Trends in Psychiatry and Psychotherapy

Original Article

Emotion comprehension and sociocognitive skills in children with high functioning autism spectrum disorders

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Abstract

Objective: This study aimed to compare sociocognitive skills and emotion comprehension between children with autism spectrum disorder (ASD) and children with neurotypical development.
Methods: This quantitative, cross-sectional, controlled study involved 19 children in each group, matched by age (6-12 years) and sex. The assessments examined cognitive aspects (Intelligence Quotient was assessed using the Vocabulary and Matrix Reasoning subtests; working memory using the digit span and letter-number sequencing subtests; attention using the Continuous Performance Test – Identical Pairs; and executive functions using the Trail Making Test), social functions (Children's Social Skills, Behavior Problems, and Academic Competence Inventory), and emotion comprehension (language was assessed using the Strange Stories Test; emotional facial expressions using the digital emotion comprehension test; emotional/affective prosody using the Profiling Elements of Prosody in Speech-Communication – Brazilian Portuguese adapted version).
Results: The group with ASD exhibited better performance in executive functions ($p = 0.02$). However, they lagged the control group in social skills ($p = 0.04$), behavior problems ($p = 0.03$), and emotion comprehension (language, facial expressions, and prosody) (all $p < 0.05$).
Conclusion: The findings indicate that children with ASD have diminished performance in social skills and emotion comprehension compared to children with neurotypical development. Therefore, the development of technologies and/or therapeutic interventions that address these deficits among children with ASD is recommended.
Keywords: Autism spectrum disorder, social skills, cognition, facial recognition, voice recognition.

Introduction

Autistic spectrum disorder (ASD) is a neurodevelopmental disorder characterized by difficulties in communication and social interaction. Furthermore, ASD includes the presence of stereotypes, restricted interests, and repetitive behaviors[1] that first manifest usually during early childhood, including various emotional, cognitive, motor, and sensory symptoms.[2] Although its etiology is unknown, multifactorial causes, such as genetic factors, gestational risks, and environmental risks, may affect an individual's functional aspects.[1,2]

Cognitive performance in individuals with ASD is not homogeneous and varies based on the severity of their symptoms.[3,4] Furthermore, factors, such as average intelligence quotient (IQ) and the development of language at an expected age, serve as prognostic indicators, which suggest a higher likelihood of development within the typical range.[2,5] Intellectual functioning is a crucial factor in diagnosing high-functioning ASD and is used for differential diagnosis.[6]

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Some studies indicated that the nuances of cognitive development in ASD influenced social and communicative skills, particularly the recognition and management of emotions. In ASD, emotion comprehension directly impacted interpersonal interactions.[7-9] Even for those with ASD with intact cognitive functions, grasping and understanding emotions could pose a considerable challenge. The ability to discern emotions – both one's own and those of others – played an important role in behavior regulation and enhanced environmental perception and decision-making processes.[10] Studies established that difficulties in maintaining eye contact impaired the recognition and management of emotions.[11] This was especially true concerning understanding certain emotional facial expressions and the assessment of facial cues related to emotion.[12,13] Although there were variation among studies that assessed differences in facial expressiveness between individuals with neurodivergent and neurotypical development, emotional facial expressions exhibited by individuals diagnosed with ASD were less precise than those of individuals with neurotypical development.[12,14,15] Furthermore, prosody was important in the context of ASD. Some studies suggest that individuals with ASD often faced challenges in both understanding and producing emotional prosody.[16-18]

Few studies have examined emotional prosody, particularly in children with ASD. This is due to the unique characteristics of neurodevelopment and rare occurrence of the disorder in the absence of associated intellectual disability.[1,19] Consequently, the significance and importance of this study for the pediatric population were highlighted. This study aimed to compare emotion comprehension and sociocognitive skills between children diagnosed with high functioning autism spectrum disorder (ASD) (without an associated intellectual deficit) who could communicate orally and children with neurotypical development. Children with high Functioning ASD will exhibit significantly different sociocognitive skills and emotion comprehension abilities compared to children with neurotypical development. Specifically, it is expected that children with ASD will demonstrate stronger executive functions but will have greater difficulties in social skills, behavior problems, and emotion comprehension, including recognizing and interpreting emotional facial expressions and prosody.

