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7-factor model of autism symptoms in 3-6-year-olds: Age-related changes

Modelo de 7 factores de los síntomas del autismo en niños de 3 a 6 años: cambios relacionados con la edad

Andrey Nasledov[1]
0000-0003-4687-3184
a.nasledov@spbu.ru

Liubov Tkacheva[1]*
0000-0002-9822-1914
l.tkachewa@spbu.ru

Sergey Miroshnikov[1]
0000-0001-7079-0624
sergeyamir@gmail.com

[1] St Petersburg University, Saint Petersburg, Russia.
* Corresponding author

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Revisado por: Karina Franco-Paredes, Universidad de Guadalajara, México.

Abstract

Background: age-related changes in autism symptoms in childhood are of a particular research interest, as they allow us to choose the best methods of intervention. **Method:** 7-factor model of autism symptoms was checked for 3-6-year-old to find age-related changes of autistic symptoms. The general structure of the model and its measurement equivalence were confirmed for 3-4 and 5-6-year-old children. However, with age, there are changes in the factors correlations. The factors were calculated as the values of the new 7 scales according to the proportions of affirmative responses to the symptoms included in each factor. **Results:** when comparing the severity of symptoms on 7 scales in younger and older children, the following dynamics were revealed: with age, there is an improvement in the speech understanding and a decrease in the symptoms of alienation. As a result of the creation of a measuring model for 5-6-year-olds, three groups of correlating symptoms were found: 1) F1 related to speech 2) F2 sensory processes and hyperactivity 3) F3 social interaction. In 3-4-year-olds, these groups of symptoms are not related, hyperactivity was an isolated symptom. In 5-6-year-olds, hyperactivity is noticeably associated with sensory disintegration. The strong connection between F2 and F3 is noteworthy. **Conclusions:** probably sensory disintegration and hyperactivity determine the quality of social interaction in 5-6-year-old children, being the key autistic symptoms at this age.

Keywords: autism symptoms, 3-6-year-olds, factor model of autism.

Resumen:

Antecedentes: Los cambios relacionados con la edad en los síntomas del autismo durante la infancia son de particular interés en la investigación, ya que permiten elegir los mejores métodos de intervención. **Método:** Se evaluó el modelo de 7 factores de los síntomas del autismo en niños de 3 a 6 años para identificar los cambios relacionados con la edad en los síntomas autistas. Se confirmó la estructura general del modelo y su equivalencia de medición para niños de 3-4 y 5-6 años. Sin embargo, con la edad, hay cambios en las correlaciones entre los factores. Los factores se calcularon como los valores de las 7 nuevas escalas según las proporciones de respuestas afirmativas a los síntomas incluidos en cada factor. **Resultados:** Al comparar la gravedad de los síntomas en las 7 escalas entre los niños más pequeños y los mayores, se reveló la siguiente dinámica: con la edad, hay una mejora en la comprensión del habla y una disminución en los síntomas de aislamiento. Como resultado de la creación de un modelo de medición para niños de 5 a 6 años, se encontraron tres grupos de síntomas correlacionados: 1) F1 relacionado con el habla, 2) F2 procesos sensoriales e hiperactividad, 3) F3 interacción social. En niños de 3 a 4 años, estos grupos de síntomas no están relacionados, y la hiperactividad fue un síntoma aislado. En niños de 5 a 6 años, la hiperactividad está notablemente asociada con la desintegración sensorial. Es destacable la fuerte conexión entre F2 y F3. **Conclusiones:** Probablemente, la desintegración sensorial y la hiperactividad determinan la calidad de la interacción social en los niños de 5 a 6 años, siendo los principales síntomas autistas a esta edad.

Palabras claves: síntomas del autismo, niños de 3 a 6 años, modelo factorial del autismo

Introduction

Autism is a complex highly prevalent neurodevelopmental disorder and as such the investigation of its structure and symptoms age related changes are subjects to empirical research. A level of autism symptom severity varies across childhood and depends on many factors, among which the key ones are genetic, neurobiological, environmental and developmental (Beopoulos et al., 2022; Wozniak, et al. 2017). Autism spectrum disorder (ASD) is highly heterogeneous condition, manifesting in impairments in social communication, sensory anomalies, repetitive patterns of behaviors and interests and varying levels of intellectual potential and adaptive skills (Lord et al., 2020). ASD is often burdened by co-occurring neurological or psychiatric disorders (Al-Beltagi, 2021), which along with heterogeneity hardens the task of timely differential diagnosis (De Giacomo et al., 2021). Lack of insight into the roots of autism pathophysiological diversity has slowed progress towards understanding its etiological mechanisms, identifying autistic phenotypes and developing effective treatments. Mathematical modelling is an approach to identify the structure of ASD for different age ranges and discover the most significant factors contributing to severity of the main symptoms; also it is a path to see the tendencies of the symptoms shifts over time by comparing different ages. Attempts to develop a factor model of autism have been made repeatedly using exploratory, confirmatory and clinical approaches. Some models are based on diagnostic tools with initially predetermined structure, such as questionnaires (Chee et al., Scheeren, 2024; Matson et al., 2009), interviews (Constantino et al., 2004; De la Marche et al., 2015; Kim et al., 2018), checking lists (Keefer et al., 2020; Medeiros et al., 2017), scales (Frazier et al., 2014; Magyar & Pandolfi, 2007) and screening instruments (Zain et al., 2023; Zhu et al., 2022). Others obtained on initially wide range of autistic symptoms using psychometric approach (Nasledov et al., 2021; Nasledov et al., 2023a) or clinical approach (Baumer et al., 2023). In addition, there are comparative models, exploring the vectors of differences between ASD and other developmental disorders (Brierley et al., 2021; Martin et al., 2014) or between ASD and typically developing people (Auyeung et al., 2008; Frazier et al., 2023; Hiruma et al., 2021; Hoekstra et al., 2008) along with the adaptations of existing factor models of personality for ASD (Schwartzman et al., 2016). Unlike the models developmental trajectories of ASD, its phenotypes and the prevalence and direction of autistic symptoms age related shifts are still not well understood and yet to be discovered. The works are scarce and mostly were focusing on discovering autism symptoms severity trajectories in childhood taken into consideration biological and sociodemographic factors (Waizbard-Bartov et al., 2022), decrypting ASD phenotypes regarding peculiar sensory profiles (Tillmann et al., 2020) and

particular language profiles (Schaeffer et al., 2023), revealing specific age related patterns in neurophysiological features (Nunes et al., 2020), cognitive changes (Torenvliet et al., 2023) and in mental health and quality of life during lifespan (Roestorf et al., 2022). However little is known about age related shifts in autistic features during childhood, the period of the fastest alterations in typically developing children. To address this gap in the literature, the current study investigates age-related changes of autistic symptoms in 5-6-year-olds compared to 3-4-year-olds. In our previous research the 7-factor model of ASD for 3-4 year-olds was obtained on a sample of 383 with ASD using an online questionnaire including 436 points - possible symptoms of ASD (Nasledov et al., 2023a). The model consisted of the following factors: 1) "Persistence on sameness" (PS); 2) "Emotional dysregulation" (ED); 3) "Alienation" (Al); 4) "Speech understanding" (SU); 5) "Disinhibition/Hyperactivity" (Hyp); 6) "Echolalia" (Ech); 7) "Sensory disintegration" (SD). The aim of the current work is to check the general structure of the previously obtained model and its measurement equivalence for 5-6-year-olds and to reveal possible changes in the factors correlations as indicators of autistic symptoms age-related changes. The objectives of this study were: to verify the configuration and measurement equivalence of the 7-factor structure of autism symptoms previously obtained for 3-4-year-old children, for 5-6-year-old children with ASD; to identify age-related changes in the structure of the relationship of factors and in the intensity of autism symptoms manifestations in children with ASD from 3-4 to 5-6 years old. Additionally, hypotheses about possible directions of cause-and-effect relationships between groups of autism symptoms in 5-6-year-old with ASD were tested.

Method

Sample selection and demographic characteristics

In 2020-2022 we collected the data on 3-4-year-old children with ASD (N=383), among those 269 boys, average age 3.57 and 114 girls, average age 3.59. For the purpose of the current study, in 2023 we examined 233 children with ASD, among those 172 boys, average age 5.56 and 61 girls, average age 5.54 and added this to the sample of 3-4-year-old children with ASD so the sample in total consisted of 616 3-4- and 5-6-year-olds with ASD. Criteria for inclusion in the study: specialists who had previously participated in research in collaboration with our research team, including those using previously developed online screening of the risk of ASD in 3-4 year-olds, were invited to participate in the collection of the data on the online questionnaire. When collecting the data in the online questionnaire, specialists

answered questions about the behavior and various features of children's development based on their observations of children in the institutions and conversations with parents as a part of routine consultations and surveys. To fill out the questionnaire, it was not necessary to conduct any tests or other activities beyond the previously agreed planned work of specialists with children and parents. And since no personal information was disclosed this study didn't require a permission of the Ethical Committee.

All the children who took part in the current study were native speakers of Russian (N=616). Among them 80.03% were Russians in their race and ethnicity (N=493), including 11.1555% of Cossacks (N=55) and 9.7355% of Pomors (N=48); 6.896% of Ukrainians (N=34); 5.27% of Belarusians (N=26); 3.652% of Tatars (N=18); 2.839% of Armenians (N=14); 1.218% of Chechens (N=6); 1.014% of Bashkirs (N=5); 0,812% of Kazakhs (N=4); 0,812% of Ingush (N=4); 0.608% of Yakuts (N=3); 0.608% of Azerbaijanis (N=3); 0.405% of Tajiks (N=2); 0.405% of Uzbeks (N=2) and 0.405% of Kyrgyz (N=2).

Socio economic status of the participants taken the level of their families' incomes and the area of residency is presented in the Table 1.

Table 1. *Socio economic status of the participants.*

		Low		Average		High	
		No	%	No	%	No	%
Residency	Rural	24	25%	50	52.08	22	22.92%
	Urban	110	21.15%	257	49.42%	153	29.42%
	Total	134	21.75%	307	49.84%	175	28.41%

The data collection

We applied a modified online questionnaire similar to the one used earlier (Nasledov et al., 2023a; Nasledov et al., 2023b). The questionnaire included the same 78 items that formed 7 vectors of autism manifestation for 3-4-year-olds (Nasledov et al., 2023a). One of the goals of this survey is to verify the structural and measurement equivalence of the 7-factor model of autistic symptoms, which was identified for 3-4-year-olds, for a sample of 5-6-year-old children with ASD. Additionally, the hypothesis of age related shifts in the symptoms of ASD in 3-4- and 5-6-year-olds was tested. The data collection was carried out with the participation of 28 practitioners (psychologists, speech therapists, psychiatrists) from counseling centers, specialized and mass preschool institutions in St. Petersburg, working with children and families in a counseling mode. The data collection did not require tests or other measurements beyond routine surveys. Specialists were asked to answer questions based on their routine examinations and observations, as well as a survey

of parents. Specialists filled out questionnaires for children with whom they had already held several meetings and conversations with their parents, as a rule, at least 5 consultations to ensure the objectivity of the data collected and to avoid bias. The group of specialists was formed from the participants in previously conducted studies.

The assignment to the group of ASD, DD and Norm was determined by the specified specialists working directly with children, based on their conclusion drawn from the results of work with the child or on the basis of the previously received assessment of other specialists (for example, presented at the admission of a child to a preschool institution). Thus, the data were collected on children who had already been assigned by specialists to the groups of ASD, DD, or Norm before the start of the current study, and undergoing routine examinations and consultations at the request of parents or suggestions from specialists. The procedure for building up the sample and the survey is described in detail in previous articles (Nasledov et al., 2021; Nasledov et al., 2023a; Nasledov et al., 2023b).

In determining the sample size, we followed the recommendations of S. B. Green (Green, 1991). Since structural equation modeling with 21 independent variables was supposed to be used, then, following the rule of at least 10 observations per independent variable, the sample size should be at least 210 participants. Guided by another rule proposed by S. B. Green, with a Power of 0.80 (Alpha = 0.05), with a number of predictors from 20 to 30, the sample size should be from 159 to 199 participants, with a medium effect value (Green, 1991). The fact that the effect size is not lower than the medium is evidenced by the values of factor loads from 0.59 to 0.87. Thus, the sample size N=233 is sufficient for the purposes of the current study.

