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SINGLE-WORD RECOGNITION INPAIRMENTS IN PRIMARY SCHOOL-AGED CHILDREN WITH AUTISM SPECTRUM DISORDER

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SINGLE-WORD RECOGNITION INPAIRMENTS IN PRIMARY-SCHOOL-AGED CHILDREN WITH AUTISM SPECTRUM DISORDER

Autism Spectrum Disorder (ASD) is a group of neurodevelopmental disorders characterized by impairments in social interaction and communication as well as behavior. Usually children with ASD have comorbid language disorders and/or delay.

The present study concentrated on single-word recognition in 7-to-11-year-old Russian children with ASD. The results showed that primary-school-aged children with autism have difficulties even with such a basic process as single-word recognition.

Keywords: Autism Spectrum Disorder, single-word recognition, language impairments, phonological errors, semantic errors.

JEL Classification: Z.

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Introduction

Autism Spectrum Disorder (ASD) is a group of neurodevelopmental disorders characterized by impairments in social interaction, including communication, and also repetitive behavior and restricted interests (APA, 2013). Although language disorders are not a core symptom in ASD, about 75% of children with autism have language development problems and/or impairments (Kjelgaard & Tager-Flusberg, 2001; Lindgren, Folstein, Tomblin, & Tager-Flusberg, 2009).

Different studies, both behavioral and neuroimaging, showed that children with ASD may have difficulties with all language levels. In the large groups of autistic kids, it was demonstrated that children with ASD have impairments in articulation and/or phonological processing (e.g., Cleland et al., 2010; Wolk et al., 2016), problems with lexical-semantic processing (Cantiani et al., 2016), and grammatical impairments (Durrleman et al., 2015; Wittke et al., 2017). However, although children with ASD, according to these studies, have difficulties at all levels of language processing, the simple common profiling of this atypically group is impossible because of the highly heterogeneity. Language impairments in ASD are usually related to other cognitive and/or mental conditions, including for example non-verbal IQ or degree of autistic severity.

The main goal of the present study is to assess the processing at one of the basic levels of comprehension, i.e., single-word recognition in primary-school-aged Russian children diagnosed with ASD, and to clarify how non-verbal IQ influences recognition accuracy.

Method

Participants

20 children with ASD (17 boys, M_{age} = 8.95, SD = 1.04), varying in non-verbal IQ (range 40 – 113), and 15 typically developing children, TD (10 boys, M_{age} = 8.58, SD = 0.94) participated in current study. All children were right-handed native Russian-speakers. Children with ASD were recruited from the Federal Resource Center for ASD, and TD children were recruited from the Moscow local schools. The written inform consents were received from the parents of each child. Non-verbal IQ of autistic kids was measured with the Kaufman Assessment Battery for Children K-ABC.

Materials

Word-to-picture-matching paradigm for objects (N = 24) and actions (N = 24) was used. Each visual set consisted of four pictures – target, phonological distractor, semantic distractor, and unrelated picture (Fig. 1). Stimuli were taken from the Nouns and Verbs Database for Russian and were balanced on subjective visual complexity, familiarity, age of acquisition, imageability,

frequency, and length (Akinina, 2014, 2015, 2016).