Methodology

Characterization of the study

This cross-sectional, quantitative study adhered to the guidelines set in the Declaration of Helsinki and its future amendments that pertained to ethical principles, legitimacy of information, and data privacy and confidentiality. The project was approved by the relevant research ethics committee. All participants and their parents or guardians provided written informed consent.

Participants

Children aged 6-12 years diagnosed with ASD according to the Statistical Manual of Mental Disorders Fifth Edition (DSM-V), with diagnoses confirmed by the investigator, were included. For the control group, children with neurotypical development who were verbal and had school affiliations within the same age range were included. These two groups were age- and sex-matched. Exclusion criteria for both groups included the presence of an intellectual deficit, diagnosis of another neurodevelopmental disorder, any associated neuropsychiatric diagnosis, and lack of oral communication. The initial evaluation involved 65 volunteers, with 19 in the study group (children with ASD) and 19 in the control group (neurotypical development). Other 27 were excluded due to an IQ of less than 70 (21 individuals), age and sex mismatch (five female volunteers), and suspicion of a possible neuropsychiatric disorder in one male participant. Consequently, the sample was determined for convenience, sourced from the community and publicized through social media, public education system, and basic health units.

Assessment instruments

Data were collected in-person from each child. Consent was obtained from the parents or guardians and participants via a signed Informed Consent Form (ICF) and Informed Assent Form (IAF). A sociodemographic questionnaire was presented to the parents or guardians, and the participants were directed to the assessments. These assessments were conducted by qualified psychologists, psychology students who received appropriate training, and a speech therapist familiar with the assessment tools. See Table 1 for the assessment tools.

Statistical analysis

A Shapiro-Wilk test was used to assess normality. A chi-squared test was used to compare categorical variables for sociodemographic and clinical differences between the groups. Furthermore, a t-test was used to compare the continuous parametric variables. A Mann-Whitney U test and Wilcoxon signed-rank test were used to analyze non-parametric variables. Descriptive data were presented as either mean and standard deviation

(MD±SD) or median and interquartile range (IQR; 1st quartile-3rd quartile), based on the data's normality. A p-value of < 0.05 (two-tailed) was considered statistically significant. However, for tests related to emotion comprehension, a p-value of < 0.0013 was considered significant, based on Bonferroni's correction (0.05/no. of tests) to minimize the chance of false-positive results. All statistical analyses were conducted using the IBM SPSS Statistics version 25.0.

Results

A total of 68.4% of children with atypical development were undergoing drug treatment, while no typical children were on such treatment. Every participant with ASD received some form of non-pharmacological treatment, including speech therapy (26.3%), occupational therapy (31.5%), psychotherapy (89.5%), and complementary therapies (78.9%). Of these, 94.7% received treatment weekly, and 5.3% fortnightly. Only 10.5% of neurotypical participants were undergoing psychotherapy, either weekly or fortnightly.

Regarding sociodemographic data (Table 2), parents of children with neurotypical development (from the evaluated population) had a lower educational level ($p = 0.002$). For other sociodemographic variables (sex, age, family income, and educational level of the participants), no significant differences were observed between the groups.

Regarding executive functions, children with ASD performed better on the TMT-B and made fewer errors ($p = 0.02$) than children with neurotypical development (Table 3). No significant differences were observed in the other variables.

Regarding social skills, there was a significant difference only in social resourcefulness ($p = 0.045$) between the groups (Table 4). There was also a statistical significance in the variable Behavior Problems – Percentile ($p = 0.03$) (Table 4). For both variables, the ASD group performed worse.

Significant differences were observed in the assessment of understanding emotion from facial expressions (Table 5), both in the Digital TEC variable – raw score **(**$p = 0.006$) and percentile ($p = 0.006$). The Strange Stories Test also demonstrated statistical significance ($p = 0.001$). In the assessment of understanding emotional prosody via the Affect Receiving Ability Test of the PEPS-C BR ($p = 0.001$) (Table 5), differences were observed between the groups. The ASD group had lower scores and means in all these parameters.

