), $\beta = -0.17$, $SE = 0.03$, $t = -4.88$, $p < 0.001$; for *Sentence production*, $M_{ASD} = 0.59$ ($SD = 0.42$) vs. $M_{TD} = 0.95$ ($SD = 0.12$),

$\beta = 0.35$, SE = 0.08, $t = 4.43$, $p < 0.001$; for *Sentence comprehension*, $M_{ASD} = 0.65$ ($SD = 0.47$) vs. $M_{TD} = 0.96$ ($SD = 0.19$), $\beta = 3.25$, SE = 0.54, $z = 6.08$, $p < 0.001$ (Fig. 3). In *Sentence repetition*, neither frequency nor length predicted accuracy in the TD group. By contrast, in the ASD group we found the significant effects of frequency, $M_{high} = 0.73$ ($SD = 0.38$) vs. $M_{low} = 0.62$ ($SD = 0.39$), $\beta = -0.11$, SE = 0.02, $t = -4.83$, $p < 0.001$, and length on accuracy, $M_{short} = 0.77$ ($SD = 0.38$) vs. $M_{long} = 0.58$ ($SD = 0.38$), $\beta = 0.19$, SE = 0.02, $t = 8.25$, $p < 0.001$. Therefore, children with ASD repeated short sentences and sentences with high-frequency words better than long sentences and sentences consisting of low-frequency words.

Additionally, for *Sentence comprehension* we fitted two generalized linear mixed-effects models (1) with the main effect of Group (ASD, TD) and the effect of Word Order (canonical SVO, noncanonical OVS; intercept corresponding to OVS) nested within the ASD group and within the TD group separately as fixed effect and Participants and Items as random intercepts; (2) with the main effect of Group (ASD, TD) and the effects of Type of third argument (Instr—Instrumental, Prep—Prepositional; intercept corresponding to Instr), and arguments' Order (D—Direct, I—Indirect; intercept corresponding to D) nested within the ASD group and within the TD group separately as fixed effects and Participants and Items as random intercepts. The first model with nested contrasts demonstrated that there was no effect of word order on accuracy in the TD group. However, in the ASD group there was the significant influence of word order on accuracy, $M_{SVO} = 0.73$ ($SD = 0.44$) vs. $M_{OVS} = 0.58$ ($SD = 0.49$), $\beta = 1.18$, SE = 0.36, $z = 3.33$, $p < 0.001$, indicating that children with autism comprehended sentences with canonical SVO word order more accurately than sentences with noncanonical OVS word order. The second model with nested contrasts also revealed the significant effects of both Order (D vs. I) and Type of the third argument of a verb (Instr vs. Prep) on accuracy in the ASD group: *Order*, $M_D = 0.54$ ($SD = 0.49$) vs. $M_I = 0.68$ ($SD = 0.46$), $\beta = 0.94$, SE = 0.30, $z = 3.18$, $p < 0.001$; *Type of the third argument of a verb*, $M_{Instr} = 0.56$ ($SD = 0.49$) vs. $M_{Prep} = 0.66$ ($SD = 0.47$), $\beta = 0.65$, SE = 0.29, $z = 2.24$, $p = 0.02$. It means that children with ASD processed sentences with prepositional arguments more accurately than sentences with instrumental arguments and sentences with indirect–direct argument order more accurately than sentences with direct–indirect argument order. In the TD group, we did not find any of these effects. The results for the ASD group are in line with previous findings for the Russian language: instrumental case is acquired last of all oblique cases (Voeikova & Gagarina, 2002) and is processed least accurately (Ladinskaya et al., 2019), and preference for indirect argument order in instrumental constructions could indicate reliance on motor stereotypes, typical for young TD children (Chrabaszcz et al., 2017).