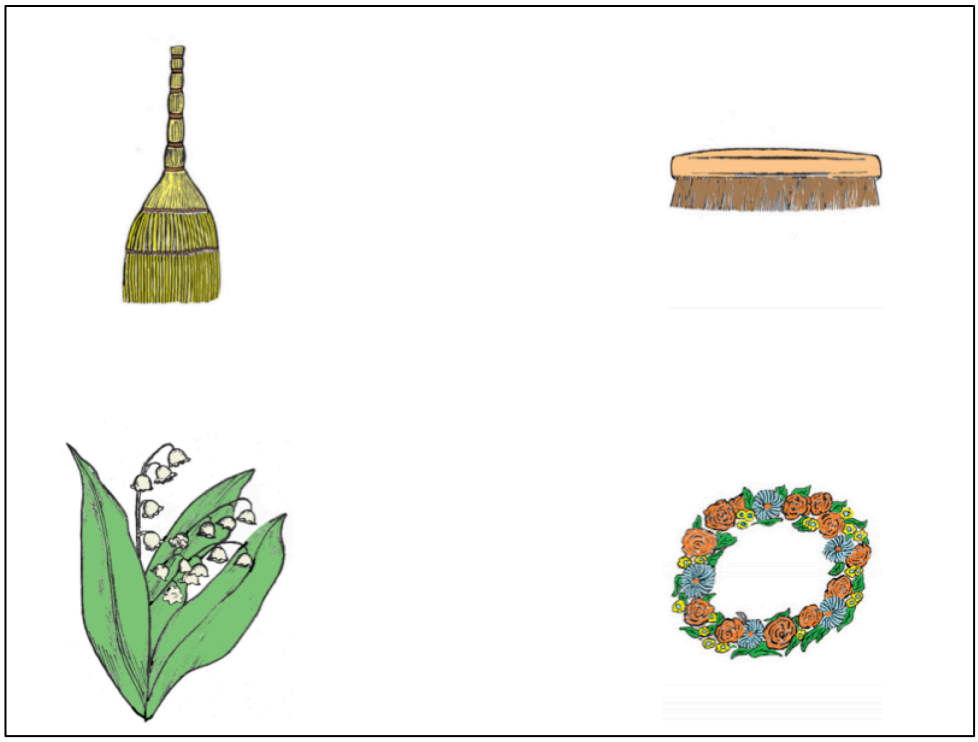

Fig.1. The example of stimulus screen: *'venik'* (broom) – target picture, *'venok'* (wreath) – phonological distractor, *'shetka'* (brush) – semantic distractor, *'landysh'* (lily of the valley) – unrelated picture.

Procedure

All children were sitting with instructor in a quiet room and were shown visual sets, each containing four pictures with using special AutoRAT tablet application created at the Center for Language and Brain, HSE (Ivanova et al., 2016). Each trial started with the presentation of four pictures for 500 ms. Then the stimulus word was played auditorily. The children had to choose a correct picture (press the screen on the picture), and accuracy registered automatically by the same program. The correct answers were coded automatically by the program as 1 whereas incorrect answers as 0 with clarification of the error type (*ph* for phonological errors, *sem* for semantic errors, and *ir* for irrelevant errors).

Analysis

We used generalized mixed-linear model[2] for comparing accuracy between ASD and TD groups with *lme4* package in *R* (Bates, Mäechler, Bolker, & Walker, 2015), and correlation analysis for

[2] The codes for generalized mixed-linear model and plotting are in supplementary materials.

assessing the influence of non-verbal IQ on recognition accuracy in ASD group with *Hmisc* package in *R* (Frank & Harrell, 2019).

Results

The results of our study showed that there is a statistically significant difference in accuracy between ASD and TD groups: ASD group was less accurate than TD group, 92% vs. 98%, *Est.* = 1.45, *SE* = 0.49, $z = 2.92$, $p = 0.003$ (Fig. 2). Also, recognition accuracy in ASD group correlated with non-verbal IQ, $r = 0.46$, $p = 0.03$ (Fig. 3).