Table 1 - Assessment tools

Assessment tool	Purpose
Wechsler Abbreviated Intelligence Scale (WASI)[20]	Assessment of intelligence; measurement of both verbal and non-verbal aspects; utilized as a screening tool for estimating IQ.
Continuous Performance Test – Identical Pairs (CPT-IP)[21]	Assesses sustained attention; records response accuracy, omissions, and reaction times.
Trail Making Test (TMT)[22]	Evaluates executive functions, cognitive flexibility, inhibition, attention, and processing speed.
Digits Subtest of the Wechsler Intelligence Scale for Children (WISC-IV)[23]	Assesses attention and working memory through sequence repetition tasks.
Numbers and Letters Sequence Subtest of the Wechsler Intelligence Scale for Children (WISC-IV)[23]	Measures working memory; requires participants to repeat and arrange verbal stimuli.
Children's Social Skills, Behavior Problems, and Academic Competence Inventory (SSRS)[24]	Assesses children's social skills, behavior problems, and academic competence through parent/guardian input.
Strange Stories Test[25]	Assesses oral language comprehension and understanding of various emotional aspects.
Test of Emotion Comprehension (TEC Digital)[26]	Evaluates comprehension of emotions across nine components, including facial expression recognition and emotion regulation.
Profiling Elements of Prosody in Speech-Communication (PEPS-C BR)[27]	Assesses receptive emotional prosody, testing the ability to receive and understand emotions through speech.

Table 2 - Participants' sociodemographic data

Variable	ASD (n = 19)	Control (n = 19)	Statistic	p-value
Male sex, n (%)	17 (89.5)	17 (89.5)	$\chi^2_{(df)} = 1_{(0)}$	1
Age, median (IQR)	9 (7-10)	9 (7-10)	z = -0.26	0.79
Ethnicity, n (%)	19 (100)	19 (100)	$\chi^2_{(df)} = 2.11_{(2)}$	0.34
White	15 (78.9)	11 (57.9)		
Brown	3 (15.8)	5 (26.3)		
Black	1 (5.3)	3 (15.8)		
Educational level, n (%)	19 (100)	19 (100)	$\chi^2_{(df)} = 1.97_{(6)}$	0.92
1st grade	2 (10.5)	1 (5.3)		
2nd grade	5 (26.3)	5 (26.3)		
3rd grade	2 (10.5)	3 (15.8)		
4th grade	4 (21.1)	5 (26.3)		
5th grade	3 (15.8)	1 (5.3)		
6th grade	2 (10.5)	2 (10.5)		
7th grade	1 (5.3)	2 (10.5)		
Educational level of adults in the family – in years of study, median (IQR)	15 (11-17)	11 (9-15)	z = -3.0	**0.002**
Number of family members, median (IQR)	4 (3-4)	4 (4-5)	z = -1.85	0.06
Family income – in reais (R$), median (IQR)	5000 (4000-7000)	3500 (2000-8000)	z = -0.62	0.53

ASD = autism spectrum disorder; df = degrees of freedom; IQR = interquartile range (1st range-3rd range).

Table 3 - Data on assessments of cognitive aspects

Variable	ASD (n = 19)	Control (n = 19)	Statistic	p-value
Digits – T score, mean ± SD	7.53±4.23	9.26±3.14	$t_{(df)} = -1.33_{(18)}$	0.20
Sequence of numbers and letters – weighted score, mean ± SD	7.89±2.54	9.26±4.21	$t_{(df)} = -1.12_{(17)}$	0.28
IQ, median (IQR)	95 (83-109)	91 (84-114)	z = -0.24	0.811
CPT-IP total score, median (IQR)	0.21 (0-0.69)	0.52 (0.21-1.12)	z = -1.4	0.12
TMT-A (time in seconds), median (IQR)	60 (44-90)	61 (48-72)	z = -0.42	0.67
TMT-A (errors), median (IQR)	1 (0-3)	1 (0-4)	z = -0.08	0.93
TMT-B (time in seconds), median (IQR)	157 (113.5-280.5)	300 (130-300)	z = -1.42	0.15
TMT-B (errors), median (IQR)	2 (0.5-8)	15 (2-32)	z = -2.33	**0.02**

ASD = autism spectrum disorder; CPT-IP = Continuous Performance Test – Identical Pairs; df = degrees of freedom; Digits = Subtest of the Wechsler Abbreviated Scale of Intelligence; IQ = intelligence quotient; IQR = interquartile range (1st range-3rd range); SD = standard deviation; Sequence of numbers and letters = Subtest of the Wechsler Intelligence Scale for Children; TMB-A = Trail Making Test – Test A; TMB-B = Trail Making Test – Test B.