Ethical steps

- Ensuring ethical standards at the research planning stage: informing parents or legal representatives of the child about the content of the survey, supervision education processes in a preschool institution. Informing parents that personal data, as well as data on the characteristics of the child's behavior, will be collected anonymously with an individual code assigned to each child; guaranteeing that the received data is stored in secure databases and cannot be transferred to the third parties.
- After the information stage, the parents or legal representatives of the child write an application with a request to take their child to a preschool

educational institution. In this application, they sign an informed consent to the processing of personal data and an informed consent to the examination and education of the child.

- Then the parents or legal representatives of the child sign an agreement with the preschool educational institution, which clearly specifies the responsibilities and obligations of the parties. Among the clauses of the agreement, there is a clause about the fact that the depersonalized data of the child can be used in scientific research.

- Monitoring compliance with ethical standards: all specialists involved in the study, when working with children and parents, ensure their protection from physical and mental discomfort, harm and danger; ensure the rights of parents to reduce or interrupt the child's participation in the examination process at any time without negative consequences for the child.

- Protection of confidential data at the stage of data collection: specialists involved in data collection sign an informed consent on non-disclosure of personal data, within which they are prohibited from specifying any personal information that allows identifying the child and/or his parents or legal representatives in the electronic or written data collection fields; to identify the child's data, specialists use the code assigned to the child.

- The entire data collection and analysis procedure is planned in such a way that it cannot have any undesirable consequences for participants, including due to anonymity and the inability to establish the results of individual participants in a common data set from many institutions and specialists.

- If desired, interested parents or legal representatives of the child and specialists can receive information about the results of the study in a convenient form (in the form of answers to questions, in the form of articles and methodological materials, or by visiting the electronic information resource of the project).

This study adhered to international ethical standards, including the principles outlined in the Declaration of Helsinki.

The data analysis

The formation of packages

Just as before, a "parcel" approach was applied: the items included in each factor were randomly distributed into 3 packages, followed by calculating each package as the mean of the items included in it (Nasledov et al., 2023). Thus, 78 initial binary variables were replaced by 21 quantitative variables, 3 variables per factor.

Confirmatory factor analysis of the 7-factor structure (3 items per factor)

The structure identified for 3-4-year-olds was used as the initial model, and its consistency was checked for the entire sample of 3-6-year-old children. The quality of the model was assessed using the following indices: Chi-squared ratio to the number of degrees of freedom (χ2/DF), comparative compliance index (CFI), Tucker-Lewis index (ilt), standard error of approximation (RMSEA) and its accuracy (Pclose). The ratio χ2/DF < 2 was perceived as acceptable. CFI and TLI values from 0.90 to 0.92 were considered adequate, from 0.92 to 0.95 - good and >0.95 - excellent. RMSEA values <0.70 were considered adequate and <0.05 were assessed as excellent compliance, Pclose values over 0.1 were assessed as acceptable agreement, and about 0.4 and above were assessed as excellent compliance (Kline, 2011; Byrne, 2010).

Checking the structural and measurement invariance of the model

The multigroup CFA was used twice to compare models for boys and girls and to compare 3-4- and 5-6-year-olds. The comparison of models for the analysis of measurement invariance was based on empirical work showing that a decrease in CFI or TLI >.01, or an increase in RMSEA >.01 implies nonequivalence of measurements (Chen, 2007; Byrne, 2010). For the present study, if any of these indices went beyond this limitation, it was considered that the more limited model had unacceptable suitability.

Analysis of the factors interrelation structure for 5-6-year-olds

For 3-4-year-old children 7 factors formed 3 groups of unrelated symptoms: communication disorders (Emotional dysregulation, Speech understanding, Echolalia, Alienation), sensory disintegration (Sensory disintegration, Persistence on sameness) and hyperactivity. The factors were calculated as the average values of the points included in them. A 3-factor model obtained for 3-4-year-olds was used

as an a priori model for 5-6-year-olds, and then it was modified in accordance with the modification indices.

Testing two hypotheses

In relation to the model obtained in the previous step, 2 alternative hypotheses on cause-effect relationships between three groups of ASD symptoms in 5-6-year-old children were tested using structural equation modeling (SEM).

Analysis of differences in 3-4- and 5-6-year-olds in the severity of ASD symptoms

Multivariate analysis of variance (MANOVA) was used: dependent variables – 7 calculated factors, factors – Gender and Age (1 – 3-4 years, 2 – 5-6 years). Welch's t-test was used to compare 3-4- and 5-6-year-old children, free from the assumption of equality of variances.

The data analysis was carried out using IBM SPSS Statistics 28 version and IBM AMOS 28 version programs (Armonk, New York: IBM Corp.).

Community Involvement Statement

When and how were patients/the public first involved in the study?

Anonymous patient data (each child was assigned a participant code, no personal data was disclosed) was included in the examination by filling out online questionnaire by specialists of the appropriate profile (psychologists, therapists, psychiatrists). To this end, specialists from ordinary and specialized educational institutions and advisory centers were invited to participate in data collection, with whom the project executors contacted during scientific forums and advanced training courses of professional development.

How the research questions were developed and how they were justified by Community priorities experience and preferences?

The array of research questions was formed on the basis of typical signs of ASD, which specialists relied on in the process of diagnostic examinations as the part of their routine work. Experts offered their own signs, from which, after discussion, an excessive array of 330 signs was formed, grouped according to the questions about their manifestation in appropriate situations.

How were patients/community involved in the study?

Since the study plan did not require additional assessments of autistic children beyond their scheduled consultations with specialists, it was not necessary to

involve new children with ASD in the study. In the usual manner for educational institutions, parents of children with ASD were informed that specialists, if necessary, can conduct examinations and process the data obtained for parental consultations. The generalization of the collected data was also used to better familiarize parents with the general characteristics of children with ASD and the necessary observations to detect the autism risk markers identified in the study.

How have patients/community been involved in the selection of methods and their coordination of plans for the dissemination of research results among participants and related communities?

Since no additional research methods were used to collect the data, parents were not involved in discussing the choice of research investigation and designing. However the results of the study along with the guidelines are planned to be published in specialized journals for specialists working with children with ASD, as well as on a public information e-portal for parents of children with ASD (can be accessed by this link https://info23rnf.testpsy.net/).

Results

Confirmatory factor analysis of the 7-factor structure for a combined sample of 3-4- and 5-6-year-olds.

The 7-factor model obtained earlier for 3-4-year-old children with ASD (Nasledov et al., 2023a) was used as the initial model. To achieve the best fit of the model with the original data, 8 more statistically significant covariances were added to the 6 covariances between factors in the original model. According to the indices of agreement, the final model corresponds well to the initial data: CFI = 0.959; RMSEA = 0.044; Pclose = 0,962.

Checking the invariance of the model for 3-6-year-olds, boys and girls.

The results of this stage are presented in Table 2.

Table 2. *Model fit indices for 3-6-year-olds, boys and girls.*

Model	χ^2	df	CFI	TLI	RMSEA
Unconstrained	615.703	350	0.947	0.936	0.035
Measurement weights	629.385	364	0.947	0.939	0.035
Structural covariances	653.266	385	0.946	0.941	0.034
Measurement residuals	677.883	406	0.946	0.944	0.033

The Unconstrained model fits well enough to the data for all the above indicators: $\chi 2/df < 2$; CFI > 0,90 и TLI > 0,90; RMSEA < 0,05. But differences are crucial for deciding on equivalence at one or another level of parameters fixation CFI, TLI and RMSEA for the preceding and subsequent of the constrained models. If this difference exceeds 0.01, the equivalence at the appropriate level is not confirmed. Based on these considerations, the equivalence of models for samples of boys and girls is certainly confirmed for all levels: a) the measurement level of explicit variables (Measurement weights); b) the level of covariance between the factors (Structural covariances); c) the level of strict invariance: equality of the residuals of explicit variables (Measurement residuals). Thus, the high configuration, metric, scalar and strict invariance of the measurement model for boys and girls is confirmed.

Checking the invariance of the 7-factor model for 3-4- and 5-6-year-old children with ASD.

The results of this stage are presented in Table 3.

Table 3. *Model fit indices for 3-4- and 5-6 year olds.*

Model	χ2	df	CFI	TLI	RMSEA
Unconstrained	643.247	350	0.933	0.944	0.037
Measurement weights	677.832	364	0.931	0.940	0.037
Structural covariances	879.681	385	0.897	0.905	0.046
Measurement residuals	999.223	406	0.883	0.887	0.049

The configuration equivalence (Unconstrained) and measurement equivalence (Measurement weights) are confirmed. But the equivalence of factor covariances (Structural covariances) is not confirmed, i.e. factors correlate differently in the samples of 3-4- and 5-6-year-olds.

Next, the values of 7 factors were calculated for the sample of 5-6-year-old children, as before for the sample of 3-4-year-olds: the mean values of the items included in each factor. Thus, the value of the factor represented the proportion of affirmative responses to the items (symptoms) included in the factor.

The structure of the factors interrelationships for 5-6-year-olds children with ASD.

The correlations of 7 factors with each other and with age (in days) for 5-6-year-old children with ASD are shown in Table 4.

Table 4. *Pearson correlations of 7 factors among themselves and with age (in days) in 5-6-year-olds children with ASD.*

Variable	Age (days)	PS	ED	Hyp	SU	SD	Al	Ech
Age (days)	1.00							
PS	-0.03	1.00						
ED	-0,14*	0,24**	1.00					
Hyp	0.03	0,29**	0,20**	1.00				
SU	0.04	-0.06	-0,17**	0.00	1.00			
SD	0.00	0,30**	0,16*	0,19**	0,37**	1.00		
Al	-0.09	0,32**	0,34**	0,17**	-0,36**	-0.02	1.00	
Ech	0.00	0,14*	0.06	0.00	0,33**	0,23**	-0.08	1.00

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

There is a large number of links between the factors of ASD symptoms, and the practical absence of links between factors and age (unlike for 3-4-year-olds).

The a priori 3-factor model corresponding to the structure of relationships for 3-4-year-olds has shown its inadequacy in relation to data for 5-6-year-olds. The model has been modified according to the modification indexes. A posteriori measurement model of the relationship structure of 7 factors is shown in Figure 1.

Figure 1 shows a measurement model of confirmatory factor analysis of the structure of relationships between 7 factors.

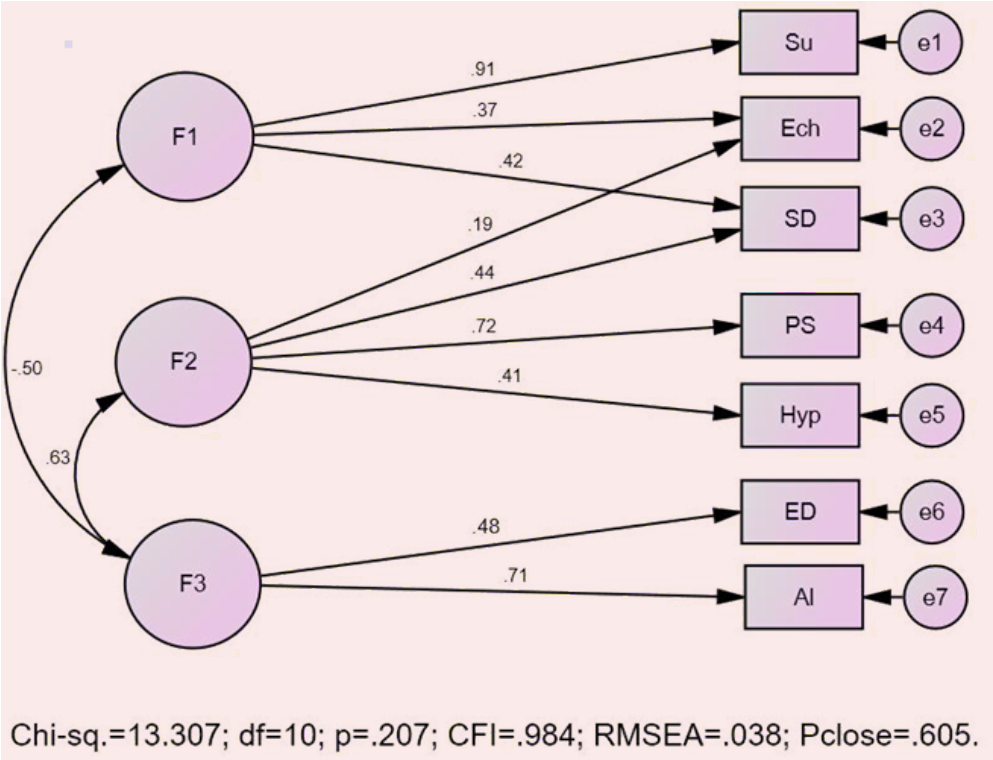


Figure 1. *Measuring model of ASD symptoms secondary factors in 5-6-year-olds.*

The model fit indices is in very good agreement with the initial data. Just as in 3-4-year-old children, 7 factors of ASD symptoms form 3 groups. But the composition of the groups is significantly different. Factor F1 combines the symptoms associated with speech development: Speech Understanding (SU), Echolalia (Ech), Sensory Disintegration (SD), with the dominant position of SU. A positive stress sign for Ech and SD means that the higher the development of speech, the more pronounced these symptoms are. The F2 factor is determined by the combination of Persistence on sameness (PS), SD and Hyperactivity (Hyp), loading at the same time Ech forming a group of sensory issues. Factor F3 binds Emotional Dysregulation (ED) and Alienation (Al), forming a group of communication disorders.