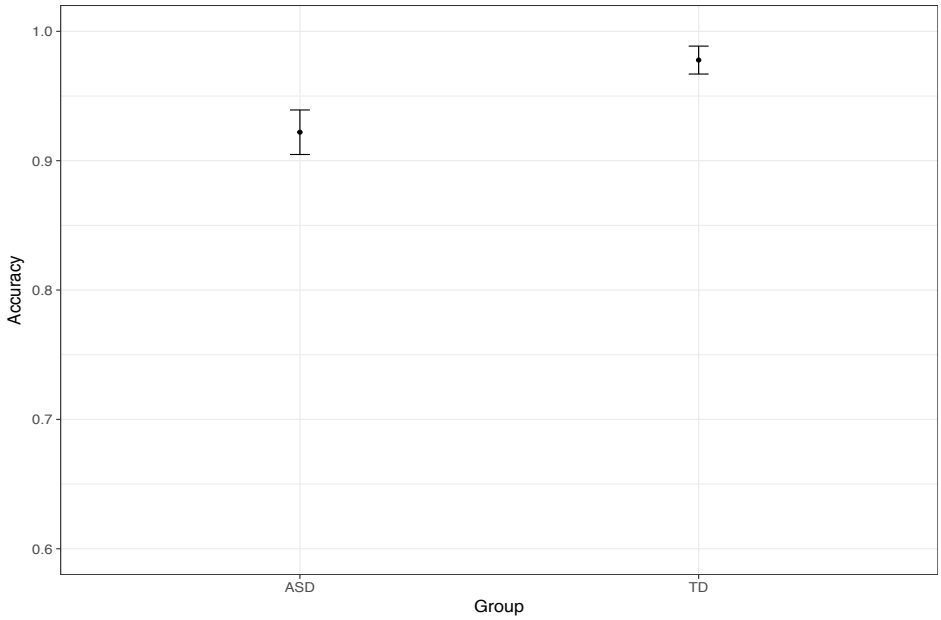

Fig. 2. Recognition accuracy between ASD and TD groups

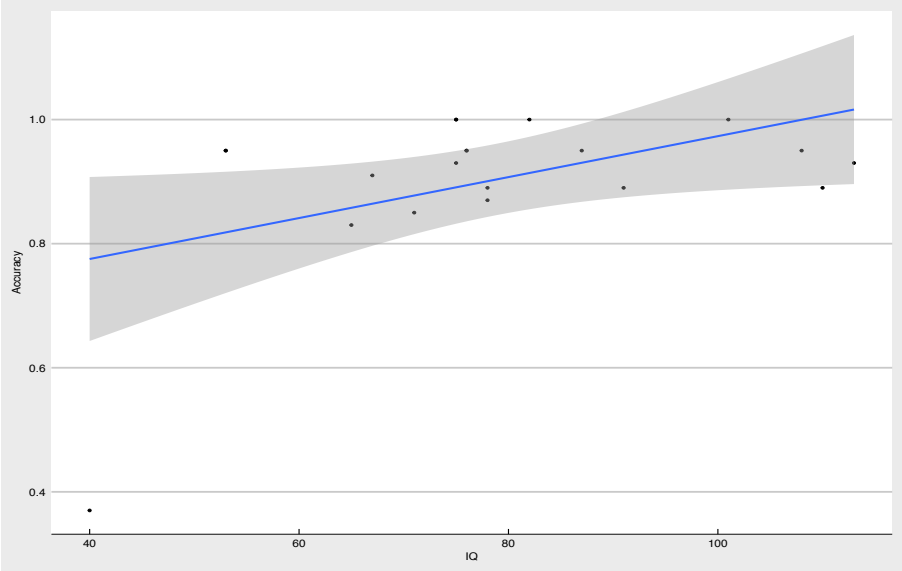

Fig. 3. Correlation between the recognition accuracy and non-verbal IQ in ASD group

Then we calculated the percentage of error types for ASD group: 12% were unrelated pictures, and it means that children were involved in the task, 67% were semantic errors and 21% were phonological errors. Although the significant part of errors was semantic, their number did not correlate with non-verbal IQ, $r = –0.09$, $p = 0.7$ (Fig. 4). By contrast, amount of phonological errors correlated with non-verbal IQ, $r = –0.51$, $p = 0.02$ (Fig. 5).

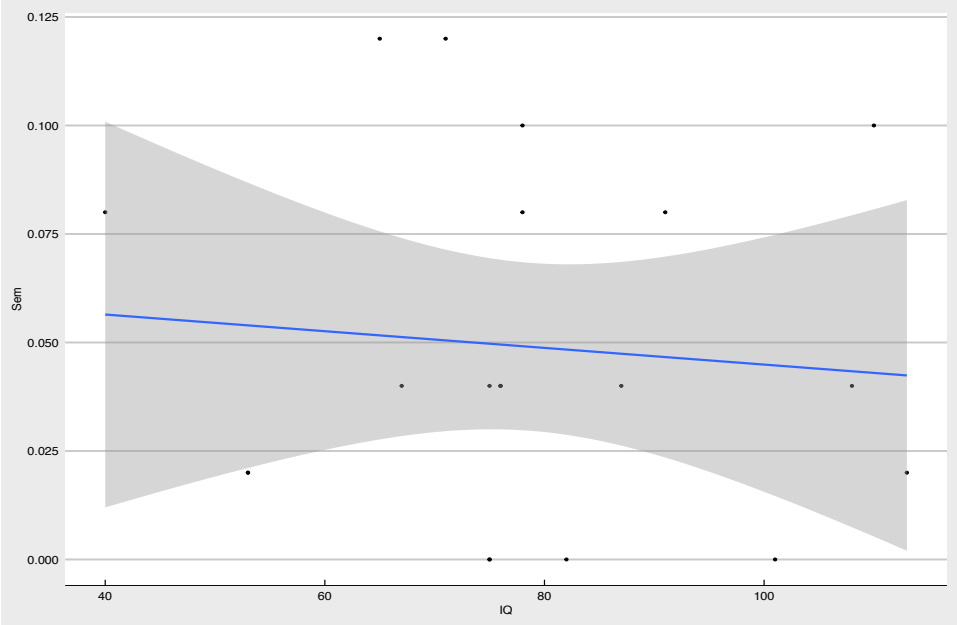

Fig. 4. Correlation between the number of semantic errors and non-verbal IQ in ASD group