Table 4 - Data on assessments of social skills and behavior problems

Variable	ASD (n = 19)	Control (n = 19)	Statistic	p-value
SSRS Social Skills – social resourcefulness, median (IQR)	5 (3-6)	6 (4-6)	z = -2	**0.045**
SSRS Social Skills – percentile, median (IQR)	35 (25-65)	65 (40-75)	z = -1.87	0.06
SSRS Behavior Problems – percentile, mean ± SD	52.37±19.32	40.68±14.64	$t_{(df)} = 2.24_{(18)}$	**0.03**

ASD = autism spectrum disorder; df = degrees of freedom; IQR = interquartile range (1st range-3rd range); SD = standard deviation; SSRS = Children's Social Skills, Behavior Problems, and Academic Competence Inventory.

Table 5 - Data on the assessment of emotion comprehension

Variable	ASD (n = 19)	Control (n = 19)	Statistic	p-value
TEC Digital – raw score, mean ± SD	22.05±4.66	25.26±1.44	$t_{(df)} = -3.14_{(18)}$	**0.006**
TEC Digital – percentile, mean ± SD	78.75±16.64	90.22±5.16	$t_{(df)} = -3.14_{(18)}$	**0.006**
Strange Stories Test – total score, median (IQR)	17 (14-20)	22 (20-23)	z = -3.27	**0.001**
PEPSC-BR (Affect Receiving Ability Test) – overall score, median (IQR)	12 (10-14)	15 (12-16)	z = -2.52	**0.01**

df = degrees of freedom; IQR = interquartile range (1st range-3rd range); SD = standard deviation; TEC Digital = Test of Emotion Comprehension; PEPS-C BR = Profiling Elements of Prosody in Speech-Communication (Brazilian Portuguese adapted version).

Discussion

This study examined sociocognitive aspects and emotion comprehension in pediatric patients with high-functioning ASD compared to a group with neurotypical development. This focus differentiated our research from previously studies as they did not explore this specific aspect.[8,15,28,29] The significance of this assessment lay in the clinical domain, as cognitive development was potentially associated with social and communicative skills. Although cognitive functions were preserved in high-functioning individuals, their ability to identify, control, and understand emotions could be compromised. Such impairments directly influenced social interactions,[7-9] as recognizing emotions – both one's own and those of others – played an important role in decision-making process, environmental perception, and behavioral regulation.[10] Additionally, emotional facial expressions exhibited by individuals diagnosed with ASD were less precise than those of individuals with neurotypical development.[12,14,15] This difference could be crucial in emotion perception and comprehension.

In the assessment of cognitive aspects, only the executive function assessment (TMT – B errors) indicated differences, showing that children with ASD performed better than the control group. This test incorporated numbers and letters, which were often areas of hyperfocus for children with ASD, which frequently manifested as hyperlexia.[30,31] Hyperfocus is a phenomenon where an individual becomes entirely engrossed in a task, to the extent that they disregard or completely "disconnect" from everything else.[32] In this study, the ASD group made fewer errors than the control group in the TMT-B test. This could be attributed to the hyperfocus phenomenon, which channeled attention towards areas of interest for most children with ASD, coupled with a potential proficiency with letters and numbers.[30] Concerning social skills and behavior problems, the data in this study aligned with previous research that suggested that individuals with ASD struggled with communication processes and interpersonal interactions.[6] Challenges related to social resourcefulness and behavior problems in ASD were associated with deficits in discerning intentions, needs, and emotions of others. This could be detected through tests that assessed the Theory of Mind,[6,32,33] which involved the capability to understand, visualize, and interpret the mental states of others via meta-representation and metacognition.[6,32,33] Our findings supported the results of a previous study[29] that involved an adult population diagnosed with high-functioning autism spectrum disorder (ASD). This earlier study demonstrated that while cognitive and social skills were maintained, there was a decline in understanding emotional facial expressions and differences in the reproduction of prosody (despite a good understanding of its emotional content). Furthermore, prosody was important in the context of ASD, as some studies suggested that individuals with ASD often faced challenges in both understanding and producing emotional prosody.[16-18]

In the assessment of emotion comprehension through language skills via the Strange Stories Test, children with atypical development faced more challenges, especially when it came to figures of speech, jokes, and the distinction between appearance and reality. These findings were consistent with earlier studies that showed that children diagnosed with ASD struggled with language skills, which included syntax.[8,34] Such impairment was anticipated and could be attributed to the nature of the test used, as the Strange Stories Test required understanding of social contexts,[19,25] a known area of deficit in ASD.