Two alternative hypotheses about the direction of the causal relationship between the three groups of symptoms were tested. According to the first hypothesis (see Model 1 in Figure 2), sensory issues (F2) and speech understanding impairments (F1) affect communication disorders (F3). According to the second hypothesis (see Model 2 in Figure 3), sensory issues (F1) are the cause of communication disorders (F2) and that hinders the development of speech (F1).

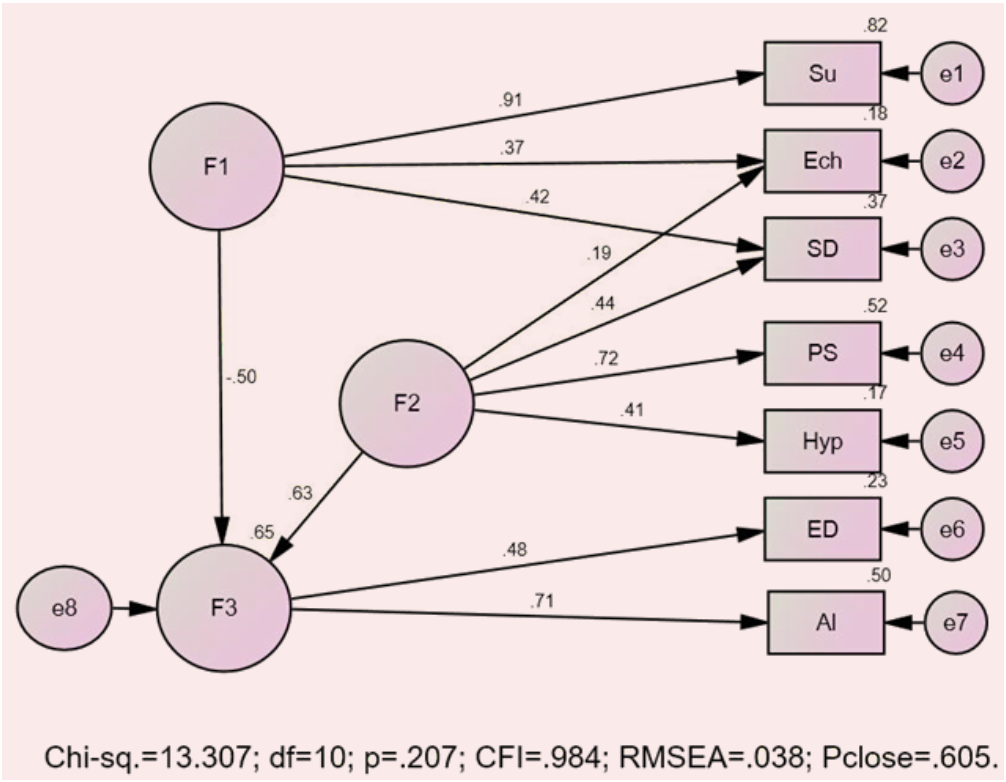


Figure 2. *Causal relationships between three groups of ASD symptoms in 5-6-year-olds (Model 1).*

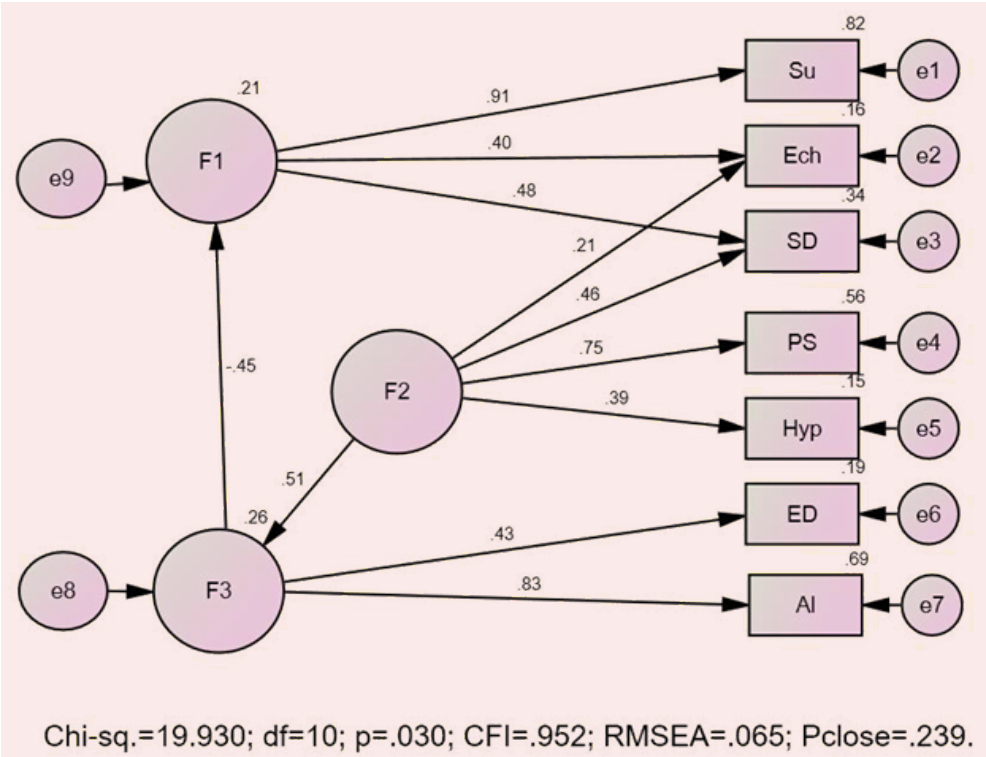


Figure 3. *Causal relationships between three groups of ASD symptoms in 5-6-year-olds (Model 2).*

Model 1 corresponds better to the data in terms of fit indices. In addition, the AIC (The Akaike information criterion) and BIC (The Bates information criterion) indicators of relative compliance of non-nested models are useful for comparison, while lower values indicate a better match. To compare models with the same number of degrees of freedom, the differences between the models are considered significant if the difference in BIC and/or AIC is > 5 (Kass and Raftery, 1995). In our case, BIC = 111.426 and AIC = 49.307 for Model 1; BIC = 118.049, AIC = 55.93 for Model 2. The difference significantly exceeds 5 in favor of the Model 1.

It is noteworthy that more than half of the variance (65%) of the F3 factor is determined by the combined positive influence of F2 and the negative influence of F1. I.e., the symptoms of communication disorders (F3) are higher, the higher the symptoms of sensory issues (F2) and the lower the symptoms of speech understanding (F1).

Comparison of the symptoms (scales) severity in 3-4- and 5-6-year-olds, depending on gender

For comparison, a multivariate ANOVA was used: dependent variables – 7 variables-factors, factors – Gender (m, f) and Age (1: 3-4 years, 2: 5-6 years). The results of applying the multidimensional Pillai's Trace criterion are shown in Table 5.

Table 5. *Results of MANOVA application (multidimensional criterion)*

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0.938	1 296.878	7.000	602.000	0.000
gender	Pillai's Trace	0.020	1.724	7.000	602.000	0.101
Age	Pillai's Trace	0.036	3.245	7.000	602.000	0.002
gender * Age	Pillai's Trace	0.005	0.473	7.000	602.000	0.855

a. Design: Intercept + gender + Age + gender * Age

According to the multidimensional criterion, only the main effect of the Age factor is statistically significant. Thus, both the influence of gender and the effect of the interaction of gender and age should be neglected. Age differences in the ASD symptoms in 3-4- and 5-6-year-old children were analyzed using Welch's t-test, since equality of variance was not observed for some variables. Descriptive statistics are given in Table 6, and comparison results are shown in Table 7.

Table 6. *Descriptive statistics for 7 factors of ASD symptoms in 3-4- and 5-6-year-olds*

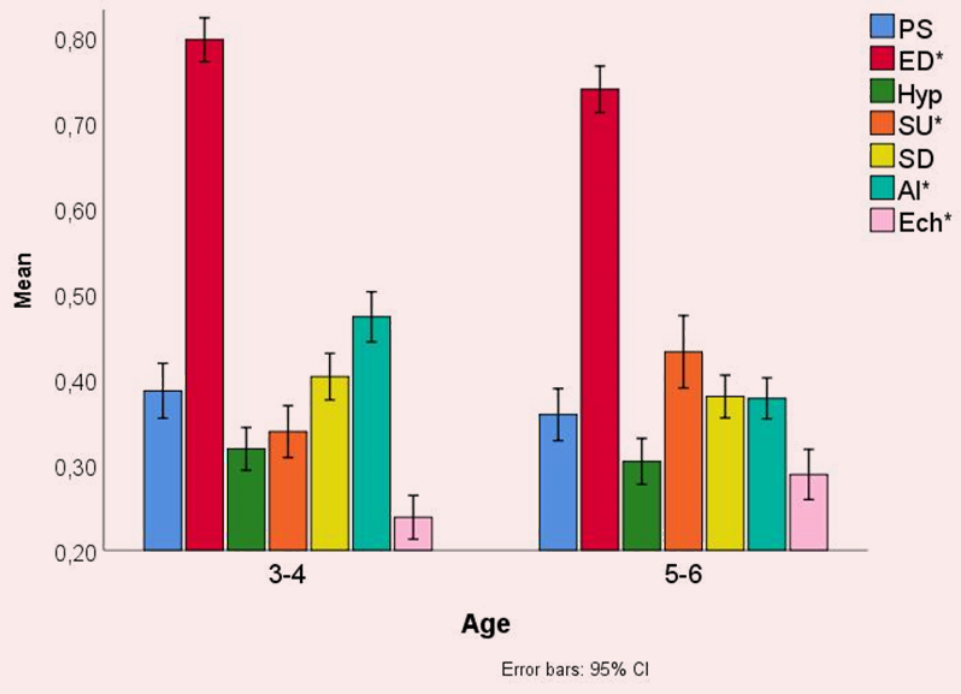
Stage		N	Mean	Stand. deviations	Stand. average error
PS_	1	383	0.386	0.320	0.016
	2	233	0.358	0.236	0.015
ED_	1	383	0.796	0.254	0.013
	2	233	0.739	0.210	0.014
Hyp_	1	383	0.318	0.249	0.013
	2	233	0.304	0.208	0.014
SU_	1	383	0.339	0.301	0.015
	2	233	0.432	0.328	0.021
SD_	1	383	0.403	0.271	0.014
	2	233	0.380	0.193	0.013
Al_	1	383	0.473	0.291	0.015
	2	233	0.377	0.186	0.012
Ech_	1	383	0.238	0.254	0.013
	2	233	0.289	0.227	0.015

Table 7. Comparison of ASD symptoms in 3-4- and 5-6-year-old children

	t	df	p	Cohen's d
PS	1.233	591.945	0.218	0.099
ED	3.063	559.293	0.002	0.249
Hyp	0.784	556.864	0.433	0.064
SU	-3.523	458.078	< .001	-0.296
SD	1.238	598.317	0.216	0.099
Al	4.953	612.749	< .001	0.39
Ech	-2.532	531.673	0.012	-0.208

Note. Welch's t-test.