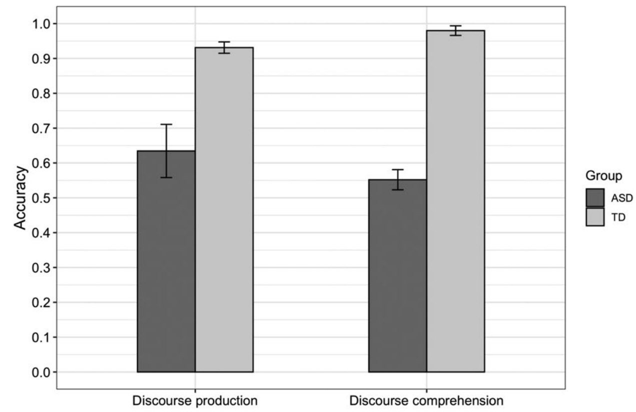

Fig. 4 The comparisons between ASD and TD groups of children in accuracy on discourse assessment tests

Discourse

For assessing the discourse level, we used *Discourse production* and *Discourse comprehension* tests. To estimate *Discourse production*, we fitted a simple linear regression model with the main effect of Group (ASD, TD) as a predictor. To estimate *Discourse comprehension*, we fitted a generalized linear mixed-effects model with the main effect of Group (ASD, TD) and the effects of Line of the story (M—questions about the main line, D—questions about details; intercept corresponding to D), and Question type (Ex—explicit, Im—implicit; intercept corresponding to Ex) each nested within the ASD group and within the TD group separately as fixed effects and Participants as random intercept. The results revealed the significant effect of Group in both tests, showing that children with ASD had lower scores than TD children: for *Discourse production*, $M_{ASD} = 0.63$ ($SD = 0.32$) vs. $M_{TD} = 0.93$ (SD = 0.03), $\beta = 0.30$, SE = 0.07, $t = 4.48$, $p < 0.001$; for *Discourse comprehension*, $M_{ASD} = 0.55$ ($SD = 0.49$) vs. $M_{TD} = 0.98$ (SD = 0.14), $\beta = 7.61$, SE = 1.30, $z = 5.87$, p < 0.001 (Fig. 4). In *Discourse comprehension* test, the model with nested contrasts demonstrated that there was no significant influence of any of the two factors on accuracy in the TD group. In the ASD group, there was no significant effect of line of the story; however, we found the significant effect of question type, $M_{explicit} = 0.58$ ($SD = 0.49$) vs. $M_{implicit} = 0.51$ ($SD = 0.50$), $\beta = -0.64$, SE = 0.30, $z = -2.16$, $p = 0.03$. Thus, children with ASD struggled more with implicit questions.

To sum up, group comparisons revealed statistically significant differences between the ASD and TD groups in accuracy scores in all language tests, except *Word repetition*. Children with ASD were less accurate than TD children. Moreover, most psycholinguistic variables influenced accuracy in the ASD group but not in the TD group. Table 4 summarizes the results of the whole assessment.

Table 4 The key findings in language measures in both groups of children (TD and ASD)

	TD–ASD[a]	TD	ASD
Phonology			
Nonword repetition	**0.96(0.18)–0.80(0.39)**		
Length in syllables		Non-significant	Non-significant
Phoneme detection	**0.89(0.31)–0.59(0.49)**		
Length in syllables		Non-significant	Non-significant
Phonological discrimination	**0.97(0.16)–0.58(0.49)**		
Length in syllables		Non-significant	Non-significant
Lexicon			
Word repetition	0.98(0.10)–0.92(0.26)		
Length in syllables		Non-significant	Non-significant
Object naming	**0.95(0.21)–0.82(0.38)**		
Action naming	**0.96(0.19)–0.68(0.46)**		
Object vs. action naming		Non-significant	**Object > Action**[b]
Noun comprehension	**0.98(0.13)–0.88(0.31)**		
Verb comprehension	**0.96(0.13)–0.84(0.36)**		
Noun vs. verb comprehension		Non-significant	**Noun > Verb**
Morphosyntax			
Sentence repetition	**0.98(0.05)–0.68(0.39)**		
Frequency		Non-significant	**High > Low**
Length in words		Non-significant	**Short > Long**
Sentence production	**0.95(0.12)–0.59(0.42)**		
Sentence comprehension	**0.96(0.19)–0.65(0.47)**		
Word order		Non-significant	**SVO > OVS**
Type of third argument		Non-significant	**Prepositional > Instrumental**
Argument order		Non-significant	**Indirect > Direct**
Discourse			
Discourse production	**0.93(0.03)–0.63(0.32)**		
Discourse comprehension	**0.98(0.14)–0.55(0.49)**		
Line of story		Non-significant	Non-significant
Question type		Non-significant	**Explicit > Implicit**

[a]The difference between TD and ASD groups, M(SD). Significant results are in bold

[b]The '>' means more accurately

The Influence of Non-language Factors on Language Abilities

This set of analyses aimed to reveal the relationships between non-language factors (age, AQ scores that reflected the severity of autistic traits, and non-verbal IQ) and language abilities in children with ASD. For each language test, we fitted a simple linear model with accuracy as the dependent variable and three predictors (age, AQ score, and non-verbal IQ) in order to assess the influence of these factors on language tests scores independently. We applied a Bonferroni correction, so that the predictors are significant at the $\alpha = 0.004$ level (total number of fitted models = 11).