A decrease in the mean score for the Digital TEC related to task analysis was observed both in raw scores and percentiles within the ASD group, which represented the relationship between imagination and language.[12] The limited ability or difficulty in imagining was connected to challenges in perceiving and understanding non-verbal elements, which included emotional facial expressions.[11,35] These findings supported a literature review study that suggested that individuals with ASD processed facial information slowly. This meant that the fewer and lower-quality facial movements they observed, the more likely they were to interpret the facial expression as neutral.[15] Furthermore, significant statistical results were found when emotional prosody was assessed via the PEPS-C BR (Affect Receiving Ability Test). Children with atypical development were more inclined to assert that a female voice conveyed a positive emotion, even when it did not. Furthermore, they recognized a male voice as having a "negative tone," even when it conveyed a positive emotion. In contrast, the control group displayed a better understanding of the audible emotions in the task. This finding was consistent with other studies that highlighted the challenge in understanding syntax and emotional prosody among individuals with ASD.[7,8,16,17,29]

Understanding emotional contexts can be challenging for individuals with high-functioning autism spectrum disorder (ASD) due to difficulties in communication and imagination, which can lead to an absence of or challenges in processing emotions and ideas.[29] However, certain tests, such as the "TMT-B errors," showed that individuals with ASD performed better than individuals with neurotypical development.

This suggested that the TMT-B errors test might not be the best test to assess executive functions in this population, especially as hyperfocus might skew the actual implications. Yet, it also indicated that a deficit in cognitive processing might not always be present in ASD, given that there was no statistical difference in other parameters that assessed cognitive function. Furthermore, this improved performance could be attributed to several factors, which included the therapeutic interventions these children undergo and their duration (frequency and years).[10,33,35] This was indicative that synaptic plasticity translated to clinical improvement as stimulation of these skills was crucial for the child's development.[10,18,33]

This study revealed that cognitive aspects were generally consistent across both groups, with the exception of TMT-B errors. Furthermore, the ASD group showed diminished social resourcefulness and a higher prevalence of behavioral problems. Regarding emotion comprehension, children with ASD exhibited challenges in interpreting emotional facial expressions, especially during mixed-emotion situations. They also struggled to understand emotional aspects related to social contexts and had difficulty understanding emotional prosody. These findings suggested that children with ASD required regular assessments and specific stimuli.

This study had limitations concerning its sample size and instruments used. We had a modest sample size, and our findings will need to be replicated in larger samples. While the sample size was chosen for convenience, it only met the minimum requirements for sample pairing. Additionally, the instruments used were not yet standardized for the target population (individuals diagnosed with ASD). Despite these limitations, the significance of this study for the pediatric audience cannot be overstated as limited studies have addressed this topic, particularly within this population. This was due to the inherent characteristics of neurodevelopment and challenges of conducting research with children already diagnosed with ASD without associated intellectual disabilities.

Conclusion

Based on our findings, we concluded that children with ASD exhibited deficits in social skills and emotion comprehension when compared to a control group of children with neurotypical development of similar age and sex. Future research on this topic, especially with a pediatric population should be done to explore the differences among patients with varying degrees of impairment concerning the emotional facial expressions displayed by both individuals with typical and atypical development. Furthermore, studies should also examine their subsequent comprehension of these expressions as well as their production and comprehension of emotional prosody. We also suggest the development of interventions tailored to enhance these skills among those with ASD. These interventions might employ various strategies, such as replicating/imitating emotional facial expressions and enhancing auditory skills through audible emotional content within a social framework.

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Disclosure

No conflicts of interest declared concerning the publication of this article.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author upon the reasonable request. The data are not publicly available due to privacy or ethical restrictions.

Author contributions

Vitoria Santos Santana: Conceptualization, Investigation, Project administration, Writing - original draft
Josemar Marchezan: Conceptualization, Supervision, Writing - original draft
Denise Bisolo Scheibe: Data curation
Joana Bücker: Conceptualization, Formal analysis, Supervision
All authors have read and approved of the final version to be published.

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