Statistically significant differences: ED is lower in 5-6-year-olds (weak effect value); SU is higher in 5-6-year-olds (medium effect value); Al is lower in 5-6-year-olds (medium effect value); Ech is higher in 5-6-year-olds (small effect value). Figure 4 shows an illustration of the comparisons made.



⋆ - the differences are statistically significant ($p < 0.05$)

Figure 4. The severity of 7 groups of ASD symptoms in 3-4- and 5-6-year-olds.

Discussion

The objectives of this study were: to verify the configuration and measurement equivalence of the 7-factor structure of autism symptoms previously obtained for 3-4-year-old children, for 5-6-year-old children with ASD; to identify age-related changes in the structure of the relationship of factors and in the intensity of autism symptoms manifestations in children with ASD from 3-4 to 5-6 years old. Additionally, hypotheses about possible directions of cause-and-effect relationships between groups of autism symptoms in 5-6-year-old with ASD were tested. The configuration and measurement equivalence of the 7-factor structure of autism symptoms for 5-6-year-olds was confirmed. The 7-factor model of autism symptoms includes such factors as 1) "Persistence on Sameness" (PS); 2) "Emotional Dysregulation" (ED); 3) "Alienation" (Al); 4) "Speech Understanding" (SU); 5) "Disinhibition/Hyperactivity" (Hyp); 6) "Echolalia" (Ech); 7) "Sensory Disintegration" (SD). It should be noted, that three of the seven factors are correspondent with classic core autistic symptoms confirmed by many researches (Happé and Frith,

2020; Lord et al., 2020) and declared in DSM-5 (American Psychiatric Association, 2013) such as impaired social communication – our factors AI, restricted and repetitive behavior – the factor PS in our model, and sensory disintegration – the factor SD. However in addition to classic triad 4 more factors were revealed as the main symptoms of autism in 3-6-year-olds.

The discussion will proceed as follows - first, each of the 7 factors will be interpreted regarding to their contribution to understanding the symptoms of autism in preschoolers in accordance with the latest research in the field. Then, the revealed tendency of age-related changes in the factors correlations when comparing younger and older children will be presented (see Figure 1). After that, the relationships between three groups of ASD symptoms in 5-6 year-olds will be analyzed (see Figures 2 and 3). And at last the severity of symptoms on 7 scales in younger and older children will be discussed (see Figure 4).

Interpretation of 7-factor model of autistic symptoms in 5-6-year-olds

Emotional dysregulation (ED) is a recent concept that could be defined as the inability to manage and control the modulatory mechanisms involved in emotion regulation (Bunford et al., 2015), resulting in inadequate emotional responses associated with elevated risks for self-injury behavior (Wolff et al., 2019), which is common among children with ASD (Steenfeldt-Kristensen et al., 2020). According to the recent discoveries ED accompanies people with autism throughout their lifespans (Dell'Osso et al., 2023). It is supposed that ED is closely related with repetitive behaviors, social difficulties and alexythimia in autistic people (Morie et al., 2019). It is hypnotized that ED can be a critical indicator of the abnormal neurodevelopment trajectory resulting in mood disorders and psychiatric conditions later on (Gormley et al., 2022; Dell'Osso et al., 2019). Moreover, special diagnostic tools have been developed to measure ED in ASD individuals (Mazefsky et al., 2018).

The next additional factors in our model are Speech understanding (SU) and Echolalia (Ech). It is also not surprising to get those factors for 3-6-year-olds autistic symptoms model because both of them are closely associated with communication, the lack of which is the core autistic symptom. Concerning language development in autistic preschoolers there is a great diversity and heterogeneity in speech and language profiles ranged from inability to understand and use verbal signals to exceptional language abilities (Vogindroukas et al., 2022). It is believed that speech and language emergence depends on the quality and quantity of early social development processes in the first years of life (Cochet & Byrne, 2016), however it is

well known that autistic children experience difficulties in social verbal and nonverbal communication and patterns of communicative skills manifestation are affected by many factors, such as intellectual potential (Hus & Segal, 2021), the level of executive functions development and age (Maemonah et al., 2021), joint attention skills (Kissine et al., 2023), severity of sensory disintegration symptoms (Yoshimura et al., 2022) and hyperactivity symptoms (Nudel et al., 2020), levels of anxiety (Khaledi et al., 2022). To date, it is customary to allocate types of language profiles in autistic children such as verbal autistic individuals without structural language impairment, verbal autistic individuals with structural language impairment, and minimally verbal autistic individuals (Schaeffer et al., 2023); according to International Classification of Diseases (ICD) there are five language profiles in ASD depending on the presence of intellectual development disorder and impairment of functional language (World Health Organization, 2022). Regarding the prevalence of speech and language difficulties in autistic children, the figures are not very optimistic; it was revealed that around the age of three, 50–60% of autistic children are still non-verbal or minimally speaking (Georgiades et al., 2022) and that approximately 3 out of 4 ASD children show some impaired verbal abilities by the age of five (Tafaroji & Kamari, 2020). It was also noted that such domains of language acquisition as phonology, vocabulary and morphosyntax are the most challenging to master for children with ASD (Mottron & Gagnon, 2023). There is still no clarity in understanding the role of different factors in predicting or shaping autistic children linguistic trajectories however it is believed that the age of 3-7 years is crucial period for studying this problem (Kissine et al., 2023). Interestingly that Echolalia (Ech), the echoing of prior speech, is commonly assumed to be a distinctive feature of autism in children however not exclusive to autism (Patra & De Jesus, 2023). Even though in early period of research in autism its presence was considered a negative and disturbing factor (McFayden et al., 2022), in the recent studies its functional role was reconsidered (Cohn et al., 2022). It is assumed that echolalia can serve as the first step to more productive language use for communicative purposes and thus be an effective adaptive communicative strategy (Xie et al., 2023), even though it still may be a disrupting factor in social interaction considering speech pragmatics (La Valle et al., 2020).

The last additional factor we obtained was Hyperactivity / disinhibition (Hyp). Even though this factor is not included in the core autistic symptoms the body of the research on hyperactivity in autism has been growing rapidly. It is not surprising because approximately 50% of individuals with autism also suffer from disinhibiting symptoms; it is noteworthy, that these symptoms were found both in autistic people with intellectual impairment (Rong et al., 2021) and in highly functional individuals

with ASD (Eaton et al., 2023). These comorbid symptoms are aggravating indeed, since they not only complicate the differential diagnosis between autism and ADHD (Hours et al., 2022), slow down the maturation of frontal cortex (Leisman & Melillo, 2022) and formation of executive functions (Mansour et al., 2021) and thus nor surprisingly deteriorate rehabilitation interventions effectiveness (Young et al., 2020). It is believed that Hyp in autistic children originates from neurochemical imbalance (Begum et al., 2022; Marotta et al., 2020), isn't easily prone to pharmacological treatment (Mellahn et al., 2022) and linked with less favorable forecast concerning social adaptation outcomes (Liu et al., 2021) and learning outcomes (Rosello et al., 2018).

Age-related changes in factors correlations for 3-4- and 5-6-year-olds

The next result of our study is the revealed tendency of age-related changes in the factors correlations when comparing younger and older children. The model of fit indices corresponds well to the initial data of 3-4-year-olds and 5-6-year-olds. Nevertheless, the structure of the factors interrelationships in 5-6-year-old children differs significantly from the one in 3-4-year-olds. For 3-4-year-olds there were 7 covariance between the factors and the identified factors formed 3 groups of symptoms, unrelated to each other: problems in communication (ED, SU, Ech, Al), persistence on sameness and sensory disintegration (PS, SD) and hyperactivity/disinhibition (Hyp) was a separate factor (Nasledov et al., 2023a). However, as a result of the creation of a measuring model for 5-6-year-olds there are 13 covariance between the factors; the factors also form 3 groups of symptoms but the composition of the groups is different (see Figure 1). Factor F1 combines the symptoms associated with speech development: SU, Ech, SD, with the leading position of SU. A positive stress sign for Ech and SD means that the higher SU, the more pronounced these symptoms are. It is not surprising that Ech and SU are related and 5-6-year-old children with comparatively better skills of speech understanding show more symptoms of Ech first of all because echolalia is a widespread phenomenon among autistic children and approximately 75% of verbal autistic individuals use echoing speech at some point in their development (Ryan et al., 2022). Also it was shown that autistic 3-6-year-olds mastered echolalia for different communicative goals or used it as a cognitive strategy (thinking aloud) and thus diversity of echo-reactions can be considered as an indicators of linguistic and communicative competence in ASD (Xie et al., 2023). Moreover, the clinical importance of echolalia symptoms for further intervention on speech development is recognized (Blackburn et al., 2023) and possible communicative function of echolalia is emphasized in regards of building meaningful skills in the context of social interaction (Cohn et al., 2022). However the connection between SU and SD

is not so clear at the first glance, taken the weak positive link between SU and more pronounced symptoms of SD. It is well known that over 86% of children with ASD report hyper and/or hypo-sensitivities or SD - one of a core symptoms of autism (American Psychiatric Association, 2013), or so-called atypical sensory processing in multiple sensory domains (Cheung & Lau, 2020) and among those more than 40% of individuals exhibiting increased sensitivity to sound (Williams et al., 2021); at the same time there is a high diversity of sensory subtypes of children with ASD (Gonçalves & Monteiro, 2023). The results of previous studies showed that SD negatively affects speech and language development in autistic children when compared with non-autistic peers (Feldman et al., 2020), and in autistic children with atypical sensory processing when compared with their autistic peers with typical sensory processing (Dellapiazza et al., 2020), and possibly it is attributed to the difficulties of integrating sensory information perceived from the body adjusting fine movement and impairments of language semantic conceptual formation (Yoshimura et al., 2022). However it was also revealed that the symptoms of SD remain stable during childhood (Balasco et al., 2020) and that anatomically they are rather linked with neurophysiological changes in primary sensory regions of the brain but not with alterations in higher-order cognitive functions such as speech or thinking (Robertson et al., 2017). It was revealed that SD also affects verbal abilities indirectly through elevated levels of anxiety connected with sensory processing difficulties (Khaledi et al., 2022). In those regards with speech development SD symptoms may not decrease but a child expands abilities to share verbally his/her sensory difficulties with others.

The F2 factor in a measuring model for 5-6-year-olds is determined by the combination of PS, SD, Hyp and Ech, with the dominant position of PS, forming the group of sensory issues and repetitive behavior. The connection between PS and Ech is obvious because echolalia in spite of its different variations is basically a verbal repetition (Ryan et al., 2022) even though it has multiple functions among them communicative, imitative, compensatory and self-stimulatory (McFayden, et al., 2022). There is also a special kind of echolalia called phonic stereotypes – involuntary verbal repetitions - typical mostly for autistic patients with intellectual disability (Lanzarini et al., 2021), however echolalia is a wider phenomenon that can't be reduced to phonetic stereotypes due to its social and communicative functions (Pruccoli et al., 2021). The link between PS and Ech was found when discovering factor structure of ASD in preschoolers based on Autism Diagnostic Interview-Revised and that link distinguished autistic children from typically developing peers (Hiruma et al., 2021). It was shown that Ech is also related with SD through body clues in form of physical and verbal imitation actions and helps to

integrate sensory inputs to promote co-orientation or initiate communication (Kawashima & Maynard, 2019). It was also revealed that Ech as other forms of repetitive behavior can be performed by an autistic child to compensate for sensory issues (Fetta et al., 2021; Cohn et al., 2023). We also discovered the connection between Hyp and Ech within F2. Previously it was shown, that using speech in repetitive manner is common for both ASD and ADHD (Attention-Deficit/Hyperactivity Disorders), nonetheless, the prevalence of repetitive behavior, including echolalia, is significantly higher in the autistic population (Hours et al., 2022). Taken that approximately 50% of preschoolers with autism also suffer from hyperactivity symptoms (Eaton et al., 2023), it is not surprising that ADHD traits account for neurocognitive impairment in ASD including enhanced levels of repetitive behavior (Schachar et al., 2023). It is also noteworthy that Ech in our model is included as a significant indicator in both F1 and F2 and considering that there is no significant relationship between autism symptoms severity and echolalia (Gladfelter & VanZuiden, 2020), possibly Ech is the key overlapping symptom for 5-6-year-olds with ASD.