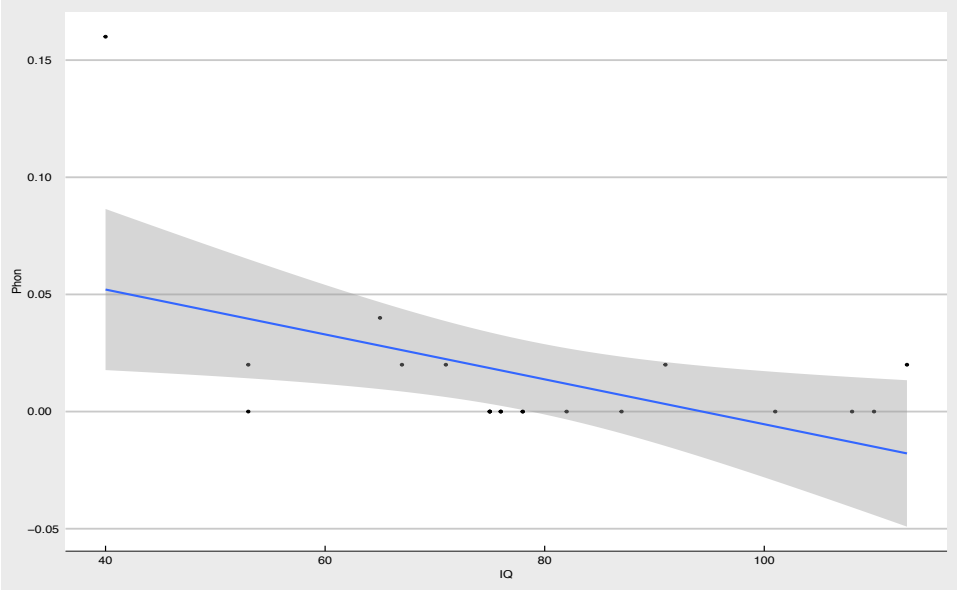

Fig. 5. Correlation between the number of phonological errors and non-verbal IQ in ASD group

There is no correlation between age and accuracy in general, $r = –0.004$, $p = 0.98$, as well as between age and number of semantic errors, $r = –0.16$, $p = 0.49$, or phonological errors, $r =$

0.25, $p = 0.27$.

Conclusion

The present study aimed to investigate how primary-school-aged Russian children with ASD recognize single words. We showed that 7-to-11-year-old children with autism have difficulties even with single-word recognition, and age of children does not correlate with the recognition accuracy. It means that there are another factors, influencing the accuracy in ASD group, e.g., non-verbal IQ.

This study demonstrated that non-verbal IQ correlates with recognition accuracy in general and, moreover, the amount of phonological errors is related to non-verbal IQ: children with low IQ do significantly more phonological errors in comparison to children with high IQ. By contrast, there is no relationship between the number of semantic errors and non-verbal IQ. At the first glance, this could mean that phonological deficit may play a significant role in atypical language development in ASD. However, our ASD group consisted of 20 children and, it is necessary to recruit more children in the study because we have only few autistic kids with very low IQ, and it could be the outlier effect in the correlation model. Thus, more children are needed for convincing conclusions.

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Supplementary materials

```
# Generalized Linear mixed-model with nested effects #

rm(list=ls())
library(lme4)
library(lmerTest)
library(tidyverse)
library(readr)
library(scales)
library(MASS)
library(remef)


ASD$ID  <- factor(ASD$ID)
ASD$Item  <- factor(ASD$Item)
ASD$Type  <- factor(ASD$Type)

nested_ASD <- glmer(Accuracy ~ 1 + Group +
      (1 | ID), data = ASD, family = binomial)

print(summary(nested_ASD), corr=FALSE)


# Plotting #

library(plyr)
library(Rmisc)
library(ggplot2)

nested_ASD <- summarySE(ASD, measurevar="Accuracy", groupvars=c("Group"),
                  na.rm = TRUE, conf.interval = 0.95)

ggplot(nested_ASD, aes(x=Group, y=Accuracy)) +
  geom_point(size = 1.5) +
  geom_errorbar(aes(ymin=Accuracy-ci, ymax=Accuracy+ci), width=0.05) +
  xlab("Group") +
  ylab("Accuracy") +
  coord_cartesian(ylim=c(0.6, 1)) +
  theme_bw(base_size=12)
```

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