The summary of results for each test is presented in Table 5.

The results showed that age and AQ scores were not related to language abilities in any test. It means that language abilities assessed in formal testing are completely independent from children's age and the severity of autistic traits. The robust predictor of language abilities was non-verbal IQ. We showed that children's non-verbal IQ predicted accuracy in 9 out of 11 language tests (in the other two tests the IQ effect was significant only before a Bonferroni correction). This is in line with numerous studies showing that intellectual level is dramatically associated with the language functioning in children with ASD (e.g., Kjelgaard & Tager-Flusberg, 2001; Nevill et al., 2019).

Subgrouping Children with ASD

The previous analysis showed the high variability of language scores in children with ASD (see *M* and *SD* in Table 3). In order to explore this variability, we created three subgroups of children with ASD based on the standard

Table 5 The influence of non-language factors on language abilities

Test	IQ				AQ				Age			
	β	SE	*t*	*p*	β	SE	*t*	*p*	β	SE	*t*	*p*
Nonword repetition	0.0025	0.0012	2.02	**0.04**	– 0.0011	0.0014	– 0.78	0.43	0.0489	0.0225	2.17	**0.03**
Phoneme detection	0.0103	0.0025	4.09	**< 0.001***	– 0.0035	0.0030	– 1.18	0.24	0.0387	0.0455	0.85	0.40
Phonological discrimination	0.0095	0.0029	3.26	**0.002***	– 0.0025	0.0035	– 0.72	0.47	0.0402	0.0530	0.75	0.45
Word repetition	0.0034	0.0012	2.65	**0.01**	– 0.0025	0.0015	– 1.62	0.11	0.0128	0.0233	0.54	0.58
Word production[a]	0.0040	0.0013	2.99	**0.004***	– 0.0009	0.0016	– 0.57	0.56	0.0176	0.0244	0.72	0.47
Word comprehension[b]	0.0027	0.0008	3.33	**0.001***	– 0.0011	0.0009	– 1.15	0.25	0.0139	0.0149	0.93	0.35
Sentence repetition	0.0076	0.0020	3.77	**< 0.001***	0.0008	0.0024	0.33	0.73	– 0.0026	0.0365	– 0.07	0.94
Sentence production	0.0107	0.0022	4.67	**< 0.001***	– 0.0033	0.0027	– 1.20	0.23	– 0.0103	0.0415	– 0.25	0.80
Sentence comprehension	0.0062	0.0018	3.28	**0.001***	– 0.0002	0.0022	– 0.12	0.90	– 0.0045	0.0342	– 0.13	0.89
Discourse production	0.0075	0.0021	3.56	**< 0.001***	– 0.0018	0.0025	– 0.71	0.47	0.0280	0.0383	0.73	0.46
Discourse comprehension	0.0111	0.0021	5.11	**< 0.001***	– 0.0047	0.0026	– 1.82	0.07	– 0.0009	0.0392	– 0.02	0.98

Predictors significant at α = .05 significance level are highlighted in bold. Predictors that retained their significance following the Bonferroni correction for the total number of models (that is, significant at the α = 0.004 level) are also labeled with *

[a]We merged *Object naming* and *Action naming* to *Word production*

[b]We merged *Noun comprehension* and *Verb comprehension* to *Word comprehension*