Factor F3 binds ED and Al, forming a group of communication disorders with the leading role of Al. As was stated earlier ED is a common and widespread phenomenon among people with autism (Gormley et al., 2022; Morie et al., 2019), whilst Al is a core autistic symptom – the main indicator of the communicative problems, which remain pervasive and poorly amenable to interventions throughout preschool childhood (Tsamitrou & Plumet, 2024) and during school years (Vinen et al., 2023). The severity of communication problems in preschoolers with autism is also associated with the severity of autistic symptoms, manifesting in social attention deficit and decreased eye contact (Wall et al., 2023). It is interesting that in our model Al goes along with ED in 5-6-year-olds with ASD. Similar results were found earlier when it was shown that the higher level of ED in autistic individuals, the lower the parameters of social adaptation and communicative skills (Williams et al., 2018). Furthermore the bi-directional connection between language and communication difficulties and ED in highly functioning autistic 9-14-year-olds was revealed. It was discovered that negative emotions limit communicative competence and at the same time subtle communicative and linguistic difficulties lead to negative emotional responses (Sturrock et al., 2022).

When comparing the resulting model for younger and older children, it should be noted that in 3-4-year-olds, another groups of symptoms were found, and hyperactivity was an isolated symptom (Nasledov et al., 2023a). Whilst in 5-6-year-olds, hyperactivity is noticeably associated with sensory disintegration and echolalia. The strong connection between F2 (PS, SD, Hyp and Ech) and F3 (ED and

AI) is also noteworthy, which is correspondent to the previous results showing that emotion regulation and social communication are closely related and ED plays a crucial role in self-injury and stereotyped behaviors (Martínez-González et al., 2022). Apparently sensory disintegration and hyperactivity determine the quality of social interaction in 5-6-year-old children, being the key autistic symptoms at this age.

Casual relationships between three groups of ASD symptoms in 5-6 year-olds

Two alternative hypotheses about the direction of the causal relationship between the three groups of symptoms were tested. According to the first hypothesis (see Model 1 in Figure 2), sensory issues (F2) and speech understanding impairments (F1) affect communication disorders (F3). According to the second hypothesis (see Model 2 in Figure 3), sensory issues (F1) are the cause of communication disorders (F2) and that hinders the development of speech (F1). The model #1 (Figure 2) related to the first hypothesis corresponds better to the initial data in terms of consent indices. F3 factor in this model is a dependent variable. It is noteworthy that more than half of the F3 factor variance (65%) is determined by the combined positive influence of F2 and the negative influence of F1. I.e., the higher the symptoms of sensory issues and repetitive behavior (F2) and the lower the level of speech understanding (F1), the higher are symptoms of communication disorders (F3). Thus, the first hypothesis was confirmed, and the second hypothesis was rejected. Our findings are correspondent with the results in the field. It is well known that the core autistic symptoms such as impaired social communication, restricted and repetitive behavior and sensory disintegration are closely related and manifest themselves in four particular domains: stereotyped and repetitive movements, persistence on sameness, fixed and restricted interests, and abnormalities in sensory processes (hyper-/hyporeactivity) (American Psychiatric Association, 2013; Lord et al., 2020). It is believed that stereotyped and repetitive behaviors and sensory issues compromise the daily functioning in children with ASD not only by reducing their communicative abilities but also by altering their social, cognitive, and motor development (Melo et al., 2020). It is noteworthy that in our causal relationship model speech development appeared to be the key symptom for elder preschoolers with ASD. It was shown that variability in language development in autistic children is the most pronounced prior to age 6 (Brignell et al., 2019). Also it was revealed that low language development profiles in children with ASD are directly linked with reduced imitation and play (Pecukonis et al., 2019) and comparatively lower social communicative abilities (Reetzke et al., 2022). Thus the casual trilateral relationship between those symptoms is not surprising in 5-6 year-olds and can be considered as an indicator of ASD symptoms severity.

The severity of autistic symptoms on 7 scales in younger and older children.

When comparing the severity of symptoms on 7 scales in younger and older children (Figure 4), the following dynamics were revealed: with age, there is a substantial improvement in the speech understanding, a weighty decrease in the symptoms of alienation, a slight decrease in ED symptoms and a minor increase of echolalia symptoms. The revealed dynamics corresponds to a cornerstone of autism intervention methods in childhood which target to improve first of all language and communication skills (Cui et al., 2023). At the same time, it was shown that the success of speech training at the age of 3 to 6 years in children with ASD is limited because it largely depends on the initial level of verbal abilities and expressive vocabularies (Sandbank et al., 2020). It is known that the dynamics of speech development in children with autism is often accompanied by echolalia, which some authors consider as a transitional phase to develop other functional language skills (Xie et al., 2023). In this regard, a slight increase in the symptoms of echolalia with age may be an indicator of speech development. A significant decrease in the symptoms of alienation with age is an expected result. It was revealed that even minimally verbal autistic children improve their social skills due to a regular and well-chosen intervention, for example such as ABA (applied behavior analysis) training (Jobin, 2020) or the TEACCH (Treatment and Education of Autistic and Related Communication Handicapped Children) program (Zeng et al., 2021). However, it is believed that it is harder to build the strategies for emotion regulation in autistic children than to train social skills (Nuske et al., 2018); apparently, that is why only a slight decrease in ED symptoms with age was revealed when comparing younger and older children with ASD. In those regards, there is an opinion that treating emotional issues may be preferable before starting social skills training so that autistic children can learn to manage emotions before maintaining communicative skills and engaging in stressful social demands (Beck et al., 2020).

Conclusion

We found age-related changes in autism symptoms within the framework of the analyzed 7-factor model when comparing 3-4- and 5-6-year-old children. The general structure of the 7-factor model of autism symptoms includes the following factors: 1) "Persistence on sameness"; 2) "Emotional dysregulation"; 3) "Alienation"; 4) "Speech understanding"; 5) "Disinhibition/Hyperactivity"; 6) "Echolalia"; 7) "Sensory disintegration". Even though the model consent indices corresponds well to the initial data of 3-4-year-olds and 5-6-year-olds, the structure of the factors interrelationships in 5-6-year-old children differs significantly from the one in 3-4-

year-olds. As a result of a measuring model elaboration 7 factors formed 3 groups of symptoms: 1) F1 related to speech development, 2) F2 sensory processes and hyperactivity, 3) F3 social interaction. Causal relationships between three groups of ASD symptoms in 5-6 year-olds with autism were revealed - the higher the symptoms of sensory disintegration (F2) and the lower the level of speech understanding (F1), the higher are symptoms of communication disorders (F3). Apparently sensory disintegration and hyperactivity are the key autistic symptoms for 5-6-year-old children which determine the quality of social interaction and the severity of autistic condition. It is noteworthy that emotional dysregulation contributes to communicative problems, whilst echolalia can be considered as an indicator of speech development and a key overlapping symptom for autistic children of this age. As practical implications of this research, practitioners should pay a special attention to building the strategies for emotion regulation in 5-6-year-olds with ASD along with social skills trainings and consider hyperactivity as an aggravating symptom that worsens the prognosis. Furthermore comprehensive intervention methods aimed at reducing hyperactivity in autistic children should be developed.

Practical implications

According to the results obtained, sensory disintegration and hyperactivity may be considered the key autistic symptoms in 5-6-year-old children with ASD. This problem deserves special attention and the targeted intervention programs need to be elaborated, depending on the predominance of hyperactivity or sensory disintegration symptoms. Since sensory disintegration is one of the key ASD symptoms, a sufficient number of intervention methods have been developed to date, the essence of which is the systematic desensitization of an autistic child, depending on his/her sensory profile (Pfeiffer et al., 2011; Martínez Pérez et al., 2023). For hyperactivity symptoms correction in autistic children two main approaches have been recently adopted. The first one is called collaborative partnerships which are collaborations between kindergartens (schools) and families. Such partnerships have long been recognized as an integral part of the successful assessment and intervention of psychological and behavioral problems in childhood and adolescence (Esler et al., 2008). Collaborative partnerships include the use of common decision-making processes so that assessment and intervention methods take into account the unique characteristics of each child and family's strengths and problems, as well as personal preferences (Liverpool et al., 2021). Collaborative partnerships also provide opportunities for psychoeducation, which includes clarifying to families any potential misconceptions about the child's condition and eliminating problems that hinder intervention effectiveness (Dahl et

al., 2020). There is strong evidence that collaborative partnerships improve family participation in the assessment and intervention of hyperactivity symptoms in autism (Levy et al., 2016; Dawson-Squibb et al., 2020). The second approach is neurodiversity (Schreibman et al., 2015; Sonuga-Barke & Thapar, 2021). Neurodiversity appeared as a group of particularly promising naturalistic interventions that have been shown to have first of all a positive effect on standardized indicators of speech and social communication development (Tiede & Walton, 2019; Sandbank et al., 2020). Within this paradigm, it is believed that environmental adjustment can benefit autistic children by contributing to the improvement of cognitive coping mechanisms associated with acceptance and systematic desensitization (Pellicano & den Houting, 2022; Roberts & Webster, 2022). All models included in the neurodiversity approach have common features and components that are based on both behavior theory and developmental theory. Although neurodiversity includes the behavioral principle of positive reinforcement, at the same time, personal preferences, opinions, motivations, and social relationships are recognized and valued. Components of neurodiversity include the implementation of intervention in vivo, general control between a child and a learning partner, the use of natural contingencies and behavioral strategies to teach skills appropriate to the level of a child's development (Vivanti & Zhong, 2020). Also this approach includes individual goals correction, focusing on learning episodes initiated by the child, using natural reinforcement and motivation of the child, and may include imitation of the child by adults.

Limitations

The 7-factor structure of ASD symptoms was identified in 3-4-year-olds based on 436 hypothetical autism symptoms, i.e. on a significant number of them. This study confirms the relative stability of this structure for 5-6-year-old children with ASD. However, the lack of equivalence between the factors in autistic 3-4- and 5-6-year-olds suggests that these 7 groups of symptoms themselves may undergo some kind of transformation in its content in older age period. We are going to test this assumption at the next stage of the study by adding to the survey questionnaire many other hypothetical symptoms of ASD, presumably inherent in older preschool children. The future study will be supplemented with new hypothetical symptoms of autism, which are noted by experts in 7-8-year-olds, or manifest themselves in activities more typical for children of primary school age, among them communicative competence in learning and leisure time, manifestations of empathy and reflective thinking, cognitive flexibility, cognitive and fine motor skills development as a basis for mastering primary school skills such as reading, writing and counting.

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References

Al-Beltagi M. (2021). Autism medical comorbidities. *World journal of clinical pediatrics*, *10*(3), 15–28. https://doi.org/10.5409/wjcp.v10.i3.15

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders: DSM-5™* (5th ed.). American Psychiatric Publishing.

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2008). The Autism Spectrum Quotient: Children's Version (AQ-Child). *Journal of Autism and Developmental Disorders, 38*, 1230–1240. https://doi.org/10.1007/s10803-007-0504-z

Balasco, L., Provenzano, G., & Bozzi, Y. (2020). Sensory Abnormalities in Autism Spectrum Disorders: A Focus on the Tactile Domain, From Genetic Mouse Models to the Clinic. *Frontiers in psychiatry*, *10*, 1016. https://doi.org/10.3389/fpsyt.2019.01016

Baumer, N. T., Pawlowski, K. G., Amaral, J. L., Zhang, B., Sideridis, G., & Levin, A. R. (2023). Clinically derived 12-factor structure and confirmatory factor analysis of the neurodevelopmental parent report for outcome monitoring. *Frontiers in psychiatry*, *14*, 1243467. https://doi.org/10.3389/fpsyt.2023.1243467

Beck, K. B., Conner, C. M., Breitenfeldt, K. E., Northrup, J. B., White, S. W., & Mazefsky, C. A. (2020). Assessment and Treatment of Emotion Regulation Impairment in Autism Spectrum Disorder Across the Life Span: Current State of the Science and Future Directions. *Child and adolescent psychiatric clinics of North America*, *29*(3), 527–542. https://doi.org/10.1016/j.chc.2020.02.003

Begum, P.S., Razak, M.A., & Rajagopal, S. (2022). *Influence of Amino Acids on Autism and Attention-Deficit Hyperactive Disorder*. In M.W. Qoronfleh, M. M. Essa, C. Saravana Babu (Eds.), *Proteins Associated with Neurodevelopmental Disorders* (pp. 257–276) Springer. https://doi.org/10.1007/978-981-15-9781-7_10

Beopoulos, A., Géa, M., Fasano, A., & Iris, F. (2022). Autism spectrum disorders pathogenesis: Toward a comprehensive model based on neuroanatomic and neurodevelopment considerations. *Frontiers in neuroscience*, *16*, 988735. https://doi.org/10.3389/fnins.2022.988735

Blackburn, C., Tueres, M., Sandanayake, N., Roberts, J., & Sutherland, R. (2023). A systematic review of interventions for echolalia in autistic children. *International journal of language and communication disorders*, *58*(6), 1977–1993. https://doi.org/10.1111/1460-6984.12931

Brierley, N. J., McDonnell, C. G., Parks, K. M. A., Schulz, S. E., Dalal, T. C., Kelley, E., Anagnostou, E., Nicolson, R., Georgiades, S., Crosbie, J., Schachar, R., Liu, X., and Stevenson, R. A. (2021). Factor Structure of Repetitive Behaviors Across Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder. *Journal of autism and developmental disorders*, *51*(10), 3391–3400. https://doi.org/10.1007/s10803-020-04800-0

Brignell, A., May, T., Morgan, A. T., and Williams, K. (2019). Predictors and growth in receptive vocabulary from 4 to 8 years in children with and without autism spectrum disorder: A population-based study. *Autism (London)*, *23*(5), 1322–1334. https://doi.org/10.1177/1362361318801617

Bunford, N., Evans, S. W., & Wymbs, F. (2015). ADHD and Emotion Dysregulation Among Children and Adolescents. *Clinical child and family psychology review*, *18*(3), 185–217. https://doi.org/10.1007/s10567-015-0187-5

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications and programming* (2nd ed). Taylor and Francis.

Chee, Z. J., Scheeren, A. M., & De Vries, M. (2024). The factor structure and measurement invariance of the Autism Spectrum Quotient-28: A cross-cultural comparison between Malaysia and the Netherlands. *Autism (London), 28*(1), 32-42. https://doi.org/10.1177/13623613221147395

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling, 14*(3), 464–504. https://doi.org/10.1080/10705510701301834

Cheung, P. P. P., & Lau, B. W. M. (2020). Neurobiology of sensory processing in autism spectrum disorder. *Progress in molecular biology and translational science*, *173*, 161–181. https://doi.org/10.1016/bs.pmbts.2020.04.020

Cochet, H., & Byrne, R. W. (2016). Communication in the second and third year of life: Relationships between nonverbal social skills and language. *Infant behavior and development*, *44*, 189–198. https://doi.org/10.1016/j.infbeh.2016.07.003

Cohn, E. G., McVilly, K. R., & Harrison, M. J. (2023). Echolalia as defined by parent communication partners. *Autism and developmental language impairments*, *8*, 23969415231151846. https://doi.org/10.1177/23969415231151846

Cohn, E. G., McVilly, K. R., Harrison, M. J., & Stiegler, L. N. (2022). Repeating purposefully: Empowering educators with functional communication models of echolalia in Autism. *Autism and developmental language impairments*, *7*, 23969415221091928. https://doi.org/10.1177/23969415221091928

Constantino, J. N., Gruber, C. P., Davis, S., Hayes, S., Passanante, N., & Przybeck, T. (2004). The factor structure of autistic traits. *Journal of Child Psychology and Psychiatry, 45*(4), 719–726. https://doi.org/10.1111/j.1469-7610.2004.00266.x

Cui, M., Ni, Q., & Wang, Q. (2023). Review of intervention methods for language and communication disorders in children with autism spectrum disorders. *PeerJ*, *11*, e15735. https://doi.org/10.7717/peerj.15735

Dahl, V., Ramakrishnan, A., Spears, A. P., Jorge, A., Lu, J., Bigio, N. A., & Chacko, A. (2020). Psychoeducation interventions for parents and teachers of children and adolescents with ADHD: A systematic review of the literature. *Journal of Developmental and Physical Disabilities, 32*(2), 257–292. https://doi.org/10.1007/s10882-019-09691-3

Dawson-Squibb, J. J., Davids, E. L., Harrison, A. J., Molony, M. A., & de Vries, P. J. (2020). Parent Education and Training for autism spectrum disorders: Scoping the evidence. *Autism: the international journal of research and practice, 24*(1), 7–25. https://doi.org/10.1177/1362361319841739

De Giacomo, A., Craig, F., Palermo, G., Coppola, A., Margari, M., Campanozzi, S., Margari, L., & Turi, M. (2021). Differential Diagnosis in Children with Autistic Symptoms and Subthreshold ADOS Total Score: An Observational Study. *Neuropsychiatric disease and treatment*, *17*, 2163–2172. https://doi.org/10.2147/NDT.S300452

De la Marche, W., Noens, I., Boets, B., Kuppens, S., & Steyaert, J. (2015). The underlying symptom structure of autism spectrum disorders: A factor analytic approach using the developmental, dimensional and diagnostic interview. *Research in Autism Spectrum Disorders, 12,* 40-51. https://doi.org/10.1016/j.rasd.2014.11.002

Dellapiazza, F., Michelon, C., Oreve, M. J., Robel, L., Schoenberger, M., Chatel, C., Vesperini, S., Maffre, T., Schmidt, R., Blanc, N., Vernhet, C., Picot, M. C., Baghdadli, A., & ELENA study group (2020). The Impact of Atypical Sensory Processing on Adaptive Functioning and Maladaptive Behaviors in Autism Spectrum Disorder During Childhood: Results From the ELENA Cohort. *Journal of autism and developmental disorders*, *50*(6), 2142–2152. https://doi.org/10.1007/s10803-019-03970-w

Dell'Osso, L., Lorenzi, P., & Carpita, B. (2019). Autistic Traits and Illness Trajectories. *Clinical practice and epidemiology in mental health*, *15*, 94–98. https://doi.org/10.2174/1745017901915010094

Dell'Osso, L., Massoni, L., Battaglini, S., De Felice, C., Nardi, B., Amatori, G., Cremone, I. M., & Carpita, B. (2023). Emotional dysregulation as a part of the autism spectrum continuum: a literature review from late childhood to adulthood. *Frontiers in psychiatry*, *14*, 1234518. https://doi.org/10.3389/fpsyt.2023.1234518

Eaton, C., Roarty, K., Doval, N., Shetty, S., Goodall, K., & Rhodes, S. M. (2023). The Prevalence of Attention Deficit/Hyperactivity Disorder Symptoms in Children and Adolescents With Autism Spectrum Disorder Without Intellectual Disability: A Systematic Review. *Journal of Attention Disorders, 27*(12), 1360-1376. https://doi.org/10.1177/10870547231177466

Esler, A., Godber, Y., & Christenson, S. L. (2008). *Best practices in supporting school-family partnerships*. In A., Thomas, & J., Grimes (Eds.), *Best practices in school psychology* (Vol. 5, pp. 917-1120). National Association of School Psychologists.

Feldman, J. I., Cassidy, M., Liu, Y., Kirby, A. V., Wallace, M. T., & Woynaroski, T. G. (2020). Relations between Sensory Responsiveness and Features of Autism in Children. *Brain sciences*, *10*(11), 775. https://doi.org/10.3390/brainsci10110775

Fetta, A., Carati, E., Moneti, L., Pignataro, V., Angotti, M., Bardasi, M. C., Cordelli, D. M., Franzoni, E., & Parmeggiani, A. (2021). Relationship between Sensory Alterations and Repetitive Behaviours in Children with Autism Spectrum Disorders: A Parents' Questionnaire Based Study. *Brain sciences*, *11*(4), 484. https://doi.org/10.3390/brainsci11040484

Frazier, T. W., Chetcuti, L., Al-Shaban, F. A., Haslam, N., Ghazal, I., Klingemier, E. W., Aldosari, M., Whitehouse, A. J. O., Youngstrom, E. A., Hardan, A. Y., & Uljarević, M. (2023). Categorical versus dimensional structure of autism spectrum disorder: A multi-method investigation. *JCPP advances*, *3*(2), e12142. https://doi.org/10.1002/jcv2.12142

Frazier, T. W., Ratliff, K. R., Gruber, C., Zhang, Y., Law, P. A., & Constantino, J. N. (2014). Confirmatory factor analytic structure and measurement invariance of quantitative autistic traits measured by the social responsiveness scale-2. *Autism : the international journal of research and practice*, *18*(1), 31–44. https://doi.org/10.1177/1362361313500382

Georgiades, S., Tait, P. A., McNicholas, P. D., Duku, E., Zwaigenbaum, L., Smith, I. M., Bennett, T., Elsabbagh, M., Kerns, C. M., Mirenda, P., Ungar, W. J., Vaillancourt, T., Volden, J., Waddell, C., Zaidman-Zait, A., Gentles, S., & Szatmari, P. (2022). Trajectories of Symptom Severity in Children with Autism: Variability and Turning Points through the Transition to School. *Journal of autism and developmental disorders*, *52*(1), 392–401. https://doi.org/10.1007/s10803-021-04949-2

Gladfelter, A., & VanZuiden, C. (2020). The Influence of Language Context on Repetitive Speech Use in Children With Autism Spectrum Disorder. *American journal of speech-language pathology*, *29*(1), 327–334. https://doi.org/10.1044/2019_AJSLP-19-00003

Gonçalves, A. M., & Monteiro, P. (2023). Autism Spectrum Disorder and auditory sensory alterations: a systematic review on the integrity of cognitive and neuronal functions related to auditory processing. *Journal of neural transmission, 130*(3), 325–408. https://doi.org/10.1007/s00702-023-02595-9

Gormley, E., Ryan, C., & McCusker, C. (2021). Alexithymia is associated with emotion dysregulation in young people with autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 34*, 171-186. https://doi.org/10.1007/s10882-021-09795-9

Green, S. B. (1991). How many subjects does it take to do a regression analysis. *Multivariate behavioral research, 26*(3), 499–510. https://doi.org/10.1207/s15327906mbr2603_7

Happé, F., & Frith, U. (2020). Annual Research Review: Looking back to look forward - changes in the concept of autism and implications for future research. *Journal of child psychology and psychiatry, and allied disciplines*, *61*(3), 218–232. https://doi.org/10.1111/jcpp.13176

Hiruma, L., Pretzel, R. E., Tapia, A. L., Bodfish, J. W., Bradley, C., Wiggins, L., Hsu, M., Lee, L. C., Levy, S. E., & Daniels, J. (2021). A Distinct Three-Factor Structure of Restricted and Repetitive Behaviors in an Epidemiologically Sound Sample of Preschool-Age Children with Autism Spectrum Disorder. *Journal of autism and developmental disorders*, *51*(10), 3456–3468. https://doi.org/10.1007/s10803-020-04776-x

Hoekstra, R. A., Bartels, M., Cath, D. C., & Boomsma, D. I. (2008). Factor structure, reliability and criterion validity of the Autism-Spectrum Quotient (AQ): a study in Dutch population and patient groups. *Journal of autism and developmental disorders, 38*(8), 1555–1566. https://doi.org/10.1007/s10803-008-0538-x

Hours, C., Recasens, C., & Baleyte, J. M. (2022). ASD and ADHD Comorbidity: What Are We Talking About?. *Frontiers in psychiatry*, *13*, 837424. https://doi.org/10.3389/fpsyt.2022.837424

Hus, Y., & Segal, O. (2021). Challenges Surrounding the Diagnosis of Autism in Children. *Neuropsychiatric disease and treatment*, *17*, 3509–3529. https://doi.org/10.2147/NDT.S282569

Jobin A. (2020). Varied treatment response in young children with autism: A relative comparison of structured and naturalistic behavioral approaches. *Autism : the international journal of research and practice*, *24*(2), 338–351. https://doi.org/10.1177/1362361319859726

Kass, R. E., & Raftery, A. E. (1995). Bayes Factors. *Journal of the American Statistical Association, 90*, 773-795. https://doi.org/10.1080/01621459.1995.10476572

Kawashima, M., & Maynard, D. W. (2019). The social organization of echolalia in clinical encounters involving a child diagnosed with autism spectrum disorder. In Lamerichs J., Danby S., Bateman A., Eckberg S. (Eds.), *Children and Mental Health Talk. The Language of Mental Health* (pp. 49–72). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-28426-8_3

Keefer, A., Singh, V., Kalb, L. G., Mazefsky, C. A., & Vasa, R. A. (2020). Investigating the factor structure of the child behavior checklist dysregulation profile in children and adolescents with autism spectrum disorder. *Autism research: official journal of the International Society for Autism Research*, *13*(3), 436–443. https://doi.org/10.1002/aur.2233

Khaledi, H., Aghaz, A., Mohammadi, A., Dadgar, H., & Meftahi, G. H. (2022). The relationship between communication skills, sensory difficulties, & anxiety in children with autism spectrum disorder. *Middle East Current Psychiatry, 29*, 69. https://doi.org/10.1186/s43045-022-00236-7

Kim, H., Keifer, C. M., Rodriguez-Seijas, C., Eaton, N. R., Lerner, M. D., & Gadow, K. D. (2018). Structural hierarchy of autism spectrum disorder symptoms: an integrative framework. *Journal of child psychology and psychiatry, and allied disciplines*, *59*(1), 30–38. https://doi.org/10.1111/jcpp.12698

Kissine, M., Saint-Denis, A., & Mottron, L. (2023). Language acquisition can be truly atypical in autism: Beyond joint attention. *Neuroscience and biobehavioral reviews*, *153*, 105384. https://doi.org/10.1016/j.neubiorev.2023.105384

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3rd ed.). Guilford.