Table 6 The language groups with number of children, scores range, *M* and *SD*

Language test	Language group		
	Normal	Borderline	Impaired
Nonword repetition	Scores of 0.96 and above (*N* = 15, *M* = 0.98, *SD* = 0.02)	Scores between 0.95 and 0.73 (*N* = 44, *M* = 0.84, *SD* = 0.05)	Scores below 0.73 (*N* = 12, *M* = 0.46, *SD* = 0.23)
Phoneme detection	Scores of 0.89 and above (*N* = 16, *M* = 0.95, *SD* = 0.03)	Scores between 0.88 and 0.50 (*N* = 27, *M* = 0.80, *SD* = 0.09)	Scores below 0.49 (*N* = 28, *M* = 0.04, *SD* = 0.12)
Phonological discrimination	Scores of 0.97 and above (*N* = 19, *M* = 1.00, *SD* = 0.00)	Scores between 0.96 and 0.77 (*N* = 20, *M* = 0.92, *SD* = 0.06)	Scores below 0.76 (*N* = 32, *M* = 0.14, *SD* = 0.25)
Word repetition	Scores of 0.98 and above (*N* = 43, *M* = 1.00, *SD* = 0.00)	Scores between 0.97 and 0.86 (*N* = 21, *M* = 0.94, *SD* = 0.02)	Scores below 0.85 (*N* = 7, *M* = 0.37, *SD* = 0.26)
Word production	Scores of 0.95 and above (*N* = 11, *M* = 0.97, *SD* = 0.01)	Scores between 0.94 and 0.70 (*N* = 45, *M* = 0.84, *SD* = 0.07)	Scores below 0.70 (*N* = 15, *M* = 0.33, *SD* = 0.18)
Word comprehension	Scores of 0.97 and above (*N* = 16, *M* = 0.99, *SD* = 0.01)	Scores between 0.96 and 0.78 (*N* = 45, *M* = 0.90, *SD* = 0.05)	Scores below 0.78 (*N* = 10, *M* = 0.49, *SD* = 0.26)
Sentence repetition	Scores of 0.98 and above (*N* = 6, *M* = 0.99, *SD* = 0.00)	Scores between 0.97 and 0.92 (*N* = 14, *M* = 0.95, *SD* = 0.02)	Scores below 0.92 (*N* = 51, *M* = 0.57, *SD* = 0.33)
Sentence production	Scores of 0.95 and above (*N* = 2, *M* = 0.95, *SD* = 0.00)	Scores between 0.94 and 0.80 (*N* = 36, *M* = 0.88, *SD* = 0.04)	Scores below 0.80 (*N* = 33, *M* = 0.26, *SD* = 0.35)
Sentence comprehension	Scores of 0.96 and above (*N* = 10, *M* = 0.97, *SD* = 0.02)	Scores between 0.95 and 0.72 (*N* = 23, *M* = 0.85, *SD* = 0.60)	Scores below 0.72 (*N* = 38, *M* = 0.45, *SD* = 0.26)
Discourse production	Scores of 0.93 and above (*N* = 3, *M* = 0.95, *SD* = 0.00)	Scores between 0.92 and 0.89 (*N* = 6, *M* = 0.90, *SD* = 0.00)	Scores below 0.89 (*N* = 62, *M* = 0.59, *SD* = 0.32)
Discourse comprehension	Scores of 0.98 and above (*N* = 6, *M* = 1.00, *SD* = 0.00)	Scores between 0.97 and 0.80 (*N* = 21, *M* = 0.84, *SD* = 0.04)	Scores below 0.80 (*N* = 44, *M* = 0.35, *SD* = 0.32)

deviations as it was done in Kjelgaard and Tager-Flusberg's (2001) study. For each language test across linguistic levels, we divided children into those who had scores within the normal range (normal language group), those who scored between 1 and 1.27 standard deviations below the mean (borderline group), and those whose scores were more than 1.27 standard deviations below the mean (impaired group). Table 6 summarizes the data.

The 1.27 standard deviation cut-off was chosen based on the literature of child language impairments (Estes et al., 2007; Tomblin et al., 1996). Although different studies used different cut-off values, ranging from 1 to 2 SD (e.g., Lewis, 2001), Tomblin et al. (1996) systematic analysis showed that 1.25 SD is a reliable cut-off for the diagnosis of vocabulary and grammar impairments in children, whereas Estes et al. (2007) meta-analysis showed that 1.27 SD is a good cut-off for diagnosis the phonological impairments, assessing with nonword repetition task. We use 1.27 SD cut-off for all our language tests.

This set of analyses compares the three subgroups of children with autism in order to reveal whether they differ from each other in age and/or non-verbal IQ. We did not include the AQ scores in this analysis because it was not significant in any test (see Table 5). In order to provide subgroup comparisons, we ran one-way ANOVA for each language test and applied a Bonferroni correction, so that the predictors are significant at the $\alpha = 0.004$ level (total number of tests = 11).