Lanzarini, E., Pruccoli, J., Grimandi, I., Spadoni, C., Angotti, M., Pignataro, V., Sacrato, L., Franzoni, E., & Parmeggiani, A. (2021). Phonic and Motor Stereotypies in Autism Spectrum Disorder: Video Analysis and Neurological Characterization. *Brain sciences*, *11*(4), 431. https://doi.org/10.3390/brainsci11040431

La Valle, C., Plesa-Skwerer, D., & Tager-Flusberg, H. (2020). Comparing the Pragmatic Speech Profiles of Minimally Verbal and Verbally Fluent Individuals with Autism Spectrum Disorder. *Journal of autism and developmental disorders*, *50*(10), 3699–3713. https://doi.org/10.1007/s10803-020-04421-7

Leisman, G., & Melillo, R. (2022). Front and center: Maturational dysregulation of frontal lobe functional neuroanatomic connections in attention deficit hyperactivity disorder. *Frontiers in neuroanatomy*, *16*, 936025. https://doi.org/10.3389/fnana.2022.936025

Levy, S. E., Frasso, R., Colantonio, S., Reed, H., Stein, G., Barg, F. K., Mandell, D. S., & Fiks, A. G. (2016). Shared Decision Making and Treatment Decisions for Young Children With Autism Spectrum Disorder. *Academic pediatrics, 16*(6), 571–578. https://doi.org/10.1016/j.acap.2016.04.007

Liu, Y., Wang, L., Xie, S., Pan, S., Zhao, J., Zou, M., & Sun, C. (2021). Attention Deficit/Hyperactivity Disorder Symptoms Impair Adaptive and Social Function in Children With Autism Spectrum Disorder. *Frontiers in psychiatry*, *12*, 654485. https://doi.org/10.3389/fpsyt.2021.654485

Liverpool, S., Pereira, B., Hayes, D., Wolpert, M., & Edbrooke-Childs, J. (2021). A scoping review and assessment of essential elements of shared decision-making of parent-involved interventions in child and adolescent mental health. *European child & adolescent psychiatry, 30*(9), 1319–1338. https://doi.org/10.1007/s00787-020-01530-7

Lord, C., Brugha, T. S., Charman, T., Cusack, J., Dumas, G., Frazier, T., Jones, E. J. H., Jones, R. M., Pickles, A., State, M. W., Taylor, J. L., & Veenstra-VanderWeele, J. (2020). Autism spectrum disorder. *Nature reviews. Disease primers*, *6*(1), 5. https://doi.org/10.1038/s41572-019-0138-4

Maemonah, S., Hamidah, H., Notobroto, H. B., Sulystiono, D., & Widarti, L. (2021). Factors affecting the ability to speak in children with autism spectrum disorders. *Journal of public health research*, *10*(2), 2236. https://doi.org/10.4081/jphr.2021.2236

Magyar, C. I., & Pandolfi, V. (2007). Factor structure evaluation of the childhood autism rating scale. *Journal of autism and developmental disorders*, *37*(9), 1787–1794. https://doi.org/10.1007/s10803-006-0313-9

Mansour, R., Ward, A. R., Lane, D. M., Loveland, K. A., Aman, M. G., Jerger, S., Schachar, R. J., & Pearson, D. A. (2021). ADHD severity as a predictor of cognitive task performance in children with Autism Spectrum Disorder (ASD). *Research in developmental disabilities*, *111*, 103882. https://doi.org/10.1016/j.ridd.2021.103882

Marotta, R., Risoleo, M. C., Messina, G., Parisi, L., Carotenuto, M., Vetri, L., & Roccella, M. (2020). The Neurochemistry of Autism. *Brain sciences*, *10*(3), 163. https://doi.org/10.3390/brainsci10030163

Martin, J., Hamshere, M. L., O'Donovan, M. C., Rutter, M., & Thapar, A. (2014). Factor structure of autistic traits in children with ADHD. *Journal of autism and developmental disorders*, *44*(1), 204–215. https://doi.org/10.1007/s10803-013-1865-0

Martínez-González, A. E., Cervin, M., & Piqueras, J. A. (2022). Relationships Between Emotion Regulation, Social Communication and Repetitive Behaviors in Autism Spectrum Disorder. *Journal of autism and developmental disorders*, *52*(10), 4519–4527. https://doi.org/10.1007/s10803-021-05340-x

Martínez Pérez, E., Adanero Velasco, A., Gómez Clemente, V., Miegimolle Herrero, M., & Planells Del Pozo, P. (2023). Importance of Desensitization for Autistic Children in Dental Practice. *Children (Basel)*, *10*(5), 796. https://doi.org/10.3390/children10050796

Matson, J.L., Boisjoli, J.A. and Dempsey, T. (2009). Factor Structure of the Autism Spectrum Disorders-Diagnostic for Children (ASD-DC). *Journal of Developmental and Physical Disabilities, 21*, 195–211. https://doi.org/10.1007/s10882-009-9135-y

Mazefsky, C. A., Yu, L., White, S. W., Siegel, M., & Pilkonis, P. A. (2018). The emotion dysregulation inventory: Psychometric properties and item response theory calibration in an autism spectrum disorder sample. *Autism research (Online)*, *11*(6), 928–941. https://doi.org/10.1002/aur.1947

McFayden, T. C., Kennison, S. M., & Bowers, J. M. (2022). Echolalia from a transdiagnostic perspective. *Autism and developmental language impairments*, *7*, 23969415221140464. https://doi.org/10.1177/23969415221140464

Medeiros, K., Mazurek, M. O., & Kanne, S. (2017). Investigating the factor structure of the Child Behavior Checklist in a large sample of children with autism spectrum disorder. *Research in Autism Spectrum Disorders, 40,* 24–40. https://doi.org/10.1016/j.rasd.2017.06.001

Mellahn, O. J., Knott, R., Tiego, J., Kallady, K., Williams, K., Bellgrove, M. A., & Johnson, B. P. (2022). Understanding the Diversity of Pharmacotherapeutic Management of ADHD With Co-occurring Autism: An Australian Cross-Sectional Survey. *Frontiers in psychiatry*, *13*, 914668. https://doi.org/10.3389/fpsyt.2022.914668

Melo, C., Ruano, L., Jorge, J., Pinto Ribeiro, T., Oliveira, G., Azevedo, L., & Temudo, T. (2020). Prevalence and determinants of motor stereotypies in autism spectrum disorder: A systematic review and meta-analysis. *Autism (London)*, *24*(3), 569–590. https://doi.org/10.1177/1362361319869118

Morie, K. P., Jackson, S., Zhai, Z. W., Potenza, M. N., & Dritschel, B. (2019). Mood Disorders in High-Functioning Autism: The Importance of Alexithymia and Emotional Regulation. *Journal of autism and developmental disorders*, *49*(7), 2935–2945. https://doi.org/10.1007/s10803-019-04020-1

Mottron, L., & Gagnon, D. (2023). Prototypical autism: New diagnostic criteria and asymmetrical bifurcation model. *Acta psychologica*, *237*, 103938. https://doi.org/10.1016/j.actpsy.2023.103938

Nasledov, A., Miroshnikov, S., Tkacheva, L., Miroshnik, K., & Semeta, M.U. (2021). Application of Psychometric Approach for ASD Evaluation in Russian 3–4-Year-Olds. *Mathematics, 9*, 1608. https://doi.org/10.3390/math9141608

Nasledov, A., Miroshnikov, S., Tkacheva, L., & Fedorov, S. (2023a). Factor Structure of ASD Symptoms in Russian 3-4-Year-Olds. *OBM Neurobiology, 7*(4), 190; https://doi.org/10.21926/obm.neurobiol.2304190

Nasledov, A., Tkacheva, L., & Miroshnikov, S. (2023b). Factor Structure and Measurement Equivalence of the Autism Scale for Children 3–4 Years Old: Analysis of Binary Data. *Psihologiâ (Moskva, Online), 20*(2), 191–210. https://doi.org/10.17323/1813-8918-2023-2-191-210

Nudel, R., Christiani, C. A. J., Ohland, J., Uddin, M. J., Hemager, N., Ellersgaard, D. V., Spang, K. S., Burton, B. K., Greve, A. N., Gantriis, D. L., Bybjerg-Grauholm, J., Jepsen, J. R. M., Thorup, A. A. E., Mors, O., Nordentoft, M., & Werge, T. (2020). Language deficits in specific language impairment, attention deficit/hyperactivity disorder, and autism spectrum disorder: An analysis of polygenic risk. *Autism research (Online)*, *13*(3), 369–381. https://doi.org/10.1002/aur.2211

Nunes, A. S., Vakorin, V. A., Kozhemiako, N., Peatfield, N., Ribary, U., & Doesburg, S. M. (2020). Atypical age-related changes in cortical thickness in autism spectrum disorder. *Scientific reports*, *10*(1), 11067. https://doi.org/njbh

Nuske, H. J., Hedley, D., Tseng, C. H., Begeer, S., & Dissanayake, C. (2018). Emotion Regulation Strategies in Preschoolers with Autism: Associations with Parent Quality of Life and Family Functioning. *Journal of autism and developmental disorders*, *48*(4), 1287–1300. https://doi.org/10.1007/s10803-017-3391-y

Patra, K. P., & De Jesus, O. (2023). *Echolalia*. StatPearls. https://tinyurl.com/2ym5ytdp

Pecukonis, M., Plesa Skwerer, D., Eggleston, B., Meyer, S., & Tager-Flusberg, H. (2019). Concurrent Social Communication Predictors of Expressive Language in Minimally Verbal Children and Adolescents with Autism Spectrum Disorder. *Journal of autism and developmental disorders*, *49*(9), 3767–3785. https://doi.org/10.1007/s10803-019-04089-8

Pellicano, E., & den Houting, J. (2022). Annual Research Review: Shifting from 'normal science' to neurodiversity in autism science. *Journal of child psychology and psychiatry, and allied disciplines, 63*(4), 381–396. https://doi.org/10.1111/jcpp.13534

Pfeiffer, B. A., Koenig, K., Kinnealey, M., Sheppard, M., & Henderson, L. (2011). Effectiveness of sensory integration interventions in children with autism spectrum disorders: a pilot study. *The American journal of occupational therapy*, *65*(1), 76–85. https://doi.org/10.5014/ajot.2011.09205

Pruccoli, J., Spadoni, C., Orsenigo, A., & Parmeggiani, A. (2021). Should Echolalia Be Considered a Phonic Stereotypy? A Narrative Review. *Brain sciences*, *11*(7), 862. https://doi.org/10.3390/brainsci11070862

Reetzke, R., Singh, V., Hong, J. S., Holingue, C. B., Kalb, L. G., Ludwig, N. N., Menon, D., Pfeiffer, D. L., & Landa, R. J. (2022). Profiles and correlates of language and social communication differences among young autistic children. *Frontiers in psychology*, *13*, 936392. https://doi.org/10.3389/fpsyg.2022.936392