Phonology

For *Nonword repetition*, the effect of non-verbal IQ was not significant, whereas for other phonological tests there was a significant difference between subgroups in non-verbal IQ: for *Phoneme detection*, $M_{Normal} = 92.8$ ($SD = 19.0$), $M_{Borderline} = 90.2$ ($SD = 16.6$), $M_{Imapaired} = 68.0$ ($SD = 17.2$), $F(2, 63) = 13.19$, $p < 0.001$; for *Phonological discrimination*, $M_{Normal} = 89.7$ ($SD = 18.8$), $M_{Borderline} = 93.2$ ($SD = 17.0$), $M_{Imapaired} = 71.6$ ($SD = 17.0$), $F(2, 63) = 9.82$, $p < 0.001$. The effect of age was significant only for *Phonological discrimination* test, $M_{Normal} = 9.11$ ($SD = 1.4$), $M_{Borderline} = 8.6$ ($SD = 1.1$), $M_{Imapaired} = 8.11$ ($SD = 1.2$), $F(2, 68) = 7.04$, $p = 0.002$.

Lexicon

In *Word repetition* and *Word production* there was no difference between the groups in non-verbal IQ and age. Non-verbal IQ was a significant factor for *Word comprehension*, that includes *Noun* and *Verb Comprehension*: $M_{Normal} = 86.2$ ($SD = 18.0$), $M_{Borderline} = 86.1$ ($SD = 18.6$), $M_{Imapaired} = 61.4$ ($SD = 23.4$), $F(2, 63) = 5.90$, $p = 0.004$, whereas age was not significant.

Morphosyntax

For *Sentence repetition*, the effect of non-verbal IQ was not significant. By contrast, for other morphosyntactic tests we found a significant effect of non-verbal IQ: for *Sentence production*, $M_{Normal} = 90.5$ ($SD = 31.8$), $M_{Borderline} = 90.4$ ($SD = 19.4$), $M_{Imapaired} = 73.2$ ($SD = 17.6$), $F(2, 63) = 3.72$, $p = 0.002$; for *Sentence comprehension*, $M_{Normal} = 89.7$ ($SD = 14.7$), $M_{Borderline} = 91.4$ ($SD = 19.5$), $M_{Imapaired} = 75.4$ ($SD = 20.1$), $F(2, 63) = 5.41$, $p = 0.006$ (marginally significant after applying a Bonferroni correction). The age effect was not significant for all three tests.

Discourse

For *Discourse production*, neither age nor non-verbal IQ were significant predictors. Age was also not significant in *Discourse comprehension*. However, we found a significant effect of non-verbal IQ in *Discourse comprehension*, $M_{Normal} = 98.3$ ($SD = 9.9$), $M_{Borderline} = 94.5$ ($SD = 17.7$), $M_{Imapaired} = 75.1$ ($SD = 19.2$), $F(2, 63) = 9.92$, $p < 0.001$.

To sum up, this analysis showed that, first, there were subgroups of autistic children with normal language abilities in any test we used. Second, the number of children within the normal range depended on the linguistic level, so that according to morphosyntax and discourse tests the groups with normal performance consisted of fewer children in comparison to phonological and lexical tests. Finally, the subgroups of children with ASD differed in non-verbal IQ in most of the tests, i.e. normal subgroups had overall higher IQ than the impaired subgroups.

Discussion

The present study assessed the language abilities in a large group of 7–11-year-old (primary-school-aged) Russian children with ASD. We used 13 tests assessing language development in Russian to describe language profiles at four linguistic levels in both production and comprehension. Additionally, to predict the language functioning in ASD, we analyzed how children's age, the severity of autistic traits, and non-verbal IQ influence performance in language tests. The significance and novelty of this research is that we described language abilities of less-studied school-aged children with autism, using not parental reports but direct formal testing of all linguistic levels in both production and comprehension. Importantly, until now there were no studies on the language abilities of Russian children with ASD. Therefore, this is the first study that described the language profiles of Russian children with autism using well-designed language tests that take into account all relevant psycholinguistic variables.

The ASD and TD group comparisons revealed significant differences in all language tests, excluding the simplest *Word repetition* test. These results are in agreement with numerous studies showing, on the one hand, that children with ASD may have language difficulties at all linguistic levels and, on the other hand, high variability in language skills (e.g., Kjelgaard & Tager-Flusberg, 2001; Kjellmer et al., 2018; Nevill et al., 2019).

At the phonological level, we showed that children with ASD have problems in both verbal working memory/

phonological short-term memory (Bishop et al., 1996; Dispaldro et al., 2013; Dollaghan & Campbell, 1998; Habib et al., 2019; Wang et al., 2017) and phonological awareness which supports studies on the phonological processing deficit in autism (Williams et al., 2013; Wolk et al., 2016). The effect of stimulus length was non-significant in all phonological tests which is in agreement with Williams et al. (2013) results demonstrated that stimulus length influenced accuracy only when items contained 4 or more syllables. Our items were 1-to-3-syllable long.

The mean scores of those participants who were able to complete the tests showed that lexicon is the least affected linguistic level with a mean accuracy of 0.87. Our results supported the findings of Kjelgaard and Tager-Flusberg (2001), which demonstrated that lexical skills of American children with ASD were higher than other language abilities. Presumably, this general cross-language pattern may be explained by the fact that usually language interventions for children with autism predominantly rely on lexical development to improve communication skills (Carr & Felce, 2007; Flippin et al., 2010; Howlin et al., 2007). We also showed that nouns are produced and comprehended more accurately than verbs which is consistent with studies on lexical development in children with ASD (Swensen et al., 2007) as well as in TD children (D'Odorico & Fasolo, 2007; Goldfield, 2000).

At the morphosyntactic level, we showed that children with ASD had difficulties in both production and comprehension contrary to TD children. In general, the complexity of syntactic structure influenced the ability of children with ASD to produce and comprehend sentences. In *Sentence repetition* test, length and frequency influenced children's accuracy: short sentences were repeated more accurately than long sentences, and sentences with high-frequency words were produced more accurately than sentences with low-frequency words by children with ASD. In *Sentence comprehension*, we found the significant effects of word order, the type of third argument and argument order in the ASD group. We showed that sentences with canonical SVO word order were comprehended more accurately than sentences with noncanonical OVS word order. This is in line with both behavioral and neurophysiological research on sentence comprehension with SVO and OVS word orders in typically developing toddlers and pre-schoolers (Arnhold et al., 2016; Strotseva-Feinschmidt et al., 2019). As the classical studies have shown, children with autism usually use the word order strategy (interpreting noun–verb–noun sequence as agent-action-object) to understand sentences, and this differentiates children with ASD from children, for example, with SLI/DLD (Paul et al., 1988; Tager-Flusberg, 1981). Additionally, we demonstrated that children with ASD struggled more with Instrumental than Prepositional case in sentence comprehension. This can be explained by the fact that Instrumental case in Russian is acquired later than other cases during child development (Voeikova & Gagarina, 2002).

At the discourse level, children with ASD also had difficulties, compared to TD children, while describing a picture and answering the questions about the heard story. In comprehension, there was also the effect of question type: children with ASD answered explicit questions more accurately than implicit questions. This agrees with previous studies that showed, on the one hand, the effectiveness of any interventions with explicit instructions for children with autism (Ganz & Flores, 2009; Smith et al., 2013), and, on the other hand, that TD 4–6-year-olds comprehended explicit information of story more easily than implicit (Florit et al., 2011).

In order to understand which non-language factors may influence the language abilities of children with ASD, we analyzed children's performance in language tests taking into account age, the severity of autistic traits (measured with AQ), and non-verbal IQ. The results showed that children's age and AQ were not significant for any language test, indicating that language abilities and age/the severity of autistic traits are independent from each other. Although some studies have demonstrated that AQ may predict language and cognitive functioning in the general population (e.g., Armstrong et al., 2017; Stewart et al., 2009), research with autistic children do not support this relationship (Stroganova et al., 2015). To the best of our knowledge, there are no studies that focus on the language abilities of children with autism in relation to AQ. Thus, we showed for the first time that AQ did not predict language processing in children with ASD.

The non-verbal IQ was the robust predictor of language abilities of children with autism in 9 out of 11 language tests. This result is in line with previous studies (e.g., Kjelgaard & Tager-Flusberg, 2001; Nevill et al., 2019). However, some studies reported that the major part of children with ASD without intellectual disability also have language difficulties (e.g., Kjellmer et al., 2018). Therefore, although non-verbal IQ may predict language abilities to some extent, it does not fully account for the high heterogeneity of language functioning in children with ASD.