Roberts, J., & Webster, A. (2022). Including students with autism in schools: A whole school approach to improve outcomes for students with autism. *International Journal of Inclusive Education, 26*(7), 701-718. https://doi.org/gg7w74

Robertson, C. E., & Baron-Cohen, S. (2017). Sensory perception in autism. *Nature reviews. Neuroscience*, *18*(11), 671–684. https://doi.org/10.1038/nrn.2017.112

Roestorf, A., Howlin, P., & Bowler, D. M. (2022). Ageing and autism: A longitudinal follow-up study of mental health and quality of life in autistic adults. *Frontiers in psychology*, *13*, 741213. https://doi.org/10.3389/fpsyg.2022.741213

Rong Y., Yang C.-J., Jin Y., & Wang Y. (2021). Prevalence of attention-deficit/hyperactivity disorder in individuals with autism spectrum disorder: A meta-analysis. *Research in Autism Spectrum Disorders*, *83*, 101759. https://doi.org/10.1016/j.rasd.2021.101759

Rosello, B., Berenguer, C., Baixauli, I., Colomer, C., & Miranda, A. (2018). ADHD symptoms and learning behaviors in children with ASD without intellectual disability. A mediation analysis of executive functions. *PloS one*, *13*(11), e0207286. https://doi.org/10.1371/journal.pone.0207286

Ryan, S., Roberts, J., & Beamish W. (2022) Echolalia in Autism: A Scoping Review. *International Journal of Disability, Development and Education*, https://doi.org/10.1080/1034912X.2022.2154324

Sandbank, M., Bottema-Beutel, K., Crowley, S., Cassidy, M., Dunham, K., Feldman, J. I., Crank, J., Albarran, S. A., Raj, S., Mahbub, P., & Woynaroski, T. G. (2020). Project AIM: Autism intervention meta-analysis for studies of young children. *Psychological bulletin, 146*(1), 1–29. https://doi.org/10.1037/bul0000215

Sandbank, M., Bottema-Beutel, K., Crowley, S., Cassidy, M., Feldman, J. I., Canihuante, M., & Woynaroski, T. (2020). Intervention Effects on Language in Children With Autism: A Project AIM Meta-Analysis. *Journal of speech, language, and hearing research*, *63*(5), 1537–1560. https://doi.org/10.1044/2020_JSLHR-19-00167

Schachar, R. J., Dupuis, A., Arnold, P. D., Anagnostou, E., Kelley, E., Georgiades, S., Nicolson, R., Townes, P., Burton, C. L., & Crosbie, J. (2023). Autism Spectrum Disorder and Attention-Deficit/Hyperactivity Disorder: Shared or Unique Neurocognitive Profiles?. *Research on child and adolescent psychopathology*, *51*(1), 17–31. https://doi.org/10.1007/s10802-022-00958-6

Schaeffer, J., Abd El-Raziq, M., Castroviejo, E., Durrleman, S., Ferré, S., Grama, I., Hendriks, P., Kissine, M., Manenti, M., Marinis, T., Meir, N., Novogrodsky, R., Perovic, A., Panzeri, F., Silleresi, S., Sukenik, N., Vicente, A., Zebib, R., Prévost, P., & Tuller, L. (2023). Language in autism: domains, profiles and co-occurring conditions. *Journal of neural transmission*, *130*(3), 433–457. https://doi.org/10.1007/s00702-023-02592-y

Schreibman, L., Dawson, G., Stahmer, A. C., Landa, R., Rogers, S. J., McGee, G. G., Kasari, C., Ingersoll, B., Kaiser, A. P., Bruinsma, Y., McNerney, E., Wetherby, A., & Halladay, A. (2015). Naturalistic Developmental Behavioral Interventions: Empirically Validated Treatments for Autism Spectrum Disorder. *Journal of autism and developmental disorders, 45*(8), 2411–2428. https://doi.org/10.1007/s10803-015-2407-8

Schwartzman, B. C., Wood, J. J., & Kapp, S. K. (2016). Can the Five Factor Model of Personality Account for the Variability of Autism Symptom Expression? Multivariate Approaches to Behavioral Phenotyping in Adult Autism Spectrum Disorder. *Journal of autism and developmental disorders*, *46*(1), 253–272. https://doi.org/10.1007/s10803-015-2571-x

Sonuga-Barke, E., & Thapar, A. (2021). The neurodiversity concept: is it helpful for clinicians and scientists?. *The lancet. Psychiatry, 8*(7), 559–561. https://doi.org/10.1016/S2215-0366(21)00167-X

Sturrock, A., Chilton, H., Foy, K., Freed, J., & Adams, C. (2022). In their own words: The impact of subtle language and communication difficulties as described by autistic girls and boys without intellectual disability. *Autism (London)*, *26*(2), 332–345. https://doi.org/10.1177/13623613211002047

Steenfeldt-Kristensen, C., Jones, C. A., & Richards, C. (2020). The Prevalence of Self-injurious Behaviour in Autism: A Meta-analytic Study. *Journal of autism and developmental disorders*, *50*(11), 3857–3873. https://doi.org/10.1007/s10803-020-04443-1

Tafaroji, Y. M., & Kamari, E. (2020). Investigating mean length of utterance (MLU) in monolingual Persian speaking children with autism spectrum disorder (ASD*). International Journal of Health Studies, 6*(2), 15–23. https://doi.org/10.22100/ijhs.v6i2.743

Tiede, G., & Walton, K. M. (2019). Meta-analysis of naturalistic developmental behavioral interventions for young children with autism spectrum disorder. *Autism (London), 23*(8), 2080–2095. https://doi.org/10.1177/1362361319836371

Tillmann, J., Uljarevic, M., Crawley, D., Dumas, G., Loth, E., Murphy, D., Buitelaar, J., Charman, T., & the AIMS-2-TRIALS LEAP group (2020). Dissecting the phenotypic heterogeneity in sensory features in autism spectrum disorder: a factor mixture modelling approach. *Molecular Autism, 11,* 67. https://doi.org/10.1186/s13229-020-00367-w

Torenvliet, C., Groenman, A. P., Radhoe, T. A., Agelink van Rentergem, J. A., Van der Putten, W. J., & Geurts, H. M. (2023). A longitudinal study on cognitive aging in autism. *Psychiatry research*, *321*, 115063. https://doi.org/10.1016/j.psychres.2023.115063

Tsamitrou, S., & Plumet, M. H. (2024). The importance and challenges of observing social interactions in autistic preschoolers during inclusive educational settings: A scoping review. *Autism and developmental language impairments*, *9*, 23969415241227077. https://doi.org/10.1177/23969415241227077

Vinen, Z., Clark, M., & Dissanayake, C. (2023). Social and Behavioural Outcomes of School Aged Autistic Children Who Received Community-Based Early Interventions. *Journal of autism and developmental disorders*, *53*(5), 1809–1820. https://doi.org/10.1007/s10803-022-05477-3

Vivanti, G., & Zhong, H. N. (2020). *Naturalistic developmental behavioral interventions for children with autism*. In G. Vivanti, K. Bottema-Beutel & L. Turner-Brown (Eds.), *Clinical guide to early interventions for children with autism* (pp. 93–130). Springer Nature. https://doi.org/10.1007/978-3-030-41160-2_6

Vogindroukas, I., Stankova, M., Chelas, E. N., & Proedrou, A. (2022). Language and Speech Characteristics in Autism. *Neuropsychiatric disease and treatment*, *18*, 2367–2377. https://doi.org/10.2147/NDT.S331987

Waizbard-Bartov, E., Ferrer, E., Heath, B., Rogers, S. J., Nordahl, C. W., Solomon, M., & Amaral, D. G. (2022). Identifying autism symptom severity trajectories across childhood. *Autism research (Online)*, *15*(4), 687–701. https://doi.org/10.1002/aur.2674

Wall, C. A., Shic, F., Varanasi, S., & Roberts, J. E. (2023). Distinct social attention profiles in preschoolers with autism contrasted to fragile X syndrome. *Autism research (Online)*, *16*(2), 340–354. https://doi.org/10.1002/aur.2857

Williams, Z. J., He, J. L., Cascio, C. J., & Woynaroski, T. G. (2021). A review of decreased sound tolerance in autism: Definitions, phenomenology, and potential mechanisms. *Neuroscience and biobehavioral reviews*, *121*, 1–17. https://doi.org/10.1016/j.neubiorev.2020.11.030

Williams, D. L., Siegel, M., Mazefsky, C. A., & Autism and Developmental Disorders Inpatient Research Collaborative (ADDIRC) (2018). Problem Behaviors in Autism Spectrum Disorder: Association with Verbal Ability and Adapting/Coping Skills. *Journal of autism and developmental disorders*, *48*(11), 3668–3677. https://doi.org/10.1007/s10803-017-3179-0

Wolff, J. C., Thompson, E., Thomas, S. A., Nesi, J., Bettis, A. H., Ransford, B., Scopelliti, K., Frazier, E. A., & Liu, R. T. (2019). Emotion dysregulation and non-suicidal self-injury: A systematic review and meta-analysis. *European psychiatry*, *59*, 25–36. https://doi.org/10.1016/j.eurpsy.2019.03.004

World Health Organization. (2022). International Classification of Diseases Eleventh Revision (ICD-11). World Health Organization. https://tinyurl.com/mu4bem7s

Wozniak, R. H., Leezenbaum, N. B., Northrup, J. B., West, K. L., & Iverson, J. M. (2017). The development of autism spectrum disorders: variability and causal complexity. *Wiley interdisciplinary reviews. Cognitive science (Online)*, *8*(1-2). https://doi.org/f9jx72

Xie, F., Pascual, E., & Oakley, T. (2023). Functional echolalia in autism speech: Verbal formulae and repeated prior utterances as communicative and cognitive strategies. *Frontiers in psychology*, *14*, 1010615. https://doi.org/10.3389/fpsyg.2023.1010615

Yoshimura, Y., Hasegawa, C., Tanaka, S., Ikeda, T., Yaoi, K., Iwasaki, S., An, K., & Kikuchi, M. (2022). Altered sensory integration from body and language development in children with autism spectrum disorder. *Psychiatry and Clinical Neurosciences Reports,* 1, e64. https://doi.org/10.1002/pcn5.64

Young, S., Hollingdale, J., Absoud, M., Bolton, P., Branney, P., Colley, W., Craze, E., Dave, M., Deeley, Q., Farrag, E., Gudjonsson, G., Hill, P., Liang, H. L., Murphy, C., Mackintosh, P., Murin, M., O'Regan, F., Ougrin, D., Rios, P., Stover, N., Taylor, E., & Woodhouse, E. (2020). Guidance for identification and treatment of individuals with attention deficit/hyperactivity disorder and autism spectrum disorder based upon expert consensus. *BMC medicine*, *18*(1), 146. https://doi.org/10.1186/s12916-020-01585-y

Zain, E., Fukui, N., Watanabe, Y., Hashijiri, K., Motegi, T., Ogawa, M., Egawa, J., Nishijima, K., & Someya, T. (2023). The three-factor structure of the Autism-Spectrum Quotient Japanese version in pregnant women. *Frontiers in psychiatry*, *14*, 1275043. https://doi.org/10.3389/fpsyt.2023.1275043

Zeng, H., Liu, S., Huang, R., Zhou, Y., Tang, J., Xie, J., Chen, P., & Yang, B. X. (2021). Effect of the TEACCH program on the rehabilitation of preschool children with autistic spectrum disorder: A randomized controlled trial. *Journal of psychiatric research*, *138*, 420–427. https://doi.org/10.1016/j.jpsychires.2021.04.025

Zhu, Y., Mu, W., Chirica, M. G., & Berenbaum, H. (2022). Testing a theory-driven factor structure of the autism-spectrum quotient. *Autism research (Online)*, *15*(9), 1710–1718. https://doi.org/10.1002/aur.2763

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Nasledov, A., Tkacheva, L., & Miroshnikov, S. (2024). 7-factor model of autism symptoms in 3-6-year-olds: Age-related changes. *Terapia Psicológica (En línea)*, *42*(3), 379-414. https://doi.org/10.4067/S0718-48082024000300379