In order to assess this heterogeneity and the profiles of language skills in ASD population, we divided our ASD group into normal, borderline, and impaired subgroups according to their language abilities as in Kjelgaard and Tager-Flusberg's (2001) profiling study, and such an approach is traditionally used in SLI/DLD literature (Estes et al., 2007; Lewis, 2001; Tomblin et al., 1996). First, our results showed that in each language test, including the most difficult, there was a group of autistic children with normal language abilities. It supports the idea that language impairment is not a universal characteristic of autism in comparison to difficulties in the pragmatic aspect of language

(Tager-Flusberg, 1996). Second, although for each language test there was a group with normal language functioning, the number of children with ASD with normal language abilities differed in different tests. For example, in the simplest *Word repetition* test, 61% of children with ASD had the scores within the normal range; in a more complex vocabulary test, *Word comprehension*, 22% of children were within the normal range. By contrast, in *Sentence repetition*, 8% of children had scores within a normal range, and in *Discourse production*, the normal language group consisted of only 4% of children with ASD. Finally, subgroup comparisons demonstrated that in most of the tests these language subgroups differed in non-verbal IQ: subgroups with normal language performance had overall higher IQ whereas impaired subgroups had lower IQ.

There are debates on the overlaps between SLI/DLD and ASD; some authors propose comorbidity between SLI/DLD and ASD, whereas others argue that language impairments in ASD have another etiology (Bishop, 2010; Williams et al., 2008). SLI/DLD is the inability to acquire language in a typical way despite normal non-verbal intelligence (Bishop et al., 1996). Although the subgroups of children with ASD in our study differed in non-verbal IQ in most of the language tests, there were a few children with normal language performance, but with low non-verbal IQ. At the same time, language-impaired groups included a few children with high non-verbal IQ. Therefore, it could mean that some children with ASD may have comorbid SLI/DLD (children without intellectual disability) whereas language impairments in other children may have another etiology, which is in line with Kjelgaard and Tager-Flusberg's (2001) study.

Although this research described language abilities of a less-studied group of school-aged children with ASD, it is limited by the fact that we compared autistic children only to TD children and not to children with other developmental disorders. So, we do not know exactly whether the identified language patterns are specific for the ASD group or whether they are common for different groups with developmental disorders. Future research would benefit from comparing language patterns at different linguistic levels in children with ASD to the children with other developmental disorders. This will help to highlight the specific language patterns which differentiate ASD from other developmental disorders.

Clinical Implications

Some studies highlighted the importance of including language assessment into general ASD diagnostic procedure because of the high variability of language skills even in autistic children without intellectual disability (Kjellmer et al., 2018). Our profiling confirms this necessity and also proposes two additional points to take into account.

First, our study showed that the language skills of children with ASD may differ depending on a linguistic level, e.g. a child may have normal vocabulary, but impaired morphosyntactic processing. This means that formal language assessment needs to include the assessment of all linguistic levels, from phonology to discourse. As a result, language testing could help speech-language therapists to choose the best therapy.

Second, the formal language assessment should become part of the general psychological assessment of children with ASD besides the tests which accounted for the severity of autistic traits or non-verbal IQ. Now in Russia, language therapy for children with autism is mostly dependent on the general communication skills of a child, the severity of autistic symptoms and the child's intellectual level: children with severe autistic traits and problems in social communication usually receive more language therapy although they can have normal language abilities. At the same time, children with good communication skills and normal non-verbal IQ may not get language therapy although some of them can have a deficit in linguistic processing. Our results demonstrated that subgroups of children with autism differed in non-verbal IQ, but there were some children with normal language abilities and low non-verbal IQ (60) as well as children with impaired language skills and high non-verbal IQ (113). Therefore, in practice, there can be a child with normal non-verbal IQ and non-severe autistic traits but with severe language impairments, who may need special intervention by a speech-language therapist.

The results of the study highlight the importance of understanding the language strengths and difficulties in children with ASD, regardless of communicative skills in order to provide effective therapy. In turn, the effective therapy could improve language ability which is, in addition to intellectual level, a significant factor for both long-term education and social outcomes.

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